

WITH VITALSOURCE®  
EBOOK



# HUMAN SECTIONAL ANATOMY

Atlas of body sections, CT and MRI images

HAROLD ELLIS • BARI M LOGAN • ADRIAN K DIXON • DAVID J BOWDEN

 CRC Press  
Taylor & Francis Group

FOURTH EDITION

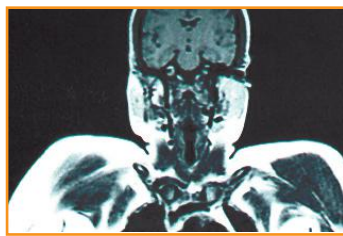
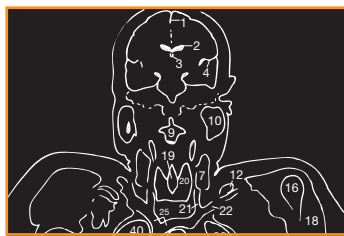
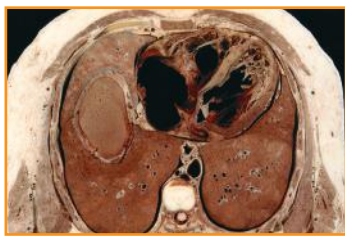
# HUMAN SECTIONAL ANATOMY

This page intentionally left blank

# HUMAN SECTIONAL ANATOMY

Atlas of body sections, CT and MRI images

FOURTH EDITION



HAROLD ELLIS

CBE MA DM MCh FRCS FRCOG

Professor  
Applied Clinical Anatomy Group  
Applied Biomedical Research  
Guy's Hospital  
London, UK

BARI M LOGAN

MA FMA Hon MBIE MAMAA

Formerly University Prosector  
Department of Anatomy  
University of Cambridge  
Cambridge, UK  
*and*  
Formerly Prosector  
Department of Anatomy  
The Royal College of Surgeons of England  
London, UK

ADRIAN K DIXON

MD FRCP FRCR FRCS FMedSci

Emeritus Professor  
Department of Radiology  
University of Cambridge  
*and*  
Honorary Consultant Radiologist  
Addenbrooke's Hospital  
Cambridge, UK  
*and*  
Master, Peterhouse  
University of Cambridge  
Cambridge, UK

DAVID J BOWDEN

MA VetMB MB BChir FRCR

Abdominal Imaging Fellow  
Department of Medical Imaging  
Sunnybrook Health Sciences Centre  
Toronto, Canada  
*and*  
Formerly Teaching Bye-Fellow  
Christ's College  
University of Cambridge  
Cambridge, UK

 **CRC Press**  
Taylor & Francis Group  
Boca Raton London New York

CRC Press is an imprint of the  
Taylor & Francis Group, an **informa** business

CRC Press  
Taylor & Francis Group  
6000 Broken Sound Parkway NW, Suite 300  
Boca Raton, FL 33487-2742

© 2015 by Taylor & Francis Group, LLC  
CRC Press is an imprint of Taylor & Francis Group, an Informa business

No claim to original U.S. Government works  
Version Date: 20141104

International Standard Book Number-13: 978-1-4987-0361-1 (eBook - PDF)

This book contains information obtained from authentic and highly regarded sources. While all reasonable efforts have been made to publish reliable data and information, neither the author[s] nor the publisher can accept any legal responsibility or liability for any errors or omissions that may be made. The publishers wish to make clear that any views or opinions expressed in this book by individual editors, authors or contributors are personal to them and do not necessarily reflect the views/opinions of the publishers. The information or guidance contained in this book is intended for use by medical, scientific or health-care professionals and is provided strictly as a supplement to the medical or other professional's own judgement, their knowledge of the patient's medical history, relevant manufacturer's instructions and the appropriate best practice guidelines. Because of the rapid advances in medical science, any information or advice on dosages, procedures or diagnoses should be independently verified. The reader is strongly urged to consult the relevant national drug formulary and the drug companies' printed instructions, and their websites, before administering any of the drugs recommended in this book. This book does not indicate whether a particular treatment is appropriate or suitable for a particular individual. Ultimately it is the sole responsibility of the medical professional to make his or her own professional judgements, so as to advise and treat patients appropriately. The authors and publishers have also attempted to trace the copyright holders of all material reproduced in this publication and apologize to copyright holders if permission to publish in this form has not been obtained. If any copyright material has not been acknowledged please write and let us know so we may rectify in any future reprint.

Except as permitted under U.S. Copyright Law, no part of this book may be reprinted, reproduced, transmitted, or utilized in any form by any electronic, mechanical, or other means, now known or hereafter invented, including photocopying, microfilming, and recording, or in any information storage or retrieval system, without written permission from the publishers.

For permission to photocopy or use material electronically from this work, please access [www.copyright.com](http://www.copyright.com) (<http://www.copyright.com/>) or contact the Copyright Clearance Center, Inc. (CCC), 222 Rosewood Drive, Danvers, MA 01923, 978-750-8400. CCC is a not-for-profit organization that provides licenses and registration for a variety of users. For organizations that have been granted a photocopy license by the CCC, a separate system of payment has been arranged.

**Trademark Notice:** Product or corporate names may be trademarks or registered trademarks, and are used only for identification and explanation without intent to infringe.

**Visit the Taylor & Francis Web site at**  
**<http://www.taylorandfrancis.com>**

**and the CRC Press Web site at**  
**<http://www.crcpress.com>**

# Contents

|  |             |
|--|-------------|
| <i>Preface</i>   | <i>viii</i> |
| <i>Introduction</i>  | <i>ix</i>   |
| The importance of cross-sectional anatomy                              | ix          |
| Orientation of sections and images                                     | xi          |
| Notes on the atlas   | xiii        |
| <i>References</i>  | <i>xiii</i> |
| <i>Acknowledgements</i>  | <i>xiv</i>  |
| <i>Interpreting cross-sections: helpful hints for medical students</i> | <i>xv</i>   |

## → BRAIN

---

|   |   |
|---|---|
| Series of Superficial Dissections [A–H] | 2 |
|---|---|

## → HEAD

---

|   |    |
|---|----|
| Base of skull [Osteology]                           | 8  |
| Cranial fossae [Cranial nerves dissection]          | 9  |
| Sagittal section                                    | 10 |
| Sagittal section [Cranial nerves dissection]        | 11 |
| Axial sections [1–19 Male]                          | 12 |
| <i>Selected images</i>                              |    |
| Axial Magnetic Resonance Images [A–C]               | 50 |
| Coronal sections [1–13 Female]                      | 52 |
| Sagittal section [1 Male]                           | 78 |
| <b>TEMPORAL BONE/INNER EAR</b>                      |    |
| Coronal sections [1–2 Male]                         | 80 |
| <i>Selected images</i>                              |    |
| Axial Computed Tomogram [A] Temporal Bone/Inner Ear | 82 |

## → NECK

---

|                             |     |
|-----------------------------|-----|
| Axial sections [1–9 Female] | 84  |
| Sagittal section [1 Male]   | 102 |

## → THORAX

---

|                            |     |
|----------------------------|-----|
| Axial sections [1–10 Male] | 104 |
| Axial section [1 Female]   | 124 |

*Selected images*

|   |     |
|---|-----|
| Axial Computed Tomograms [A–C] Heart                      | 126 |
| Axial Computed Tomograms [A–D] Mediastinum                | 128 |
| Coronal Magnetic Resonance Images [A–C]                   | 130 |
| Reconstructed Computed Tomograms [A–E] Chest              | 132 |
| Reconstructed 3D Computed Tomograms [A–B] Arterial System | 134 |

## → ABDOMEN

---

|   |     |
|---|-----|
| Axial sections [1–8 Male]                             | 136 |
| Axial sections [1–2 Female]                           | 152 |
| <i>Selected images</i>                                |     |
| 3D Computed Tomography Colonogram [A]                 | 156 |
| Coronal Computed Tomograms [A–C]                      | 158 |
| Axial Computed Tomograms [A–F] Lumbar Spine           | 160 |
| Coronal Magnetic Resonance Images [A–B] Lumbar Spine  | 162 |
| Sagittal Magnetic Resonance Images [A–D] Lumbar Spine | 164 |

## → PELVIS

---

|   |     |
|---|-----|
| Axial sections [1–11 Male]              | 166 |
| <i>Selected images</i>                  |     |
| Coronal Magnetic Resonance Images [A–C] | 188 |
| Axial sections [1–7 Female]             | 190 |
| <i>Selected images</i>                  |     |
| Axial Magnetic Resonance Images [A–B]   | 204 |
| Coronal Magnetic Resonance Images [A–C] | 206 |
| Sagittal Magnetic Resonance Image [A]   | 208 |

## → LOWER LIMB

---

|                                       |     |
|---------------------------------------|-----|
| HIP – Coronal section [1 Female]      | 210 |
| <i>Selected images</i>                |     |
| 3D Computed Tomograms [A–B] Pelvis    | 212 |
| THIGH – Axial sections [1–3 Male]     | 214 |
| KNEE – Axial sections [1–3 Male]      | 217 |
| KNEE – Coronal section [1 Male]       | 220 |
| KNEE – Sagittal sections [1–3 Female] | 222 |
| LEG – Axial sections [1–2 Male]       | 228 |
| ANKLE – Axial sections [1–3 Male]     | 230 |

|  |     |
|--|-----|
| ANKLE – Coronal section [1 Female]     | 234 |
| ANKLE/FOOT – Sagittal section [1 Male] | 236 |
| FOOT – Coronal section [1 Male]        | 238 |

→ UPPER LIMB

---

|   |         |
|---|---------|
| SHOULDER – Axial section [1 Female]         | 240     |
| SHOULDER – Coronal section [1 Male]         | 242     |
| <i>Selected images</i>                      |         |
| 3D Computed Tomograms [A–B] Shoulder Girdle | 244     |
| ARM – Axial section [1 Male]                | 246     |
| ELBOW – Axial sections [1–3 Male]           | 247     |
| ELBOW – Coronal section [1 Female]          | 250     |
| FOREARM – Axial sections [1–2 Male]         | 252     |
| WRIST – Axial sections [1–3 Male]           | 254     |
| WRIST/HAND – Coronal section [1 Female]     | 258     |
| WRIST/HAND – Sagittal section [1 Female]    | 260     |
| HAND – Axial sections [1–2 Male]            | 262     |
| <br><i>Index</i>                            | <br>264 |



# Preface

The study of sectional anatomy of the human body goes back to the earliest days of systematic topographical anatomy. The beautiful drawings of the sagittal sections of the male and female trunk and of the pregnant uterus by Leonardo da Vinci (1452–1519) are well known. Among his figures, which were based on some 30 dissections, are a number of transverse sections of the lower limb. These constitute the first known examples of the use of cross-sections for the study of gross anatomy and anticipate modern technique by several hundred years. In the absence of hardening reagents or methods of freezing, sectional anatomy was used seldom by Leonardo (O'Malley and Saunders, 1952). Andreas Vesalius pictured transverse sections of the brain in his *Fabrica* published in 1543 and in the seventeenth century portrayals of sections of various parts of the body, including the brain, eye and the genitalia, were made by Vidius, Bartholin, de Graaf and others. Drawings of sagittal section anatomy were used to illustrate surgical works in the eighteenth century, for example those of Antonio Scarpa of Pavia and Peter Camper of Leyden. William Smellie, one of the fathers of British midwifery, published his magnificent *Anatomical Tables* in 1754, mostly drawn by Riemsdyk, which comprised mainly sagittal sections; William Hunter's illustrations of the human gravid uterus are also well known.

The obstacle to detailed sectional anatomical studies was, of course, the problem of fixation of tissues during the cutting process. De Riemer, a Dutch anatomist, published an atlas of human transverse sections in 1818, which were obtained by freezing the cadaver. The other technique developed during the early nineteenth century was the use of gypsum to envelop the parts and to retain the organs in their anatomical position – a method used by the Weber brothers in 1836.

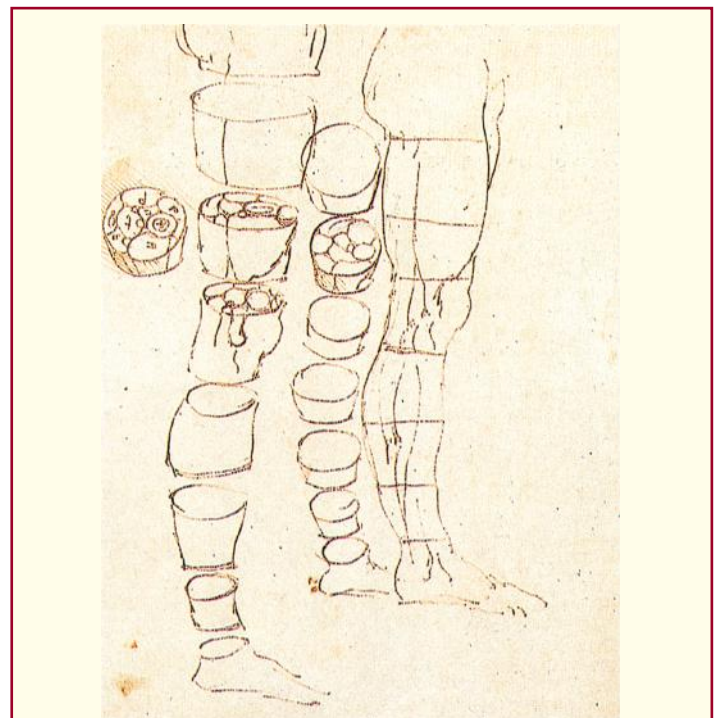
Pirogoff, a well-known Russian surgeon, produced his massive five-volume cross-sectional anatomy between 1852 and 1859, which was illustrated with 213 plates. He used the freezing technique, which he claimed (falsely, as noted above) to have introduced as a novel method of fixation.

The second half of the nineteenth century saw the publication of a number of excellent sectional atlases, and photographic reproductions were used by Braun as early as 1875.

Perhaps the best known atlas of this era in the United Kingdom was that of Sir William Macewen, Professor of Surgery in Glasgow, published in 1893. Entitled *Atlas of Head Sections*, this comprised a

series of coronal, sagittal and transverse sections of the head in the adult and child. This was the first atlas to show the skull and brain together in detail. Macewen intended his atlas to be of practical, clinical value and wrote in his preface 'the surgeon who is about to perform an operation on the brain has in these cephalic sections a means of refreshing his memory regarding the position of the various structures he is about to encounter'; this from the surgeon who first proved in his treatment of cerebral abscess that clinical neurological localization could be correlated with accurate surgical exposure.

The use of formalin as a hardening and preserving fluid was introduced by Gerota in 1895 and it was soon found that thorough perfusion of the vascular system of the cadaver enabled satisfactory sections to be obtained of the formalin-hardened material. The early years of the twentieth century saw the publication of a number of atlases based on this technique. Perhaps the most comprehensive and beautifully executed of these was *A Cross-Section Anatomy* produced by Eycleshymer and Schoemaker of St Louis University, which was first published in 1911 and whose masterly historical introduction in the 1930 edition provides an extensive bibliography of sectional anatomy.



**Leonardo da Vinci.** The right leg of a man measured, then cut into sections (Source: The Royal Collection © 2007 Her Majesty Queen Elizabeth II).

# Introduction

## The importance of cross-sectional anatomy

Successive authors of atlases on sectional anatomy have emphasized the value to the anatomist and the surgeon of being able to view the body in this dimension. It is always difficult to consider three dimensions in the mind's eye; to be able to view the relationships of the viscera and fascial planes in transverse and vertical section helps to clarify the conventional appearances of the body's structure as seen in the operating theatre, in the dissecting room and in the textbook.

The introduction of modern imaging techniques, especially ultrasound, computed tomography (CT) and magnetic resonance imaging (MRI), has enormously expanded the already considerable importance of sectional anatomy. The radiologist, neurologist, internist, chest physician and oncologist, as well as specialists in the various fields of surgery, have had to re-educate themselves in the appearances and relationships of anatomical structures in transverse and vertical section. Indeed, precise diagnosis, as well as the detailed planning of therapy (for example, the ablative surgery of extensive cancer) and of interventional radiology, often depends on the cross-sectional anatomical approach.

This atlas combines three presentations of cross-sectional anatomy – that of the dissecting room, CT and MRI. The series are matched to each other as closely as possible on opposite pages. Students of anatomy, surgeons, clinicians and radiologists should find the illustrations of anatomical cross-sections (obtained by the most modern techniques of preparation and photographic reproduction) and the equivalent cuts on imaging (obtained on state-of-the-art apparatus) both interesting and rewarding.

### Preservation of cadavers

Preservation of the cadavers used for the sections in this atlas was by standard embalming technique, using two electric motor pumps set at a maximum pressure rate of 15 p.s.i. Preservative fluid was circulated through the arterial system via two cannulae inserted into the femoral artery of one leg. A partial flushing of blood was effected from the accompanying femoral vein by the insertion of a large-bore drainage tube.

After the successful acceptance of 20 L of preservative fluid, local injection by automatic syringe was carried out on those areas that remained unaffected. On average, approximately 30 L of preservative fluid was used to preserve each cadaver.

Following preservation, the cadavers were stored in thick-gauge polythene tubes and refrigerated

to a temperature of 10.6 °C at 40 per cent humidity for a minimum of 16 weeks before sectioning. This period allowed the preservative solution to saturate the body tissues thoroughly, resulting in a highly satisfactory state of preservation.

The chemical formula for the preservative solution (Logan *et al.*, 1989) is:

|                                 |               |
|---------------------------------|---------------|
| Methylated spirit 64 over proof | 12.5 L        |
| Phenol liquefied 80%            | 2.5 L         |
| Formaldehyde solution 38%       | 1.5 L         |
| Glycerine BP                    | 3.5 L         |
| <b>Total</b>                    | <b>= 20 L</b> |

The resultant working strengths of each constituent is:

|                       |     |
|-----------------------|-----|
| Methylated spirit     | 55% |
| Glycerine             | 12% |
| Phenol                | 10% |
| Formaldehyde solution | 3%  |

The advantages of this particular preservative solution are that (i) a state of soft preservation is achieved; (ii) the low formaldehyde solution content obviates excessive noxious fumes during dissection; (iii) a degree of natural tissue colour is maintained, which benefits photography; and (iv) mould growth does not occur on either whole cadavers thus preserved or their subsequent prosected and stored parts.

### Safety footnote

Since the preparation of the anatomical material for this book, in 1988, there have been several major changes to health and safety regulations concerning the use of certain chemical constituents in preservative (embalming) fluids. It is important, therefore, to seek local health and safety guidance if intending to adopt the above preservative solution.

### Sectioning

In order to produce the 119 cross-sections illustrated in this atlas, five preserved cadavers, two male and three female, were utilised in addition to five upper and five lower separate limbs and two temporal bone specimens.

The parts to be sectioned were deep-frozen to a temperature of -40 °C for a minimum of 3 days immediately before sectioning.

Sectioning was carried out on a purpose-built AEW 600 stainless-steel bandsaw (AEW Delford Systems, Gresham House, Pinetrees Business Park, Salhouse Road, Norwich, Norfolk, NR7 9BB, England). The machine is equipped with a 10 horse power, three-phase electric motor capable of producing a constant blade speed of 6000 feet/minute.

A fine-toothed (four skip) stainless-steel blade was used, 19 mm in depth and precisely 1 mm in thickness (including tooth set).

The design and precision manufacture of the machine results, during operation, in the loss of only 1 mm of material between each section.

Sections were taken from the cadavers to the following thickness of cut:

|                |                    |
|----------------|--------------------|
| Head           | 1 cm serial        |
| Temporal bones | at selected levels |
| Neck           | 1.5 cm serial      |
| Thorax         | 2 cm serial        |
| Abdomen        | 2 cm serial        |
| Pelvis male    | 2 cm serial        |
| Pelvis female  | 2 cm serial        |
| Lower limb     | at selected levels |
| Upper limb     | at selected levels |

### Computed tomography

Since the invention of CT by Sir Godfrey Hounsfield (1973) who was awarded a Nobel Prize for its contribution to medicine, there has been renewed interest in sectional anatomy. Despite the high cost, CT systems are now used widely throughout more affluent countries. Radiologists in particular have had to go through a rapid learning process. Several excellent sectional CT anatomy books have been written. More modern CT technology allows a wider range of structures to be demonstrated with better image quality, due mainly to improved spatial resolution and shorter data-acquisition times. Spiral CT techniques have lowered data acquisition time further still, allowing a volume acquisition during a single breath-hold – hence, the justification for yet another atlas that correlates anatomical and CT images. The development of multidetector CT allows multiple thin sections to be acquired during a single breath-hold. The computer can then assimilate this volume of data, from which coronal, sagittal and 3D images can be extracted.

Most of the images in this volume have been obtained on Siemens (Forchheim, Germany) CT systems in Addenbrooke's Hospital, Cambridge. Imaging protocols have continued to evolve from the original descriptions (e.g. Dixon, 1983a), particularly with the advent of multi-detector CT systems capable of performing isometric volume acquisitions. Oral

contrast medium is nowadays less often given for abdomino-pelvic studies; thus the stomach and small bowel may be filled with water dense material rather than opacified as in the past. For some applications (e.g. CT colonography) the bowel may be intentionally distended with gas. There has also been a generalised increase in the use of intravenous contrast agents and thus in most sections the vessels will appear opaque, according to the timing of the data acquisition following the injection.

Precise correlation between the cadaveric sections and the clinical images is very difficult to obtain in practice. No two patients are quite the same shape. The distribution of fat, particularly in the abdomen, varies from patient to patient and between the sexes (Dixon, 1983b). Furthermore, there are the inevitable physiological discrepancies between cadaveric slices and images obtained in vivo. These are especially noticeable in the juxta-diaphragmatic region. In particular, the vertebral levels do not quite correlate because of the effect of inspiration; all intrathoracic structures are better displayed on images obtained at suspended inspiration. Furthermore, in order to obtain as precise a correlation as possible, some CT images may not be quite of optimal quality. A further difficulty encountered when attempting to correlate the two sets of images is caused by the fact that CT involves ionizing radiation. The radiation dose has to be kept to the minimum that answers the clinical problem; thus, it is not always possible to find photogenic examples of the anatomy shown in the cadavers for all parts of the body.

Some knowledge of the X-ray attenuation of normal structures is useful to assist interpretation of the images. The Hounsfield scale extends from air, which measures  $-1000$  HU (Hounsfield units), through pure water at  $0$  HU, to beyond  $+1000$  HU for dense cortical bone. Most soft tissues are in the range  $+35$  to  $+70$  HU (kidney, muscle, liver, etc.). Fat provides useful negative contrast at around  $-100$  HU. The displayed image can appear very different depending on the chosen window width (the spread of the grey scale) and the window level (the centre of the grey scale). These differences are especially apparent in Axial section 8 of the thorax, where the images are displayed both at soft-tissue settings (window 400, level  $+20$  HU) and at lung settings (window c.1250, level  $-850$  HU). Such image manipulation merely requires alteration of the stored electronic data at the viewing console, where any parameters can be chosen. The hard-copy photographic record of the electronic data is always a rather poor representation. Indeed, in clinical practice, it may be difficult to display all structures and some lesions on hard-copy film.

### Magnetic resonance imaging

The evolution of MRI to its present status from long-established chemical magnetic resonance techniques has been gradual. A key milestone occurred when Lauterbur (1973) first revealed the imaging potential of MRI. Clinical images followed quickly, initially from

Aberdeen and Nottingham (e.g. Hawkes *et al.*, 1980). Subsequently Sir Peter Mansfield (Nottingham) was to share a Nobel Prize with Lauterbur for its invention. Subsequent research by various manufacturers has led to a plethora of techniques, moving toward shorter and shorter acquisition times, some of which are nearly as short as CT data acquisition. Most of the MR images in this volume were obtained on GE (Milwaukee, USA) MR systems in Addenbrooke's Hospital, Cambridge.

The physics of MRI are substantially more complex than CT, even though the principles of picture elements (pixels) derived from volume elements (voxels) within the body are similar, along with the partial volume artefacts that can occur. Much of the computing and viewing software is similar; indeed, many manufacturers allow viewing of CT and MR images on the same viewing console.

Central to an MRI system is a very strong magnet, usually between 0.2 and 3.0 Tesla (T). 1T = 10000 Gauss; the earth's magnetic field strength is approximately 0.5 Gauss.

When the patient is in the magnet, the hydrogen protons within the body align their spins according to the strength and direction of the magnetic field. The hydrogen protons within the water of the body are particularly suitable for magnetic resonance techniques. At 1.0T, protons within hydrogen nuclei resonate at approximately 42.6 MHz. The protons can be excited so that the net magnetism of the spins is flipped by the application of a radiofrequency signal. Gradient magnetic fields are applied to vary the precessional frequency. The emitted signal is detected as an echo to provide spatial information and data about the chemical environment of the protons within the voxel, etc.

Some common imaging sequences are:

- *Proton density images*: conventionally acquired using a long repetition time (TR; c.2000 ms between signals) and a short echo time (TE; c.20 ms) before readout. These provide a map of the distribution of hydrogen protons (mainly within water).
- *T1-weighted images*: conventionally acquired with short TR (c.700 ms) and short TE (c.20 ms). They are useful for demonstrating the anatomy. The T1 time of the tissue refers to the time taken for the longitudinal magnetism to decay following the radiofrequency (RF) pulse and involves energy loss to the lattice in the chemical environment.
- *T2-weighted images*: conventionally acquired using long TR (e.g. 2000 ms) and long TE (80+ ms). These images often show oedema and fluid most clearly and are good for demonstrating lesions. The T2 time of the tissue refers to the time taken for the transverse magnetism to decay following the RF pulse. It involves the way in which the spin of one proton interacts with the spins of neighbouring protons.
- *Fast imaging sequences*: in order to complete acquisitions quickly (e.g. within a breath-hold),

numerous techniques have been devised. These include gradient echo sequences, whereby the magnetization is never allowed to recover fully. Other techniques involve a rapid succession (train) of RF pulses and echoes, requiring advanced computer processing.

- *Tissue-specific techniques*: the different environments of protons (fat, water, flowing blood, etc.) mean that protocols can be adapted to accentuate certain features. Fat can be suppressed by the application of a RF pulse at the resonant frequency of fat followed by a gradient pulse to null the signal from fat. Images can also be generated to show either static fluid or flowing blood.

Because of the range of possible sequences, the appearances of the resulting images vary considerably. It is important to realize that the grey scale of the image reflects the intensity of the returning signal. There are no absolute values, such as in CT.

In general, fat returns high signal and appears bright (white), unless fat suppression is used (see above).

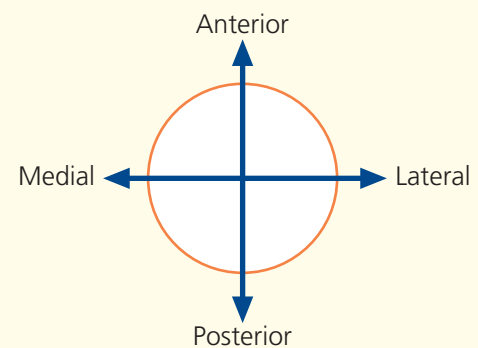
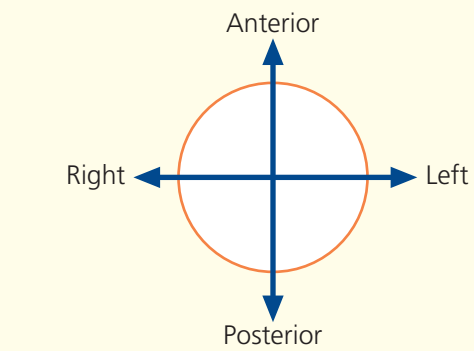
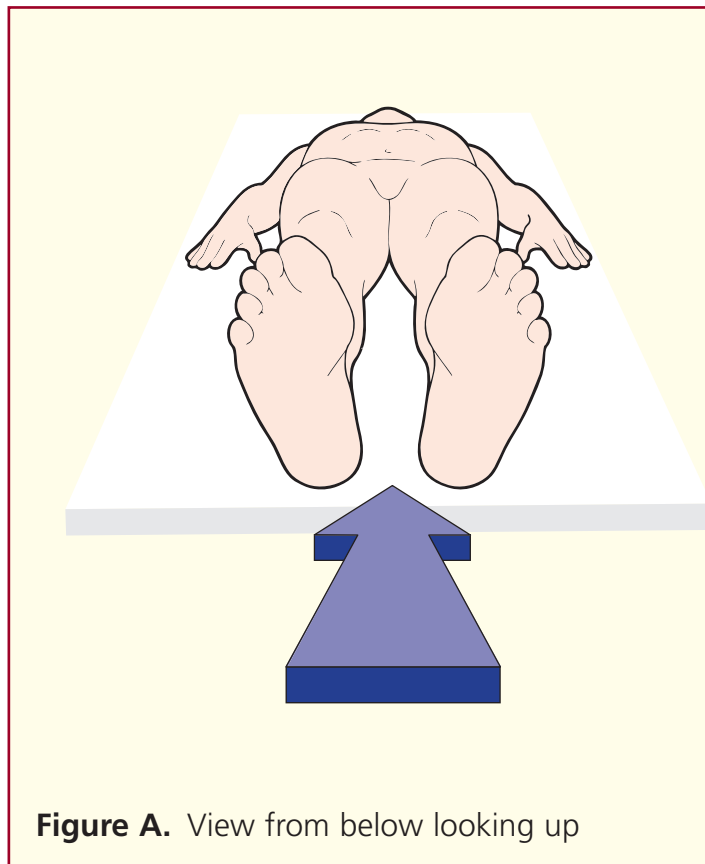
There is not sufficient water vapour in air to produce a signal. Therefore, air always returns very little signal and appears dark (black). Dense cortical bone also appears black; cortical bone has very tightly bound protons within its structure, and the lack of mobility results in reduced signal. Medullary bone contains a lot of fatty marrow and thus usually appears bright. Sequences can be performed so that blood within the vessels will return high signal; this is the basis of magnetic resonance angiography.

In the magnetic resonance images presented here, the sequence(s) have been chosen to demonstrate certain anatomical features to best effect. Thus, the precise parameters and the appearance vary extensively. As with computed tomography, there is increasing use of intravenous gadolinium-based agents; fat suppressed imaging is also increasingly used.

### Orientation of sections and images

A concerted effort over recent years has meant that axial cross-sectional and coronal images are now viewed in a standard conventional manner. Hitherto, there was wide variation, which led to considerable confusion and even medicolegal complications.

All axial cross-sectional images in clinical practice are now viewed as shown in **Figure A**; that is, from 'below' and 'looking up'. This is the logical method, in so far that the standard way in which a doctor approaches the examination of the supine patient is from the right-hand foot end of a couch. The image is thus in the correct orientation for the doctor's palpating right hand. For example, the doctor has to 'reach across' the image in order to find the spleen, exactly as he or she would during the clinical examination of the abdomen. Similarly, for the head, the right eye is the one more accessible for right-



handed ophthalmoscopy. Thus, all axial sections should be considered, learned and even displayed with an orientation logo shown in **Figure B**. This is the same orientation as that used for other images (e.g. chest X-ray). Here, again, the right of the patient is on the viewer's left, just as if the clinician was about to shake hands with the patient.

There is now worldwide agreement over this matter with regard to axial imaging. Furthermore, many anatomy books have adopted this approach so that students learn this method from the outset. Ideally, embryologists and members of all other disciplines concerned with anatomical orientation should, ultimately, conform to this method.

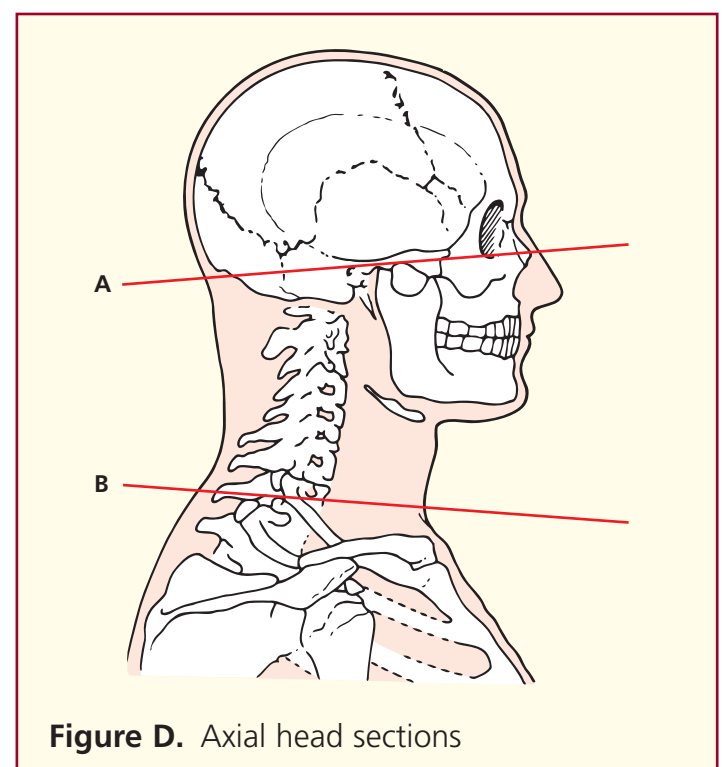
The orientation logo in **Figure B** is suitable for the head, neck, thorax, abdomen and pelvis. In the limbs, however, when only one limb is displayed, further clarification is required. All depends on whether a right or left limb is being examined. To assist this quandary, a medial and a lateral marker is provided in **Figure C**. In this book, a left limb has been used throughout. Again, viewing is as from 'below'.

The orientation of coronal images has also been standardized so that they are viewed with the patient's right on the left, exactly as for a chest X-ray or when talking to the patient face to face.

There is no firm standardization of sagittal images. Various manufacturers display their images in different ways. Although there is a certain logic in viewing from the patient's right side, the visual approach for a clinician examining a patient on a couch, the majority of manufacturers display sagittal images viewed from the left. Thus, in this book most sagittal images are viewed from the left side of the patient.

**Figure D, line A:** the radiographic baseline used for axial head sections and images in this atlas has been selected as that running from the inferior orbital margin to the external auditory meatus. This allows most of the brain to be demonstrated without excessive bony artefact.

**Figure D, line B:** for sections and images of the neck and the rest of the body, a true axial plane has been used.



### Notes on the atlas

This atlas presents various sections of the cadaver with corresponding radiological images. The logical sequence should enable the student to find the desired anatomical level with ease.

The numbers placed on the colour photographs and on the line drawings that accompany each radiological image match, and the key to these numbers is given on the accompanying list on each page spread. Where numbers are in coloured boxes on the key, these refer to features that are apparent only on the radiological image.

Brief notes accompany each section and refer to important anatomical and radiological features.

In the majority of sections, bilateral structures have been labelled only on one side. This has been done in order to allow readers to have an unobscured view of structures and to put their own anatomical knowledge to the test.

A series of views of a minimally dissected brain is provided in order to clarify the orientation of cerebral topography in the series of head sections.

The colour photographs of the brain dissections and of the sections of the upper and lower limb are of natural size. Those of the head and neck sections have been reduced slightly, and still greater reduction has been used in the thorax, abdomen and pelvis series in order to fit the page format.

Several spreads of selected images (e.g. mediastinum) have been included in order to show the features of important anatomical areas in more detail than can be demonstrated easily in cadavers and standard imaging.

### Terminology

Terminology conforms to the International Anatomical Terminology – *Terminologia Anatomica* – created in 1988 by the Federative Committee on Anatomical Terminology (FCAT) and approved by the 56 member associations of the International Federation of Associations of Anatomists (IFAA).

Important changes to note are:

The Greek adjective 'peroneal' is now replaced by the Latin 'fibular' for various muscles, vessels, nerves and structures of the lower limb, e.g. Fibularis tertius instead of Peroneus tertius; Fibular artery instead of Peroneal artery; Common fibular nerve instead of Common peroneal nerve.

For this new edition, the term 'peroneal' is included italicized in brackets in order to help identify change, e.g. Common fibular (*peroneal*) nerve.

Note also that flexor accessories are now known as 'quadratus plantae'.

## References

- Dixon, A.K. (1983a) *Body CT: A Handbook*. Churchill Livingstone, Edinburgh.
- Dixon, A.K. (1983b) Abdominal fat assessed by computed tomography: sex difference in distribution. *Clinical Radiology* 34, 189–91.
- Eycleshymer, A.C. and Schoemaker, D.M. (1930) *A Cross-Section Anatomy*. Appleton, New York.
- Federative Committee on Anatomical Terminology (1988) *Terminologia Anatomica: International Anatomical Terminology*. Thieme, New York.
- Hawkes, R.C., Holland, G.N., Moore, W.S and Worthington, B.S. (1980) Nuclear magnetic resonance tomography of the brain. *Journal of Computer Assisted Tomography* 4, 577–80.
- Hounsfield, G.N. (1973) Computerized transverse axial scanning (tomography). *British Journal of Radiology* 46, 1016–102.
- Lauterbur, P.C. (1973) Image formation by induced local interaction: examples employing nuclear magnetic resonance. *Nature* 242, 190–91.
- Logan, B.M., Watson, M. and Tattersall, R. (1989) A basic synopsis of the 'Cambridge' procedure for the preservation of whole human cadavers. *Institute of Anatomical Sciences Journal* 3, 25.
- Logan, B.M., Liles, R.P. and Bolton, I. (1990) A photographic technique for teaching topographical anatomy from whole body transverse sections. *Journal of Audio Visual Media in Medicine* 13, 45–8.
- Logan, B.M. and Ellis, H. (2000) Medial exposure for dissection of the cranial nerves in situ by medical students. *Clinical Anatomy* 13(5), 387–91.
- Logan, B.M., and Reynolds, P. (2009) *McMinn's Colour Atlas of Head and Neck Anatomy, 4<sup>th</sup> edition*. Mosby/Elsevier, Philadelphia.
- Logan, B.M. (2012) *McMinn's Colour Atlas of Foot and Ankle Anatomy, 4<sup>th</sup> edition*. Elsevier Saunders, Philadelphia.
- O'Malley, C.D. and Saunders, J.B. (1952) *Leonardo da Vinci on the Human Body*. Schuman, New York.
- Parkin, I., Logan, B.M. and McCarthy, M.J. (2007) *Core Anatomy Illustrated*. Hodder Arnold, London.

# Acknowledgements

## Dissecting room staff

---

*For skilled technical assistance in the preservation and sectioning of the cadavers*

Mr M Watson, Senior Technician  
Mr R Tattersall, Technician  
Ms L Nearn, Technician  
Mrs C Bester, Technician  
Mr M O'Hannan, Porter

Department of Anatomy, University of Cambridge

## Audiovisual unit

---

*For photographic expertise*

Mr J Bashford  
Mr R Liles LMPA  
Mr I Bolton  
Mr A Newman

Department of Anatomy, University of Cambridge

*For the excellent artwork and graphics*

Mrs Rachel Chesterton and Ms Emily Evans

## Printing of colour photographs

---

Streamline Colour Labs, Cambridge

## Secretarial

---

*For typing of manuscript*

Miss J McLachlan  
Miss AJJ Burton  
Miss S Clark  
Mrs K Frans

Departments of Anatomy and Radiology, University of Cambridge

## Annotation of central nervous system (brain and head sections)

---

Professor Roger Lemon  
Dr Catherine Horner

## Annotation of head and limb sections

---

Professor Ian Parkin

## Computed tomography and magnetic resonance imaging

---

*For performing many of the procedures*

Mrs B Housden DCR  
Mrs L Clements DCR  
Mrs C Sims DCR  
Mr D Gibbons DCR

and many other radiographers at Addenbrooke's Hospital, Cambridge.

Many radiological colleagues provided useful advice.

Dan Gibbons also kindly constructed many of the 3D generated CT images.

## Note

---

The four illustrations on pages 8–11 are reproduced with permission, from *McMinn's Colour Atlas of Head and Neck Anatomy, 4<sup>th</sup> edition* (Mosby/Elsevier, 2010) by B.M. Logan and P. Reynolds; and *Core Anatomy Illustrated* (Hodder Arnold, 2007) by I. Parkin, B.M. Logan, and M.J. McCarthy. We are grateful to the authors of these books for the permission and important contribution.

## Final editing

---

The authors would like to thank Joanna Koster and Paul Bennett for their considerable help.

# Interpreting cross-sections: helpful hints for medical students

When first confronted with an anatomical cross-section or a corresponding CT/MRI image, students are often overwhelmed by the amount of structural information on display to be identified. This apprehension may be overcome by adopting a logical approach to interpretation by appreciating the 'tight-packed' compartmental composition of a cross-section. The following series of 'build-up' pictures (A-L) of an anatomical axial cross-section have been created in order to illustrate this strategy of thought.



The above is an axial cross-section through the abdomen of an adult male subject.

Many important key structures are displayed, but where to begin identifying them in a logical sequence?

First establish:

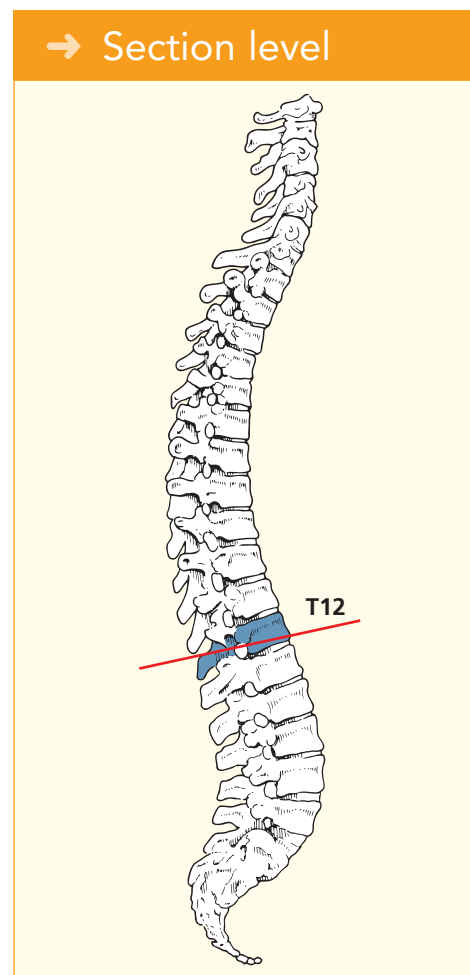
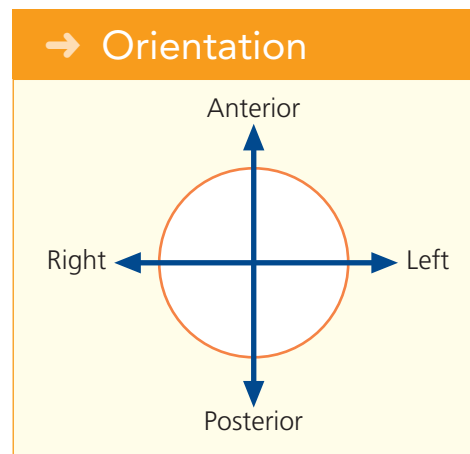
1. View:

Is the view looking up or down?  
*The orientation guide will solve this.*

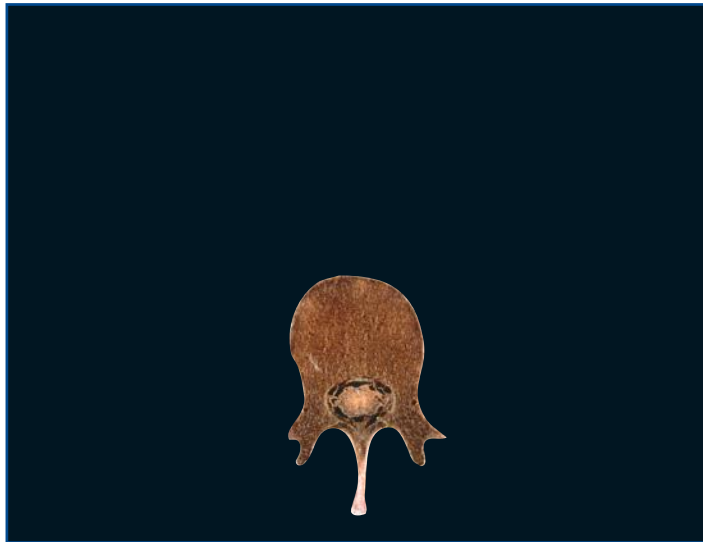
2. Section level:

Where does the slice pass through the body of the subject?  
*The section level guide will solve this.*

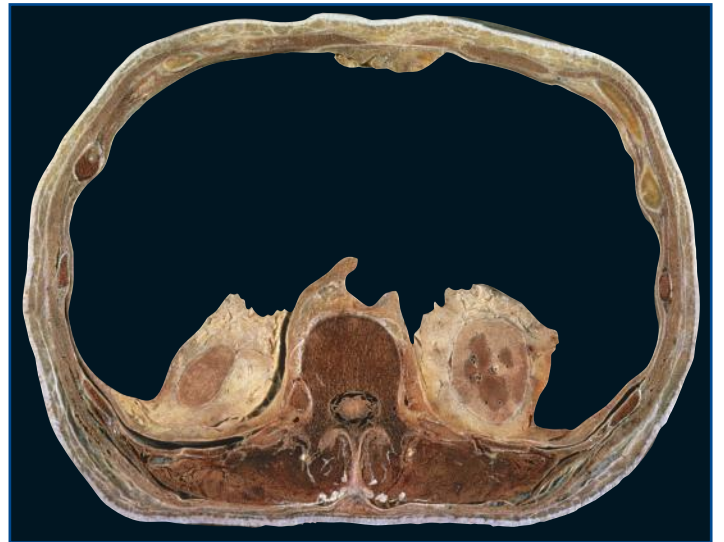
Now begin a logical tour of the section, beginning over the page with picture A and build up your knowledge through the sequence of pictures to L.



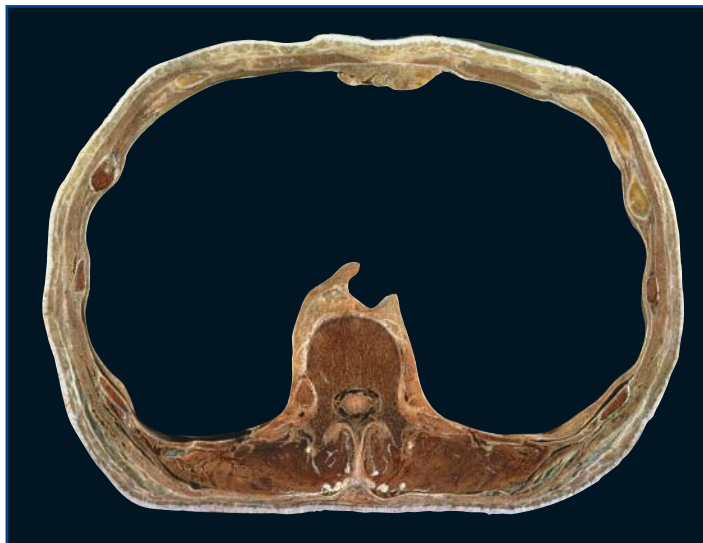




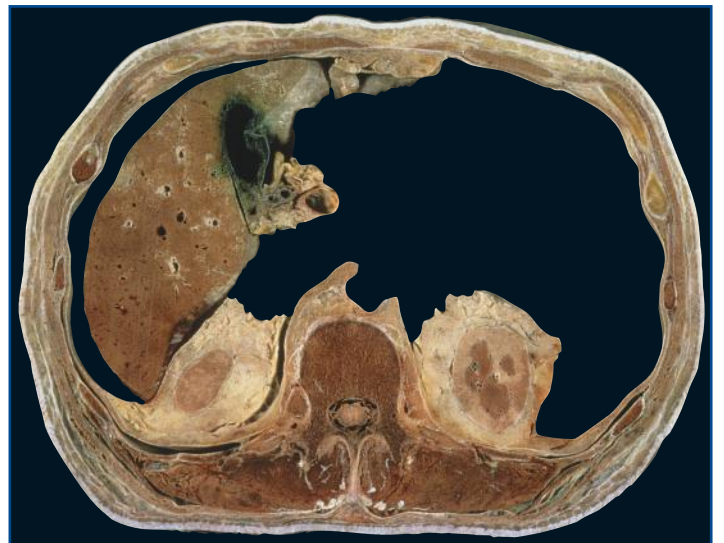
**A** Vertebral body of twelfth thoracic vertebra, spine, transverse process and laminae, spinal cord within the meninges.



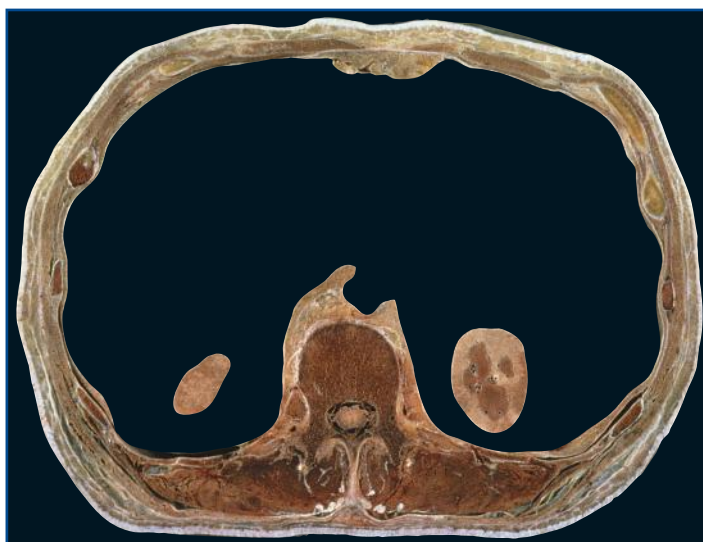
**D** Para and perirenal (perinephric) fat capsules surrounding the kidneys.



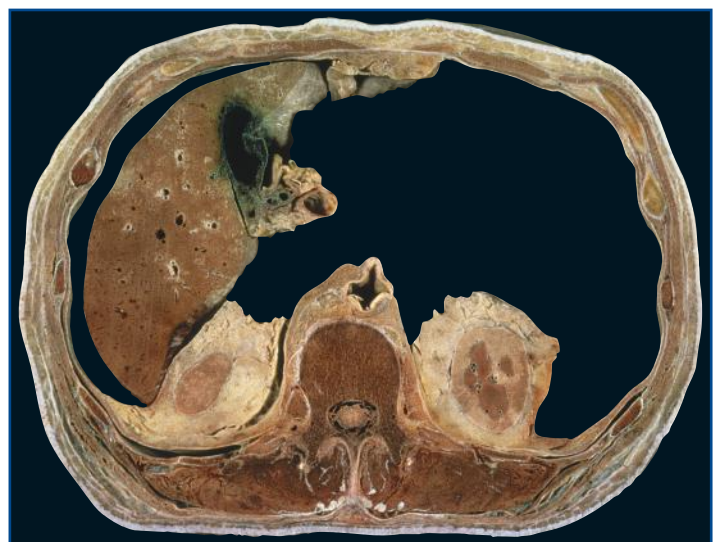
**B** Outer skin of abdominal wall and back, muscles of the abdominal wall, ribs, intercostal muscles, erector spinae muscles of back, psoas muscles. Appreciate the size of the abdominal cavity.



**E** Liver (green bile staining from the gall bladder), gall bladder, common bile duct, hepatic artery and portal vein (the largest of the three components of the portal triad).



**C** Left and right kidney; disparate in size because the left is positioned higher than the right within the abdomen.



**F** Aorta (misshapen in this subject due to arteriosclerosis). At this level (T12), it is just emerging behind the median arcuate ligament into the abdominal cavity.



**G** Inferior vena cava separated from the portal triad by the epiploic foramen (foramen of Winslow).



**J** The pancreas (head, body and tail).



**H** Adipose tissue containing small blood vessels, lymph nodes, lymphatics and the fine nerves of the sympathetic trunk.



**K** Stomach, part of pylorus with part of first part of the duodenum, right gastro-epiploic blood vessels within omentum.



**I** The spleen.



**L** Large bowel (portion of transverse and descending colon, the splenic flexure), surrounded by greater omentum.

A detailed account of a similar section to this with an accompanying CT can be found on pages 138–141.