A Textbook of
Head and Neck Anatomy

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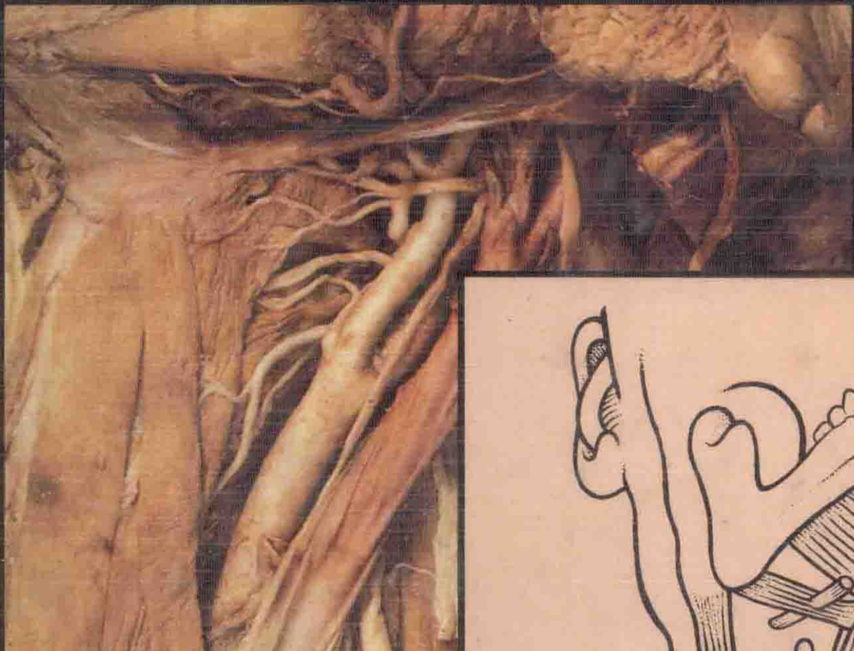

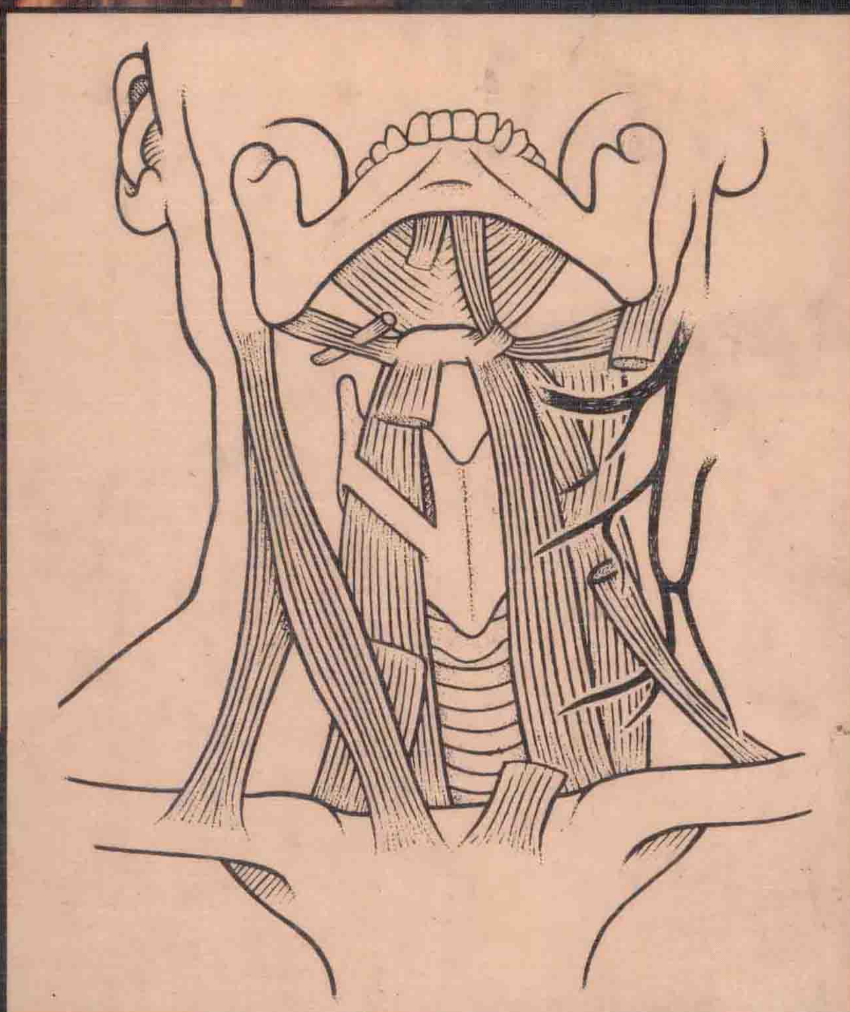

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A Textbook of

Head and Neck Anatomy

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Preface

Major advances in medicine appear almost daily. The medical curriculum perforce must constantly change, so that new subject matter is regularly introduced alongside the traditional disciplines. In many schools, anatomy teaching has changed radically, and this is reflected in some modern textbooks which sacrifice detail to provide a simplified and general account of the structure of the human body. Paradoxically, all this is taking place against a background of increasing specialisation. We believe, therefore, that there is a need for textbooks which are restricted to specific regions of the body and which have detailed coverage. A volume dealing with the anatomy of the head and neck might be welcome for two reasons. First, this region is especially complex. Second, the head and neck is the concern of a variety of specialists: neurologists, ear nose and throat surgeons, ophthalmologists, maxillofacial surgeons, and oral and dental surgeons.

A proper appreciation of anatomy relies not merely upon the assimilation of a mass of facts, but upon an awareness of the three-dimensional disposition of structures. Thus, anatomy should be regarded as essentially a visual subject that cannot be mastered simply by reading a text. Although most textbooks of anatomy make extensive use of diagrams, the illustration usually remains subordinate to the text. Our textbook was written with the purpose of reversing this hierarchy, and is to be regarded as an adjunct to *A Colour Atlas of Head and Neck Anatomy* by McMinn, Hutchings and Logan. Indeed, figure references in the margins of our text relate to pictures of dissections in the Atlas and enable the reader to use both books simultaneously. The inclusion of numerous line drawings in the textbook furthers our aim of emphasising the visual aspects of anatomy in two ways. First, they have a didactic purpose where the use of dissections alone may complicate the understanding of a topic. Second, they illustrate areas not amenable to dissection.

We have endeavoured to follow the terminology and the order of topics used in *A Colour Atlas of Head and Neck Anatomy*. There are, however, two notable exceptions with regard to the order of topics. Within the first chapter, the description of the extracranial appearance of the skull has been rearranged so that the less complicated surfaces are considered first. In the last chapter, the description of the central nervous system has also been rearranged for pedagogic purposes, beginning at the spinal cord and working through to the cerebrum. This approach has the added advantage of enabling us to adopt the modern practice of considering neuroanatomy functionally as well as topographically.

Although anatomy is generally taught as a preclinical subject, many clinical subjects cannot be fully appreciated without it. To emphasise the relevance of anatomy to the clinic, we have provided numerous case histories which require some anatomical information for their elucidation. We hope the case histories will entertain as well as instruct, for we believe this to be an effective way of motivating students in the undoubtedly difficult task of learning anatomy. Furthermore, they ensure that the student is not merely a passive recipient of information, but must be involved in some aspects of problem solving.

We wish to thank the many friends and colleagues who helped with this book. We owe a considerable debt to Dr Malcolm Brown for writing the chapter on the central nervous system. We also gratefully appreciate the work of the illustrator, Jack Furnival. In addition to his obvious skill, he brought commendable enthusiasm to the task. The case histories were written in collaboration with several of our clinical colleagues at Bristol: M. Aldoori, C. Bevan, P.A. Bloom, R.J. Canter, M.V. Griffiths, J.E. Harcourt, S. Hickey, J. Hill, T.R. Magee, K.J. Nicpon, N.K. Ragge, R. Redmond, A.K. Robson, P.M.J. Scott, W.E. Sponsel, and R.M. Tillman. Photographic assistance was provided by D. Telling and J. Long, and secretarial assistance by E. Wheatley. Last, but by no means least, we acknowledge the help of our wives, Sylvia Berkovitz and Ruth Moxham, whose support extended well beyond the most tangible manifestations of typing and proof reading.

B.K.B. Berkovitz
B.J. Moxham

Bristol, 1988.

How to use this book

This textbook should be used with *A Colour Atlas of Head and Neck Anatomy* by McMinn, Hutchings and Logan. Figure references to this Atlas are provided in the margins of our text to enable the reader to use both books simultaneously. The system of referencing adopted is generally a two-figure system. The first figure refers to the page of the Colour Atlas on which the relevant dissection is illustrated. The second figure provides an identification number overlying a specified structure. Where occasionally a single figure reference is used, this is a page reference only, and implies either that a general appreciation of the dissection is required and/or that the page depicts a major dissection for which many other figure references will soon follow. To provide an example: figure references 26A,3; 14 indicate that on page 26 (picture A) of the Colour Atlas is found a view of the infratemporal region of the skull displaying the sphenopalatine foramen (label 3), and that a general lateral view of the skull is found on page 14.

Contents

The skull

The skull is the bony skeleton of the head and is the most complex osseous structure in the body. It protects the brain, the organs of special sense and the cranial parts of the respiratory and digestive systems. The skull also provides attachments for many of the muscles of the head and neck.

Although often thought of as a single bone, the skull is composed of 28 separate bones (Table 1). Many of these bones are flat bones, consisting of two thin plates of compact bone enclosing a narrow layer of cancellous bone. In terms of shape, however, the
21,12 bones are far from flat and can show pronounced curvatures. The term diploë is used to describe the cancellous bone within the flat bones of the skull.

In order to make the skull easier to understand, two major subdivisions have been proposed. First, one can subdivide the skull into cranium and mandible. This subdivision is based upon the fact that, whereas most of the bones of the skull articulate by relatively fixed joints, the mandible is easily detached. The cranium may then itself be subdivided into a number of regions, including:

- The cranial vault: The upper, dome-like part of the skull (including the skullcap or calvaria).
- The cranial base: The inferior surface of the skull extracranially, and the floor of the cranial cavity intracranially.
- The facial skeleton: The face (including the orbital cavities and the nasal fossae).
- The jaws: The tooth-bearing bones.
- The acoustic cavities: The ear.
- The cranial cavity: The interior of the skull housing the brain.

Second, one can subdivide the skull into neurocranium and viscerocranium. The neurocranium is defined as that part of the skull that houses and protects the brain and the organs of special sense. The viscerocranium is that region associated with the cranial parts of the respiratory and digestive tracts. In many mammals, the neurocranium and the viscerocranium are reasonably distinct and the viscerocranium is particularly prominent. In man, there is no elongated snout or muzzle. Instead, the face is wide, flat and vertical. Furthermore, the neurocranium is extraordinarily large. A particularly important feature concerns the base of the cranium. The floor of the cranial cavity in most mammals is relatively flat and lies some way from the viscerocranium. In man, however, it shows a marked curvature and lies immediately above the viscerocranium (Figure 1). The neurocranium and viscerocranium of the human skull are thus not readily separable.

The evolutionary changes leading to the shape of the human skull cannot be fully explained. It has been proposed by some that the development of a large brain has been all-important, whereas others invoke the change to an upright stance. Certainly, the form of the human skull can be related to the change to bipedal locomotion. The absence of a snout has been beneficial to the development of stereoscopic vision. In addition, as the upper limbs have taken on functions other than locomotion, there is less need for the jaws to be organs of offence or defence. Indeed, the human jaws appear gracile and the ridges on the skull for the jaw muscles are very much reduced. The spinal cord in quadrupeds leaves the cranium at a foramen (the foramen magnum) located on the posterior aspect of the skull. The foramen magnum in man is positioned underneath the skull, and thus the spinal cord has become vertically orientated.

The changes in the skull wrought by the enlarged brain are no less significant. In particular, the well-developed frontal lobes of the cerebrum are associated with the

TABLE 1 Bones of the skull.

NAME	NUMBER	PRIMARY LOCATION	SHORT DESCRIPTION
ETHMOID	1	Nasal and orbital cavities of face	T-shaped. Processes form superior and middle conchae of lateral wall of nasal cavities
FRONTAL	1	Cranial vault	Forms forehead and roof of orbital cavities
INFERIOR CONCHA	2	Nasal cavity of face	Projects from lateral wall of nasal cavity
INCUS	2	Acoustic cavity	Shaped like an anvil
LACRIMAL	2	Orbital cavity of face	Situated on medial wall of orbital cavity. Related to lacrimal sac
MALLEUS	2	Acoustic cavity	Shaped like a hammer
MANDIBLE	1	Jaws	Forms lower jaw
MAXILLA	2	Jaws	Forms upper jaw. Also contributes to nasal and orbital cavities
NASAL	2	Face	Forms bridge of nose
OCCIPITAL	1	Cranial vault	Forms back of head. Also contributes to cranial base
PALATINE	2	Nasal cavity of face	L-shaped. Contributes to lateral wall of nose and hard palate
PARIETAL	2	Cranial vault	Forms mid-portion of cranial vault
SPHENOID	1	Cranial base	Butterfly-shaped. Also contributes to orbital and nasal cavities and lateral sides of skull
STAPES	2	Acoustic cavity	Stirrup-shaped
TEMPORAL	2	Cranial base	Also contributes to lateral sides of skull
VOMER	1	Nasal cavity of face	Contributes to nasal septum
ZYGOMATIC	2	Face	Forms cheek bone

development of a vertical forehead that bulges above the face. The orbits also undergo a forward rotation, making them vertically aligned and facing forwards. Because of this, the roof of the orbit becomes related to the floor of the cranial cavity, and the floor of the orbit comes to lie in the upper part of the face. As the orbits encroach on the midline, the root of the nose becomes much thinner.

There have also been changes in the location of the olfactory structures. The naso-maxillary complex becomes related to the anterior cranial fossa and the olfactory mucosa is then situated in the roof of the nose and not on the posterior walls. Many of these features are illustrated in Figure 1.

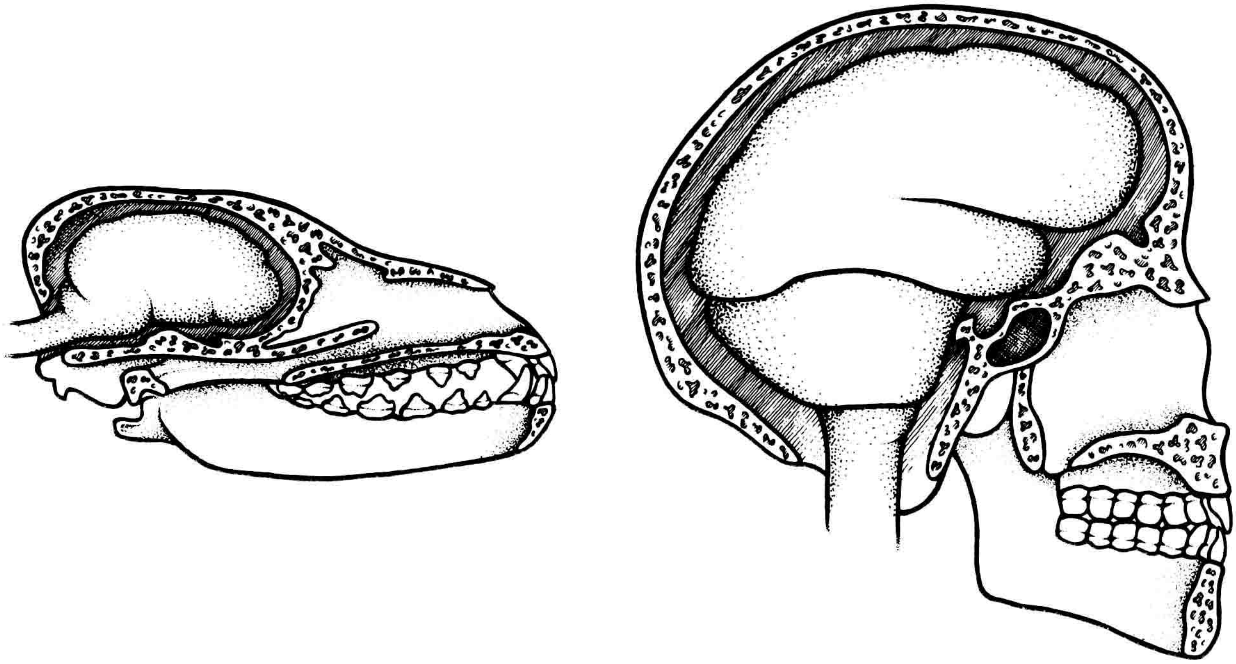

Figure 1 ***Comparison between the typical mammalian (dog) and human skulls.*** *Note the differences in a) the cranial capacity, b) the shape and position of the cranial base, c) the size and position of the viscerocranium, d) the position of the foramen magnum, e) the position and orientation of the olfactory region. Thus, the human skull has a large neurocranium, the cranial base is curved and extends over the viscerocranium anteriorly, it shows no snout and the facial skeleton is orientated vertically, the foramen magnum lies beneath the skull and the cribriform plate and olfactory area are not in the posterior wall of the nose but in its roof.*

The extracranial appearance of the skull

The following views of the exterior of the skull will be described:

- The norma verticalis — the skull seen from above.
- The norma occipitalis — the skull seen from behind.
- The norma frontalis — the skull seen from the front.
- The norma lateralis — the skull seen from the side.
- The norma basalis — the skull seen from below.

They are described in this order so that the less complex regions are considered first.

20A **THE NORMA VERTICALIS**

This view is so named because the most superior point of the skull is called the vertex. The region observed is the skullcap or calvaria.

The calvaria is approximately oval in shape, the anteroposterior dimension being the greater. It is usually wider posteriorly than anteriorly. It is comprised of four bones
20,9 separated by three prominent sutures. Anteriorly is found the squamous part of the
20,1 frontal bone. Posteriorly is the squamous part of the occipital bone. Between the

frontal and occipital bones lie the two parietal bones. The suture between the frontal 20,6
bone and the parietal bones is called the coronal suture. It is this suture that gives its 20,8
name to the coronal plane of the body. The midline suture between the parietal bones
is the sagittal suture and this gives its name to the sagittal plane. The junction of the 20,5
coronal and sagittal sutures is termed the bregma. The bregma corresponds to the 20,10
anterior fontanelle ('soft spot') on the fetal skull. The suture dividing the occipital 74A,1
bone from the parietal bones is the lambdoid suture. The point of meeting of the 20,3
lambdoid and sagittal sutures is called the lambda. This site marks the position of the 20,2
posterior fontanelle on the fetal skull. 74C,30

The calvaria is otherwise rather featureless. The region of maximum convexity of the
parietal bone is called the parietal tuberosity. Close to the tuberosity run the superior 20,7
and inferior temporal lines, though these lines are best seen in the norma lateralis.
Parietal foramina may be found on either side of the sagittal suture. They transmit 20,4
emissary veins (veins that link the intracranial and extracranial venous systems) from
the superior sagittal sinus within the cranium. Sometimes terminal branches of the
occipital arteries also pass through the parietal foramina.

THE NORMA OCCIPITALIS 18

Viewed from behind, the occipital bone is prominent — hence the term norma occi- 18,9
pitalis. The lambdoid suture is also conspicuous, being seen in its entirety. A common 18,4
variation is the presence of islands of bone within the suture. These sutural bones
arise from separate centres of ossification, but they have no clinical significance. 19,19
Inferiorly, the lambdoid suture meets the occipitomastoid and the parietomastoid 18,7; 18,18
sutures. These sutures lie above and behind the mastoid process of the temporal bone.
The temporal bones, though most clearly seen on the lateral views of the skull, just 18,7
appear as the mastoid processes to form the inferolateral parts of the back of the skull. 18,8
The superolateral parts are formed by the parietal bones. 18,5

A marked feature at the back of the skull is the external occipital protuberance. It 18,10
appears on the occipital bone in the midline as either a ridge or a distinct process.
Extending laterally from the protuberance are two ridges called the superior nuchal 18,12
lines. These lines finish above the mastoid processes. Inferior nuchal lines run parallel
to, and below the superior nuchal lines. Above the superior nuchal lines may be seen 18,13
the supreme nuchal lines. The external occipital protuberance and the nuchal lines are 18,11
associated with muscle attachments. The supreme nuchal lines afford attachment to
the epicranial aponeurosis of the scalp (see page 188). The roughened appearance of
the occipital bone between the nuchal lines is also caused by muscle attachments.

The muscles attached to the skull in the occipital region are:

Muscle	Attached to:
Longissimus capitis	Superior nuchal line
Occipital belly of occipitofrontalis	Superior nuchal line
Semispinalis capitis	Between superior and inferior nuchal lines
Splenius capitis	Superior nuchal line
Sternocleidomastoid	Mastoid process and superior nuchal line
Obliquus capitis superior	Between superior and inferior nuchal lines
Trapezius	External occipital protuberance and superior nuchal line

THE NORMA FRONTALIS 10

Most of the features seen on the front of the skull relate to the face. In particular, there
are four apertures associated with the facial skeleton: the two orbital apertures, the

anterior nasal aperture (the piriform aperture), and the oral aperture between the jaws. The osteology of the orbital and nasal apertures and cavities is considered with the skull articulations (see pages 46 to 48).

10,1 The upper part of the facial skeleton is formed by the frontal bone and is related to the
10,2 forehead. Above the bridge of the nose lies a slight elevation called the glabella. This
10,33; 10,32 part of the frontal bone joins the nasal bones and the frontal processes of the maxillary
10,34; 10,35 bones at the frontonasal and frontomaxillary sutures. At the superior rim of each orbit
10,6; 10,5 are found the supra-orbital foramen (or notch) and the frontal notch. These transmit
the supra-orbital and supratrochlear nerves (and accompanying vessels) from the orbit
on to the forehead. Laterally, the zygomatic processes of the frontal bone join the
10,25 cheek bones (zygomatic bones) at the frontozygomatic sutures.

10,13 The central part of the face is occupied by the maxillary bones. Each bone contributes
not only to the upper jaw, but also to the nasal aperture, the bridge of the nose, the
floor of an orbital cavity and the bones of the cheek. Beneath the inferior rim of each
10,12 orbit lies the infra-orbital foramen. Through this foramen the infra-orbital nerve
(from the maxillary division of the trigeminal nerve) and accompanying vessels pass
on to the face. At the inferior margin of the nasal aperture in the midline lies a pro-
10,18 jection called the anterior nasal spine. The maxillary bones meet at the intermaxillary
suture.

10,15 The lower part of the face is formed by the body of the mandible. In the midline is the
10,17 prominence of the chin, the mental protuberance. In line with the supra-orbital and
10,16 infra-orbital foramina lies the mental foramen. Through this foramen pass the mental
nerve (from the mandibular division of the trigeminal nerve) and accompanying
vessels.

12 The muscles attached to the front of the skull are:

Muscle	Attached to:
Buccinator	Maxillary and mandibular buccal alveolar plates in region of molars
Corrugator supercilii	Frontal bone
Depressor anguli oris	Mandible below mental foramen
Depressor labii inferioris	Mandible between chin and mental foramen
Depressor septi	Maxilla below nasal aperture
Levator anguli oris	Maxilla below the infra-orbital foramen
Levator labii superioris	Inferior rim of orbit above infra-orbital foramen
Levator labii superioris alaeque nasi	Frontal process of maxilla
Masseter	Zygomatic arch and lateral surface of ramus of mandible
Mentalis	Incisive fossa of mandible
Nasalis	Maxilla close to nasal aperture
Orbicularis oculi	Nasal part of the frontal bone, frontal process of maxilla and crest of lacrimal bone
Platysma	Inferior border of body of mandible
Procerus	Nasal bone
Temporalis	Temporal fossa and coronoid process and anterior border of ramus
Zygomaticus major	Zygomatic bone
Zygomaticus minor	Zygomatic bone

THE NORMA LATERALIS 14

The skull, viewed from the side, can be subdivided into three zones. Anteriorly is the
face, and posteriorly is the occipital region (these have already been described). The
intermediate zone shows two fossae: the temporal and infratemporal fossae. The
boundary between the fossae is the zygomatic arch. The calvaria superiorly has been 14,19
described with the norma verticalis.

The temporal fossa is so named because it is related to the temple of the head. The
fossa is bounded inferiorly by the zygomatic arch; superiorly and posteriorly by the 14,19
temporal lines on the calvaria; and anteriorly by the frontal process of the zygomatic 14,4
bone. It continues beneath the zygomatic arch into the infratemporal fossa. The
temporal lines often present anteriorly as distinct ridges, but become much less
prominent as they arch across the parietal bone. Indeed, the superior line usually 14,4
disappears posteriorly. On the other hand, the inferior temporal line becomes distinct 14,5
once more as it curves down the squamous part of the temporal bone, forming a
supramastoid crest at the base of the mastoid process. The superior temporal line
gives attachment to the temporal fascia (see page 172). The inferior temporal line
provides attachment for the temporalis muscle (see page 171).

The floor of the temporal fossa is formed by the frontal, sphenoid (greater wing), 14,1; 14,23
parietal and temporal (squamous part) bones. These four bones meet at an area called 14,3; 14,20
the pterion, where there is an H-shaped junction of sutures. This is an important 14,21
landmark on the side of the skull. It overlies the middle meningeal vessels intra-
cranially and corresponds to the sphenoidal fontanelle on the neonatal skull. 74B,27

The suture between the temporal and parietal bones is called the squamosal suture. 14,6
The sphenosquamosal suture lies between the greater wing of the sphenoid and the 14,22
squamous part of the temporal bone.

The infratemporal fossa has the following bony boundaries: the ramus of the mandible 14,30
laterally; the lateral pterygoid plate of the sphenoid bone medially; the infratemporal 26A,2
surface of the greater wing of the sphenoid superiorly; and the maxilla anteriorly. 22,15; 26A,5
Beneath the zygomatic arch, the infratemporal fossa communicates with the temporal
fossa. Between the lateral pterygoid plate and the maxilla lies the pterygomaxillary
fissure. This fissure marks the site where the infratemporal fossa communicates with 26A,4
the pterygopalatine fossa (see pages 48 to 49 for the osteology of this fossa).

The lateral surface of the ramus of the mandible should also be briefly described at
this point. The ramus is a plate of bone projecting upwards from the back of the body 14,30
of the mandible. Most of its lateral surface provides attachment for the masseter
muscle. Two prominent processes are seen superiorly, the coronoid and condylar
processes. The coronoid process is the site for the insertion of the temporalis muscle. 14,28
The condylar process articulates with the mandibular fossa of the temporal bone at the 14,29
temporomandibular synovial joint. Between the two processes is the mandibular
notch. The angle of the mandible is the region where the inferior and posterior borders
of the ramus meet.

The zygomatic arch stands clear of the rest of the skull, the gap being where the 14,19
temporal and infratemporal fossae communicate. Whereas the bones of the cheek
comprise the zygomatic bone and the zygomatic processes of the frontal, maxillary 14,26
and temporal bones, the zygomatic arch is a term restricted to that part formed by the 14,19
temporal process of the zygomatic bone and the zygomatic process of the temporal
bone. These processes meet at the zygomaticotemporal suture. The suture between
the frontal process of the zygomatic bone and the zygomatic process of the temporal
bone is called the frontozygomatic suture. The zygomaticomaxillary suture marks the 14,25
union of the maxillary margin of the zygomatic bone and the zygomatic process of the
maxillary bone. The zygomatic bone also joins the sphenoid bone, at the spheno-
zygomatic suture. As the zygomatic process of the temporal bone passes posteriorly, it
becomes associated with the mandibular fossa and the supramastoid crest.

The upper border of the zygomatic arch serves as an attachment for the temporal fascia. The inferior border and the deep surface provide attachment for the masseter
14,27; 53C,21 muscle. A small foramen, the zygomaticofacial foramen, lies on the outer surface of
53D,26; 23,56 the zygomatic bone. Another foramen, the zygomaticotemporal foramen, is situated on the inner surface. These foramina transmit nerves and vessels of the same name on to the face.

The temporal bone is a prominent structure on the lateral aspect of the skull. As
14,20 mentioned, its squamous part lies in the floor of the temporal fossa and its zygomatic
14,19 process contributes to the bones of the cheek. Additional features found are the mandibular fossa and its articular tubercle, the tympanic plate and external acoustic meatus, and the mastoid and styloid processes.

26A,14 The mandibular fossa has also been called the glenoid fossa. It is the part of the
14,29 temporomandibular joint into which the condylar process of the mandible articulates.
26A,13; 26A,16 It is bounded in front by the articular tubercle and behind by the tympanic plate. Occasionally, there is a postglenoid tubercle. The articular tubercle is important functionally as it provides a surface down which the mandibular condyle glides during mandibular movements. The tubercle also marks the site of attachment of the lateral ligament of the temporomandibular joint (see page 173).

14,14 The tympanic part of the temporal bone contributes most of the margin of the external
14,16 acoustic meatus, the squamous part forming the upper margin and the upper part of the posterior margin. The margin is roughened to provide an attachment for the cartilaginous part of the meatus. Above and behind the meatus lies a small depression,
14,15 the suprameatal triangle, which is related to the lateral wall of the mastoid antrum (see page 369).

14,13 The mastoid process is the large prominence located immediately behind the external acoustic meatus. It is the site of attachment of a prominent muscle of the neck, the sternocleidomastoid muscle. Above the process lies the supramastoid crest which is continuous with the inferior temporal line. The mastoid process articulates with the
14,11; 14,10 parietal and occipital bones at the parietomastoid and occipitomastoid sutures. The
14,12 junction of these sutures with the lambdoid suture is called the asterion. This
74B,20 corresponds to the mastoid fontanelle in the neonatal skull. A mastoid foramen may
22,26 be found near the occipitomastoid suture. This foramen transmits an emissary vein from the sigmoid sinus.

14,18 The styloid process is a long, slender process that emerges from the base of the skull in front of the mastoid process. It projects downwards and forwards towards the mandible. The base of the styloid process is formed by the tympanic part of the temporal bone. The process gives attachment to several muscles and ligaments.

16 The muscles attached to the lateral side of the skull are:

Muscle	Attached to:
Buccinator	Maxillary and mandibular buccal alveolar plates in region of molars
Corrugator supercilii	Frontal bone
Depressor anguli oris	Mandible below mental foramen
Depressor labii inferioris	Mandible between chin and mental foramen
Depressor septi	Maxilla below nasal aperture
Levator anguli oris	Maxilla below infra-orbital foramen
Levator labii superioris	Inferior rim of orbit above infra-orbital foramen
Levator labii superioris alaeque nasi	Frontal process of maxilla