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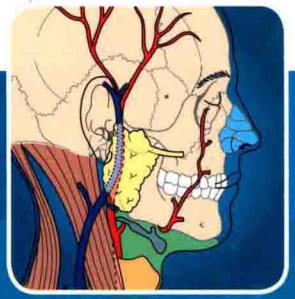
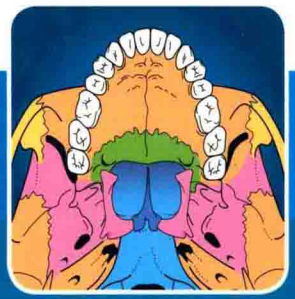
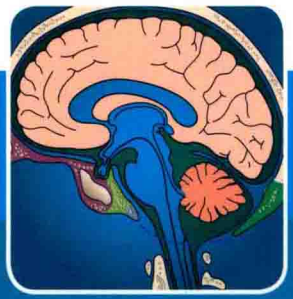
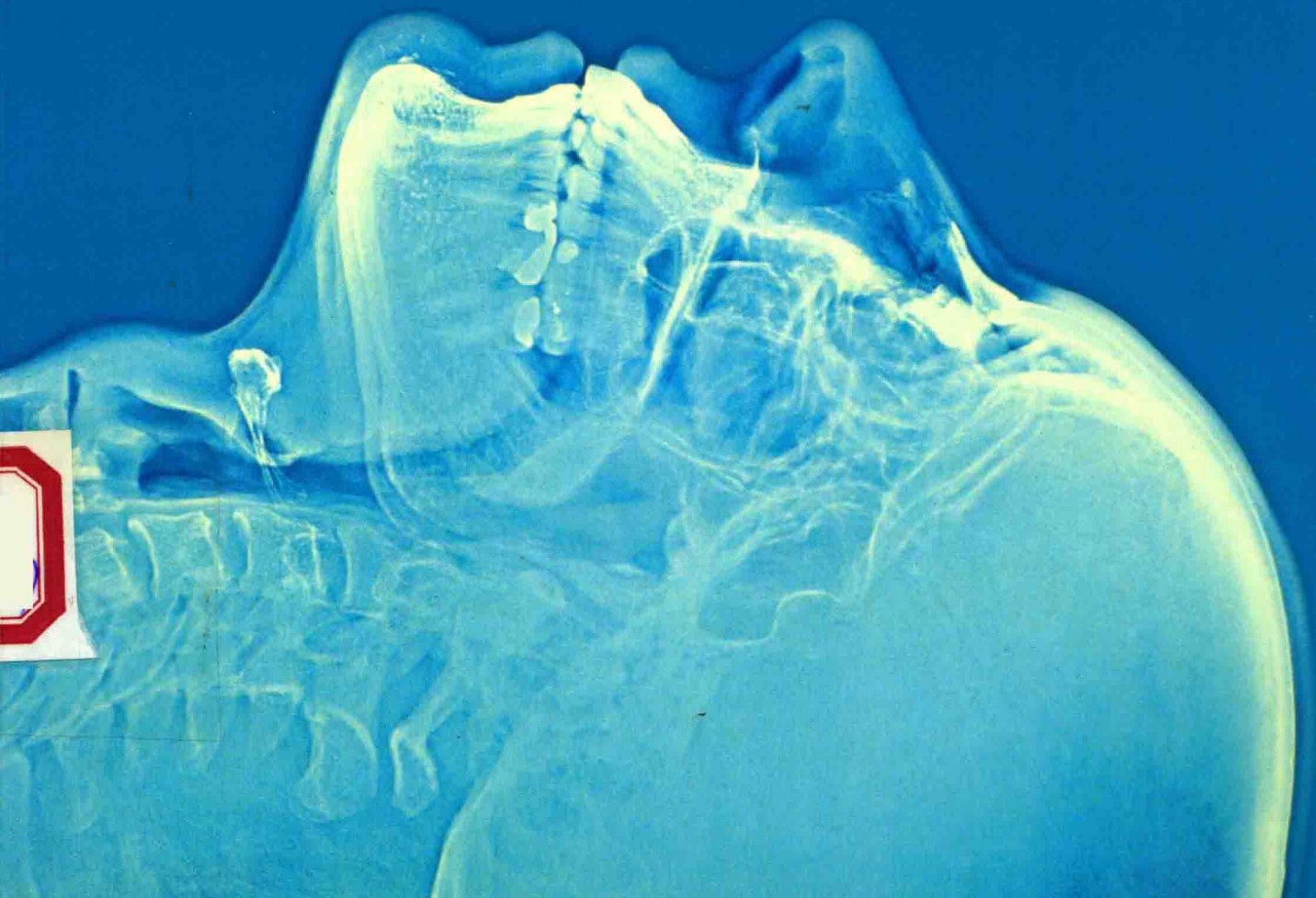
Anatomy for Dental Students

Fourth edition

Martin E. Atkinson



Anatomy for dental students

FOURTH EDITION

Martin E. Atkinson

B.Sc., Ph.D.
Professor of Dental Anatomy Education,
University of Sheffield

OXFORD
UNIVERSITY PRESS

OXFORD
UNIVERSITY PRESS
Great Clarendon Street, Oxford OX2 6DP,
United Kingdom
Oxford University Press is a department of the University of Oxford.
It furthers the University's objective of excellence in research, scholarship,
and education by publishing worldwide. Oxford is a registered trade mark of
Oxford University Press in the UK and in certain other countries

First Edition published 1983

Second Edition published 1989

Third Edition published 1997

Fourth Edition published 2013

Impression: 1

British Library Cataloguing in Publication Data
Data available

ISBN 978-0-19-923446-2

Printed in China by
C&C Offset Printing Co.Ltd

Anatomy for dental students

Preface to fourth edition of *Anatomy for Dental Students*

I was delighted to be asked to edit the fourth edition of *Anatomy for Dental Students* by Oxford University Press. It brought things full circle for me. Jim Moore, one of the original authors alongside David Johnson, was one of my excellent anatomy teachers at Birmingham University and was instrumental in guiding me into a career in anatomy. It is fitting that I can repay that debt by editing "Johnson and Moore".

Reading the preface to the first edition published almost thirty years ago shows that many aspects of dental education are still much the same. Development of dental course delivery and assessment continues in many dental schools and the introduction of integrated curricula blur or demolish traditional subject boundaries. Why then is there still a need for a "single subject" book in this brave new world? David Johnson and Jim Moore hit the bull's eye with their first aim in the original preface—that all health care professionals need a sound working knowledge of the structure and function of the human body and its application to their particular clinical area. This is paramount whether students study anatomy as a named subject or whether it is integrated into wider units of the curriculum. Three editions of *Anatomy for Dental Students* have provided a concise and precise account of the development, structure and function of the human body relevant to dental students and practitioners and it is my hope that the fourth edition will continue in that role.

Anatomy and publishing technology have advanced considerably since the last edition in 1997. The fourth edition has an entirely different style and presentation which will make it easier to use. One new feature of the fourth edition is the use of text boxes; 'clinical' boxes emphasise the application of anatomical information to clinical practice and 'sidelines' boxes contain additional interesting material not necessarily required in all dental courses. Colour illustrations are used much more extensively; all the figures have been expertly redrawn by David Gardner but the majority are based on the original drawings of Anne Johnson. David redrew Figures 3.2, 5.1, 5.3, 5.4, 14.1, 15.19, 17.1, 17.2, 18.5, 20.5, 24.6, 26.2, 26.1, 27.8, 28.6, 28.11, 28.14 and 32.17 from illustrations published in *Basic Medical Science for Speech and Language Therapy Students* by Martin Atkinson and Stephen McHanwell; I am grateful to Wiley-Blackwell for permission to use them.

The entire book has been edited and reordered to bring it into line with the requirements of students studying dental courses today. Section 1 on the basic structure and function of systems pertinent to dental practice has been expanded to benefit students who enter dental school without a biological background and also those who have studied one of the myriad modular higher level biology courses where vital material on human biology often falls through the gaps. Section 1 should create a level playing field for everyone irrespective of their previous biological experience. An appreciation of the nervous system, especially the cranial nerves, is fundamental to understanding the head and neck; the section on the nervous system therefore now precedes the section on head and neck anatomy. The head and neck section has been substantially reordered to describe the anatomy from the superficial to deep aspects of the head and then down the neck, the sequence of dissection usually followed by those who still have the opportunity to carry it out. An innovative approach to the study of the skull is used in chapter 22. The skull is assembled bone by bone so that the relationships and contributions of each bone to different subdivisions of the skull can be appreciated. The requisite detail of specific bones is then described with reference to soft tissue anatomy in chapters 23 onwards, each covering a particular region of the head and neck or their development. All the chapters on the nervous system and embryology and development have been rewritten to incorporate recent advances in these subjects; the developmental chapters have been integrated with the pertinent anatomy.

I wish to thank my colleagues Keith Figures and Adrian Jowett for their helpful discussions on various clinical aspects of anatomy and current guidelines to clinicians issued in the UK; I am also grateful to Keith for reading various clinically related sections and giving me extremely useful comments. Nevertheless any errors in the book are entirely my responsibility. Martin Payne kindly provided some of the radiographs used in chapter 31. Thanks also to Martin and Jane Wattam for introducing me to the wonders of cone beam computerized tomography. I am indebted to Geraldine Jeffers, my editor at Oxford University Press—the most exacting but also the most encouraging and supportive editor I have ever worked with—great *craic* Geraldine. I must also thank Hannah Lloyd and Abigail Stanley who played a significant part in bringing this edition to fruition. Diana—thanks as ever for your support, encouragement, and input throughout this venture. Can life return to normal now?

M.E.A.
Sheffield
June 2012

Abbreviations and symbols

β	beta
°	degree
%	percent
Ach	acetylcholine
AE	anterior extension
ANS	autonomic nervous system
AV	atrioventricular
BA	basicranial
BMP	bone morphogenic protein
Ca^{++}	calcium ion
CHL	conducting hearing loss
Cl^-	chloride ion
cm	centimetre
CN	cranial nerve
CNS	central nervous system
CPR	cardiopulmonary resuscitation
CSF	cerebrospinal fluid
CT	computed-assisted tomography
CVA	cerebrovascular accident
DPT	dental panoramic tomograph
ECM	extracellular matrix
ECO	endochondral ossification
e.g.	*exempli gratia* (for example)
FGF	fibroblastic growth factor
fMRI	functional magnetic resonance imaging
g	gram
GAG	glycosaminoglycan
GIT	gastrointestinal tract
h	hour
Hz	Hertz
ICP	intracranial pressure
ID	inferior dental (block)
IMO	intramembranous ossification
K^+	potassium ion
LRT	lower respiratory tract
m	metre
µm	micrometer
MRI	magnetic resonance imaging
mV	millivolt
Na^+	sodium ion
NA	noradrenalin
nm	nanometer
PM	premotor (cortex)
PNS	peripheral nervous system
®	registered trademark
RA	retinoic acid
SA	sinoatrial
SEA	spheno-ethmoidal angle
SHH	sonic hedgehog
SMA	supplemental motor area
SNHL	sensorineural hearing loss
TCMS	transcutaneous magnetic stimulation
TMJ	temporomandibular joint
TSNC	trigeminal sensory nuclear complex
UK	United Kingdom
URT	upper respiratory tract
VPL	ventroposterolateral
VPM	ventroposteromedial

Online Resource Centre

To help you consolidate your knowledge and revise for exams, we have provided interactive learning resources on the following site: http://www.oxfordtextbooks.co.uk/orc/atkinson/

Single Best Answer and Multiple Choice Questions

Test yourself with over 50 revision questions in single best answer and multiple choice styles. These questions apply to all four sections of the book to give you comprehensive coverage of the content.

Interactive figures

Selected figures from the book are available for you to test your knowledge with interactive 'drag-and-drop' labels. With over 30 figures from across the four sections, the drag-and-drop exercises are a great way to revise complicated anatomical structures.

How to use this book

This book has been developed not only with hundreds of colour illustrations, but also several learning features to enhance your understanding.

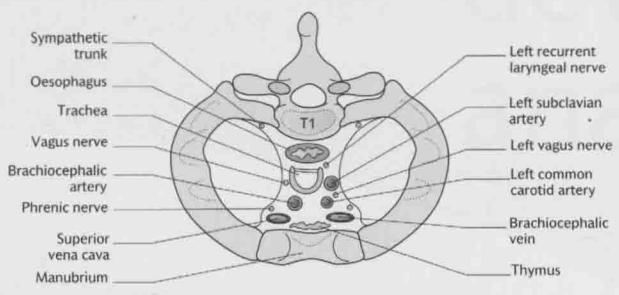


Fig. 12.2 Structures in the superior mediastinum at the level of the first rib.

Illustrations

This book is illustrated throughout with over 300 clear, colourful, and high-quality line drawings. The captions and accompanying text have been carefully written to take you through complex structures step-by-step.

Box 2.1 The clinical importance of periosteum

Periosteum is clinically important during operations on bone. It must be carefully reflected off the bone surface and then carefully replaced. Periosteum is the source of osteoblasts essential for repair of bone. It is also the main route for nutrition of bone; blood vessels passing over the bone give branches to the periosteum that then penetrate into the bone to supply it; if peri-

Clinical applications boxes

These blue boxes demonstrate how the form and function of anatomy might have consequences for clinical practice.

Box 2.3 The evolution of bone

The two types of bone formation have a long evolutionary history. A skeleton based on calcium rather than silicon appeared in the Cambrian geological period (between 545 and 510 million years ago), presumably because of a change in the chemistry of the ocean or the physiology of the creatures which lived in it. The first vertebrates had an exoskeleton consisting of bony

Sidelines boxes

Deepen your understanding with green boxes that take a closer look at selected anatomical structures.

Anatomical terms

The following list is composed of an anatomical term, a plural form (pl.) where this is in common use or unusual, the language of origin, and a short explanation or translation.

Alar (L) From ala = a wing, hence wing-like
Alveolus pl. alveoli (L) A cavity or socket
Amygdala; amygdaloid (G) An almond; resembling an almond

Glossary

Glossary terms are highlighted in bold and collected at the back of the book, forming a great revision aid to help you master anatomical vocabulary. The glossary includes a short list of common suffixes and prefixes and explains the Latin or Greek roots of the terms.

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Section 1
Introduction and developmental anatomy

Section contents

1 The study of anatomy

Chapter contents

1.1 Introduction

Human anatomy concerns the structure of the human body. Anatomy is often interpreted as the study of only those structures that can be seen with the naked eye (**gross anatomy**). Anatomy also covers the study of structure at the cellular (histology) and subcellular level (ultrastructure). The formation (**embryology**) and growth of anatomical structures (**developmental anatomy**) influence their organization, appearance, and their relationship to other structures and often explain gross anatomical arrangement.

Historically, physiology (the study of the function of the body) was regarded as a separate subject from anatomy but the relationships between structure and function (**functional anatomy**) is critical to understanding how the body works at all levels. Most modern dental curricula now have some degree of integration between anatomy and physiology to emphasize their interrelationship in the study of the human body. It is impossible to recognize changes in structure brought about by disease and their clinical manifestations and effects on function without an understanding of healthy structure and function. It is impossible to use any surgical procedures effectively and safely without a good working knowledge of the anatomy of the relevant part of the body. In clinical work, internal structures often need to be located accurately even when they cannot be visualized directly. A good example of this is the need to be able to locate the nerves supplying the teeth in order to deliver local anaesthetic accurately prior to carrying out a restoration or extraction. Fortunately, most structures have a fairly constant relationship to surface features (**surface anatomy**) to allow their position to be determined with considerable accuracy. Information about deep structures can also be obtained by the use of imaging techniques such as X-rays or scanning technology. Interpretation of radiographs and scans requires knowledge of the radiographic appearance of normal body structures (**radiological anatomy**). Surface and radiological anatomy are obviously of great practical importance and are covered in the relevant sections of the book.

The principal aim of this book is to provide you with sufficient practical information about the anatomy of the human body to form a basis on which to build your clinical skills and practice. Gross anatomy, including functional, clinical, surface, and radiological anatomy will be covered, together with embryology and developmental anatomy where relevant. Histology and ultrastructure will be only included where they aid understanding of structure and function.

Gross anatomy can be studied in two ways. One method is to take each region of the body in turn and examine all the structures found there and their relationships to each other; this is regional or topographical anatomy. It is the anatomy that surgeons need to know so that they are always aware of the structures they will encounter in the area of the body in which they specialize. The second method is to deal with all aspects of each of the body systems in turn; this is systemic anatomy. Ideally, systemic and regional anatomy go hand in hand; systemic anatomy gives a whole picture of several structures forming a system and regional anatomy examines the structures from different systems contributing to a particular region. For example, when you encounter a blood vessel in one region, you would need to know where it came from and where it was going to beyond that immediate region before subjecting it to any surgical procedure; you could then assess the likely consequences of your actions elsewhere in the body. In this book, the areas of the body most important to the practice of dentistry are considered on a **regional anatomy** basis. However, it is easier to understand the anatomy of a specific area if you build up in your mind a picture of the **systemic anatomy** of the structures you find there. In other words, *try and discover the plan or pattern of an area before studying the detail.*

As a prelude to the important aspects of regional anatomy, **Section 1** presents brief descriptions of the major body systems relevant to the practice of dentistry to enable you to see the overall pattern of the body. These chapters are also a useful orientation for students entering dental schools without a biological background. This introductory section concludes with a brief outline of early embryological development. The relevant developmental anatomy of specific systems and regions will be included in the corresponding sections of the book.

Section 2 covers the anatomy of the thorax. Diseases of the chest are frequent; many common drugs used to treat illnesses of this region have systematically acting effects and may have implications in the planning of dental treatment.

Section 3 deals with the nervous system. Some knowledge of the structure and function of this system is essential for anyone concerned with the diagnosis and treatment of disease. It is also vital to gain an overall understanding of the cranial nerves, their function, and distribution as they are the basis for the structure and function of the head and neck. The cranial nerves are one of the cardinal areas where an understanding of the general pattern and distribution aids the detailed understanding of the regional anatomy.

Section 4 focuses on the head and neck—that part of the body in which, as dentists, you will spend most of your working life.

1.2 How to approach anatomy

Anatomy can be quite daunting to start with. More or less as soon as you start to examine a given structure, you will find you need some information on other structures or distant parts of the same structure. Try to see the overall pattern first and worry about individual detail later. As your knowledge increases, the jigsaw will start to come together and the whole picture will begin to emerge.

However anatomy is taught to you, you will be convinced that your teachers are talking a language foreign to most of you. To some extent, they will be because the naming of bodily structures is historically based on ancient Greek and Latin (see Glossary). Many structures were named because, in the mind of early anatomists, they bore a resemblance to everyday objects such as drinking vessels and fruits. If you understand why

a particular Latin or Greek term is used, this often aids understanding and memory of anatomical terminology. However, when you look for the resemblance yourself, you may well conclude that some of the pioneer anatomists must have had very vivid imaginations. To help with terminology, a **glossary** of the meaning and derivations of the commoner anatomical terms is included. When you begin your study of anatomy, you will also encounter a number of specific **anatomical terms** used to describe the position of different structures and their relationship to each other; these are described and illustrated in Section 1.3. Study of anatomical specimens will help you understand and memorize structures much more easily than any amount of reading or studying of illustrations and will give you the true scale of things. Anatomical specimens take many forms; it may be yourself or a partner (living anatomy), a **cadaver** in a dissecting room on which you can carry out your own dissection, a **prosection** (a prepared dissection), or anatomical models. If you are fortunate enough to have access to a dissecting room, cadaver, or prosections, make full use of the opportunity you have been given. Human beings, like all other organisms, vary in all aspects of their structure and function. All structures of the body vary in size, shape, and arrangement and you will encounter such variations in every facet of your clinical career. No two anatomical specimens, living or dead, are identical; you will frequently find that the specimens you are examining differ considerably from the textbook description. Using anatomical material to study the subject shows variation that idealized diagrams or selected photographs in textbooks cannot. The descriptions given within this book are those that are the most usual or typical, but common variations that may be clinically relevant are described.

1.3 Descriptive anatomical terms

1.3.1 The anatomical position

For consistency and a basic reference point, the body is always referred to as if it were in the **anatomical position** which is illustrated in Figure 1.1.

Examine the illustration and note that:

- The individuals are standing erect;
- Their face and eyes are directed forward;
- Their hands are by their sides with palms directed forward;
- Their heels are together, the feet pointing forward so that the great toes are adjacent.

Anatomical descriptions are always written from this reference position. Much more significantly, your patients are *always* described as if they were in the anatomical position. If you remember this basic rule,

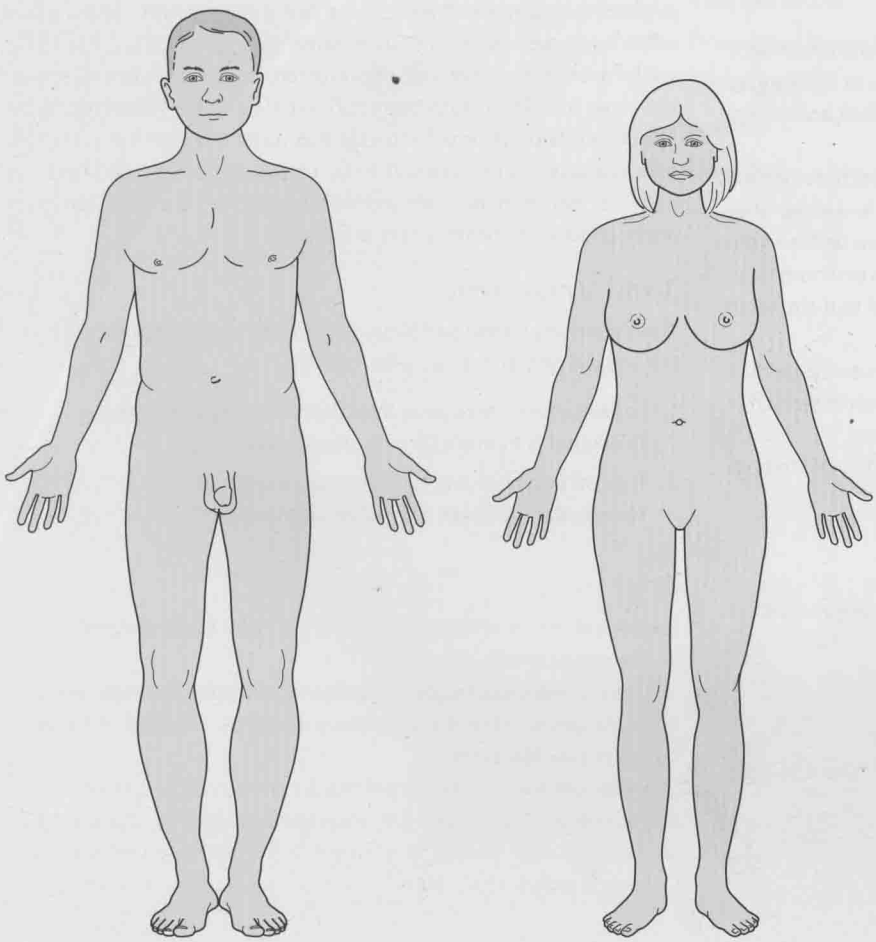

Fig. 1.1 The anatomical position.

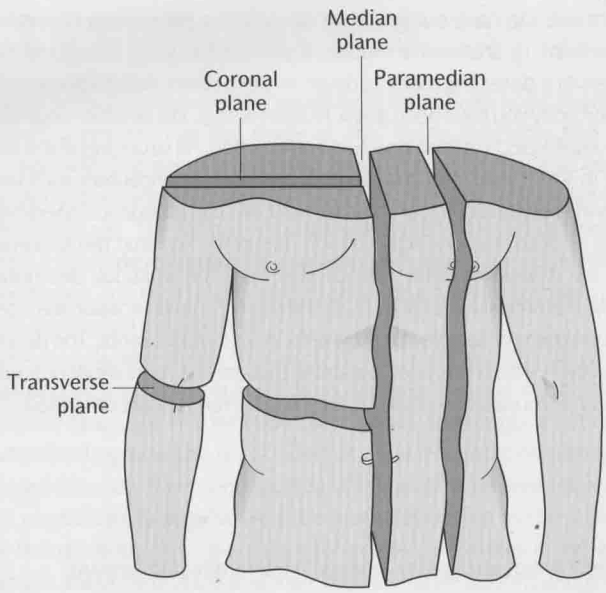

Fig. 1.2 Planes of section of the body.

you will never extract the wrong tooth by taking one from the opposite side of the body than the one intended.

1.3.2 Anatomical planes

Figure 1.2 illustrates the body standing in the anatomical position once again, but this time, the body is divided by three planes at right angles to one another. These planes are the reference points that anatomical descriptive terms are referred to.

The **median** or **sagittal plane** is the vertical plane which divides the body into left and right halves down the **midline**. It is named after the sagittal suture in the skull; the term 'sagittal' is in turn derived from the supposed resemblance of the suture in the skull of a newborn to an arrow. As you can see from Figure 1.2, any plane parallel to the median or sagittal plane is **paramedian** or **parasagittal**.

The **coronal plane** is any vertical plane at right angles to the median plane. It is named from the coronal suture passing through the crown of the skull and divides the body into front and back portions.

A **transverse** or **horizontal plane** is any plane at right angles to both median and coronal planes.

1.3.3 Anatomical descriptive terms

The following *pairs* of descriptive terms are related to the anatomical planes.

1. **Medial**—closer to the midline of the body;
   Lateral—further from the midline of the body.

If you are in the anatomical position, your arms are lateral to your chest and your chest is medial to your arms.

2. **Anterior**—nearer the front surface of the body;
   Posterior—nearer the rear surface of the body.

Your nose is anterior to your ears and conversely, your ears are posterior to your nose. **Ventral** and **dorsal** are used as synonyms for anterior and posterior. These terms are used in comparative anatomical descriptions of four-legged animals when the anatomical position cannot be applied. These terms have become incorporated into the names of structures you will encounter later in the book.

3. **Superior**—nearer the crown of the head;
   Inferior—nearer the soles of the feet.

Your head is superior to your chest and your legs are inferior to your chest.

4. **Proximal**—nearer the median plane;
   Distal—further from the median plane.

These terms are used to indicate the relative positions of structures along a long structure such as a nerve or blood vessel. A branch near to the origin of the vessel would be proximal to a branch further down the vessel. These two terms are also used extensively in description of the limbs; in Figure 1.1, your wrist is distal to your elbow, but your shoulder is proximal to your elbow.

5. **Superficial**—near to the skin surface;
   Deep—below the skin surface.

Note that all the terms defined above are *paired*. These terms are often incorporated into the names of structures as well as being used to describe their position. If you come across a structure with one of a pair of the terms described above in its name, you can be certain that there will be another structure with opposite term in its name. Two examples will show this. The *medial* pterygoid muscle and the *lateral* pterygoid muscle are two important muscles that move the jaw; the *superficial* temporal artery is just below the skin on the side of the head (and can even be seen in many bald individuals) whereas the *deep* temporal artery is hidden beneath a layer of muscles.

Terms of movement

There are many terms used to describe movements at joints in the body, but you will only encounter a few of them.

1. To **abduct** is to draw away from the midline median plane.
   To **adduct** is to move towards the midline.
2. To **protrude** or protract is to move forwards.
   To **retrude** or **retract** is to move backwards.

Other terms

Ipsilateral means on the same side of the body. **Contralateral** means on the opposite side.

Interior, internal, inside and **external, exterior, outside** are mostly used to describe position in relation to body cavities like the thorax or hollow organs like the gut.

Invaginations and **evaginations** are inward and outward bulges in the wall of a cavity and are often used to describe movement of structures during development so you will meet these terms again in Chapter 8 and other chapters.