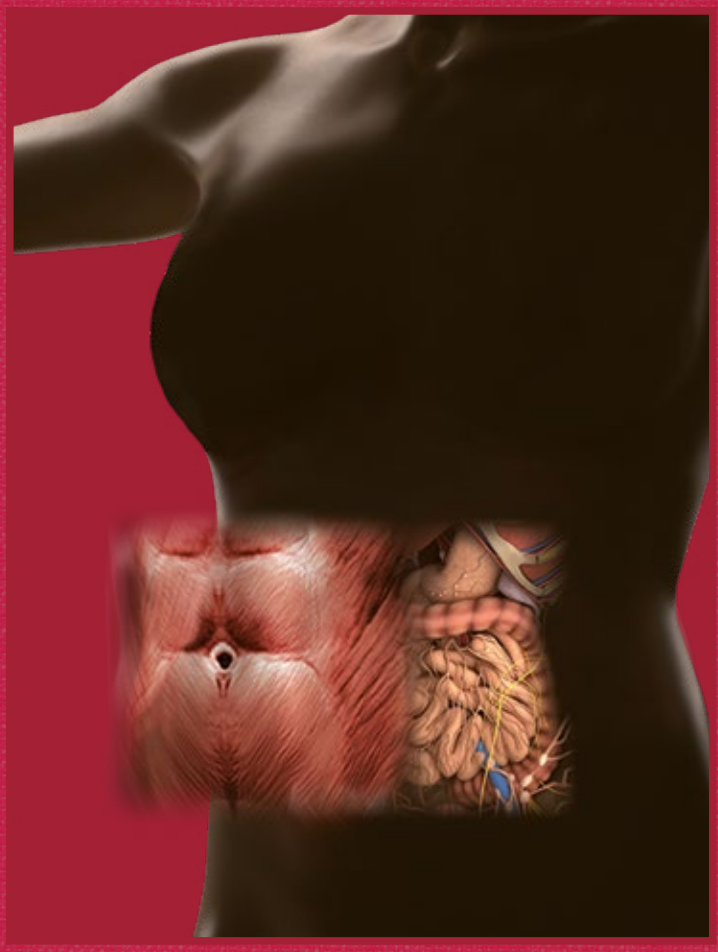
HUMAN ANATOMY

TOPOGRAPHIC APPROACH

Isabella BARAJON
Vincenzo BENAGIANO
Rita BUSINARO
Francesco CAPPELLO
Sergio CASTORINA
Claudio CELEGHINI
Angela DI BALDASSARRE
Andrea FRONTINI
Marco GESI
Stefano GEUNA
Antonio GIORDANO
Ludovico MAGAUDDA
Daniela MURTAS
Stefania A. NOTTOLA
Paolo ONORI
Alessandra PACINI
Filippo RENÒ
Domenico RIBATTI
Luigi Fabrizio RODELLA
Daniele SAVERINO
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Carlo TACCHETTI
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Andrea Frontini
Marco Gesi
Stefano Geuna
Antonio Giordano
Ludovico Magaudda
Daniela Murtas
Stefania A. Nottola
Paolo Onori
Alessandra Pacini
Filippo Renò
Domenico Ribatti
Luigi Fabrizio Rodella†
Daniele Saverino
Guglielmo Sorci
Carlo Tacchetti
Maurizio Vertemati

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Estomih Mtui (Editor English Edition)

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For enquiries or suggestions about this volume, please use the following address:
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PREFACE

During a clinical examination or diagnostic images, as well as during a surgery, the doctor and the surgeon are faced with a sort of three-dimensional puzzle in which various anatomical structures delimit or occupy *spaces*, or define *cavities*, that are related to each other independently of the functions they perform. These structures are projected onto the body surface defining imaginary "fields", the *regions*, which represent real two-dimensional maps. The ability to imagine, and mentally organize, this three-dimensional puzzle, making use of surface projections and knowledge of the boundaries of spaces and cavities, of the reciprocal relationships that the various organs and vascular, lymphatic and nervous structures have internally and with the surrounding bony and/or muscular structures, is a daily necessity in medical practice. The study of *Topographic Anatomy* helps to acquire these skills; in fact, it is the compendium of all methods of approach to the study of anatomy included in the definitions such as Regional Anatomy, Medical-Surgical Anatomy, Radiological Anatomy, Applied Practical Anatomy, Clinical Anatomy.

It is from these considerations that the Authors decided to write a new original text of the Italian Anatomical School for medical students, convinced that *Topographic Anatomy* is an indispensable complement to Systemic Anatomy as it motivates and clarifies the applications of anatomical concepts to many aspects of practical medicine. We tried to be concise and to provide a method. At the same time, clinical references have been proposed to highlight the relevance of certain knowledge in medical practice. The abundance and richness of the iconographic material, created to facilitate the understanding and memorization of the most significant anatomical data, make this text a useful integration in the study of Human Anatomy.

In conclusion, we sought essentiality, practicality and alignment with current teaching trends, aimed at students of the New Millennium. We hope that we have succeeded in providing the medical student with a valid professional preparation tool. Certainly, if these objectives will be achieved, it will also be due to the inspiration and ideas taken from the valuable work done by the Authors of the text of Topographic Anatomy published for the first time by Edi. Ermes in 1978. To the colleagues who took part as Authors (E. Brizzi, M. Casini, S. Castorina, A.T. Franzi, A.C. Levi, A. Lucheroni, G. Marinozzi, A. Miani, P. Pacini, T. Renda, A. Ruggeri, A. Santoro, A. Soscia) goes the gratitude and recognition of all of us.

The Authors &
Estomih Mtui
(Editor English Edition)

Virtual Campus

The volume is enriched by an online platform (*Virtual Campus*), accessible through the code shown at the beginning of the volume. In this virtual area, some resources are available such as: video lectures, interactive 3D reconstructions of organs or anatomical regions, starting from CT or MRI scans, commented videos, interactive stratigraphic animations, elements of microscopic anatomy, flash cards.

The code also enables the download of the digital version of the book. Instructions are available in the platform.

Both access to the platform and consultation of the digital book are available for a limited time starting from registration date.

AUTHORS

Estomih MTUI	**Editor English Edition** Weill Cornell Medicine, New York, USA
Isabella BARAJON	Dipartimento di Scienze Biomediche, Humanitas University, Milano
Vincenzo BENAGIANO	Dipartimento di Scienze Mediche di Base, Neuroscienze e Organi di Senso, Università degli Studi Aldo Moro, Bari
Rita BUSINARO	Dipartimento di Scienze e Biotecnologie Medico-Chirurgiche, Facoltà di Farmacia e Medicina, Università Sapienza, Latina
Francesco CAPPELLO	Dipartimento di Biomedicina, Neuroscienze e Diagnostica Avanzata, Università degli Studi, Palermo
Sergio CASTORINA	Dipartimento di Scienze Mediche, Chirurgiche e Tecnologie Avanzate G.F. Ingrassia, Scuola di Medicina, Università degli Studi, Catania
Claudio CELEGHINI	Dipartimento di Morfologia, Chirurgia e Medicina Sperimentale, Università degli Studi, Ferrara
Angela DI BALDASSARRE	Dipartimento di Medicina e Scienze dell'Invecchiamento, Scuola di Medicina e Scienze della Salute, Università degli Studi G. D'Annunzio, Chieti
Andrea FRONTINI	Dipartimento di Sanità Pubblica, Medicina Sperimentale e Forense, Università degli Studi, Pavia
Marco GESI	Dipartimento di Ricerca Traslazionale e delle Nuove Tecnologie in Medicina e Chirurgia, Università degli Studi, Pisa
Stefano GEUNA	Neuroscience Institute Cavalieri Ottolenghi, Università degli Studi, Torino
Antonio GIORDANO	Dipartimento di Medicina Sperimentale e Clinica, Facoltà di Medicina e Chirurgia, Università Politecnica delle Marche, Ancona
Ludovico MAGAUDDA	Dipartimento di Scienze Biomediche, Odontoiatriche e delle Immagini Morfologiche e Funzionali, Facoltà di Medicina e Chirurgia, Università degli Studi, Messina
Daniela MURTAS	Dipartimento di Scienze Biomediche, Facoltà di Medicina e Chirurgia, Università degli Studi, Cagliari
Stefania A. NOTTOLA	Dipartimento di Scienze Anatomiche, Istologiche, Medico-Legali e dell'Apparato Locomotore, Facoltà di Farmacia e Medicina, Università Sapienza, Roma
Paolo ONORI	Dipartimento di Scienze Anatomiche, Istologiche, Medico-Legali e dell'Apparato Locomotore, Facoltà di Farmacia e Medicina, Università Sapienza, Roma
Alessandra PACINI	Dipartimento di Medicina Sperimentale e Clinica, Scuola di Scienze della Salute Umana, Università degli Studi, Firenze
Filippo RENÒ	Dipartimento di Scienze della Salute, Scuola di Medicina, Università degli Studi, Novara
Domenico RIBATTI	Dipartimento di Scienze Mediche di Base, Neuroscienze e Organi di Senso, Università degli Studi, Bari
Luigi Fabrizio RODELLA†	Dipartimento di Scienze Cliniche e Sperimentali, Facoltà di Medicina e Chirurgia, Università degli Studi, Brescia
Daniele SAVERINO	Dipartimento di Medicina Sperimentale, Scuola di Scienze Mediche e Farmaceutiche, Università degli Studi, Genova
Guglielmo SORCI	Dipartimento di Medicina Sperimentale, Scuola di Medicina e Chirurgia, Università degli Studi, Perugia
Carlo TACCHETTI	Facoltà di Medicina e Chirurgia, Università Vita-Salute San Raffaele, Milano
Maurizio VERTEMATI	Dipartimento di Scienze Biomediche e Cliniche L. Sacco, Facoltà di Medicina e Chirurgia, Università degli Studi, Milano

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1.2.2 TEMPORAL AND INFRATEMPORAL REGIONS

Temporal region	It corresponds to the temporal fossa of the cranium and is bounded by the posterior border of the zygomatic bone, by the zygomatic process of the frontal bone and by the temporal line on the frontal bone (anteriorly), by the superior temporal line up to the asterion (posteriorly and superiorly) and by a horizontal line passing through the inferior border of the zygomatic bone (inferiorly)		
Regions	**Infratemporal region**	Superficial area of the temporal region that corresponds to the zygomatic arch	
Skin	Anterior part: glabrous, thin and mobile Posterior two-thirds: it is covered by **hair** and is particularly robust (**scalp**)		
Subcutaneous tissue	**Skin ligaments**	Short, dense fibrous bridles that from the deep surface of the dermis continue into the musculoaponeurotic layer	
	Muscles	Auricularis anterior and auricularis superior	
Superficial vessels and nerves	*Arteries*	Superficial temporal artery (a terminal branch of the external carotid artery, provides the zygomatico-orbital and middle temporal arteries)	
	Veins	Superficial temporal vein	
	Lymphatic vessels	The vessels anterior to the auricle drain into the parotid nodes The vessels posterior to the auricle drain into the mastoid nodes	
	Nerves	Branches of the facial nerve, branches of the zygomatic nerve, great auricular nerve, auriculotemporal nerve, branches of the lesser occipital nerve	
Fasciae	**Temporal fascia**	Robust fibrous lamina, which has the shape of the temporal region and extends as far as this	
Connective tissue spaces	**Temporal compartment**	Space between the skeletal plane and the temporal fascia	
		Contents: Adipose tissue	
		Muscles: Temporalis	
		Arteries: Middle temporal, posterior deep temporal and anterior deep temporal arteries	
		Veins: Deep temporal veins	
		Nerves: Deep temporal nerves (from the mandibular nerve)	
Skeletal plane	**Pericranium**	External periosteum of the cranium, in this region particularly adherent to the joints	
		Bones: Part of the parietal bone, squamous part of the temporal bone, part of the frontal bone, greater wing of the sphenoid	
		Structures: **Groove for the middle temporal artery** — Longitudinal depression on the lateral surface of the temporal bone	
		Structures: **Infratemporal crest** — Elongated prominence of the sphenoid that separates the temporal region from the infratemporal fossa	
		Arteries: Middle meningeal artery (a branch of the maxillary artery)	

The **temporal region** corresponds to the temporal fossa of the cranium.



POSITION, BOUNDARIES AND RELATIONSHIPS

The temporal region is bounded (**Fig. 1.14**):

- anteriorly: by the posterior border of the zygomatic bone, by the zygomatic process of the frontal bone and by the temporal line on the frontal bone;
- posteriorly and superiorly: by the superior temporal line for all its extension on the parietal bone to a point corresponding to the posteroinferior angle of the parietal bone (asterion);
- inferiorly: by a horizontal line passing through the inferior border of the zygomatic arch.

An additional region of interest can be identified, the **infratemporal region**, which corresponds to the zygomatic arch.

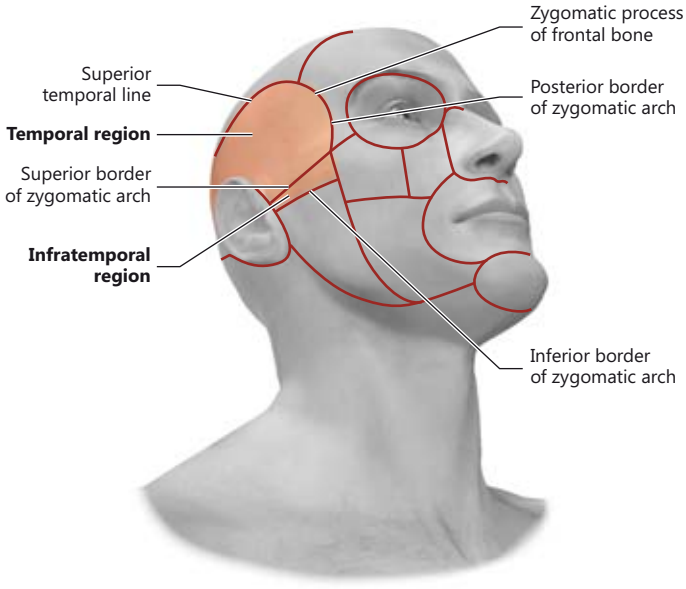


Figure 1.14 - Occipitofrontal region of the head: boundaries. The infratemporal region, which corresponds to the zygomatic arch, is observed in this region.

STRATIGRAPHIC EXAMINATION

Skin

In the anterior part of the temporal region, the skin is glabrous, thin and mobile. However, it is covered by hair in the posterior two-thirds, thus with the features of the scalp.

Subcutaneous tissue

In the anterior part of the temporal region, the connective tissue is areolar. However, in the posterior two-thirds, it has the features of the scalp with the two areolar and lamellar layers separated by the epicranial aponeurosis (**Fig. 1.15**).

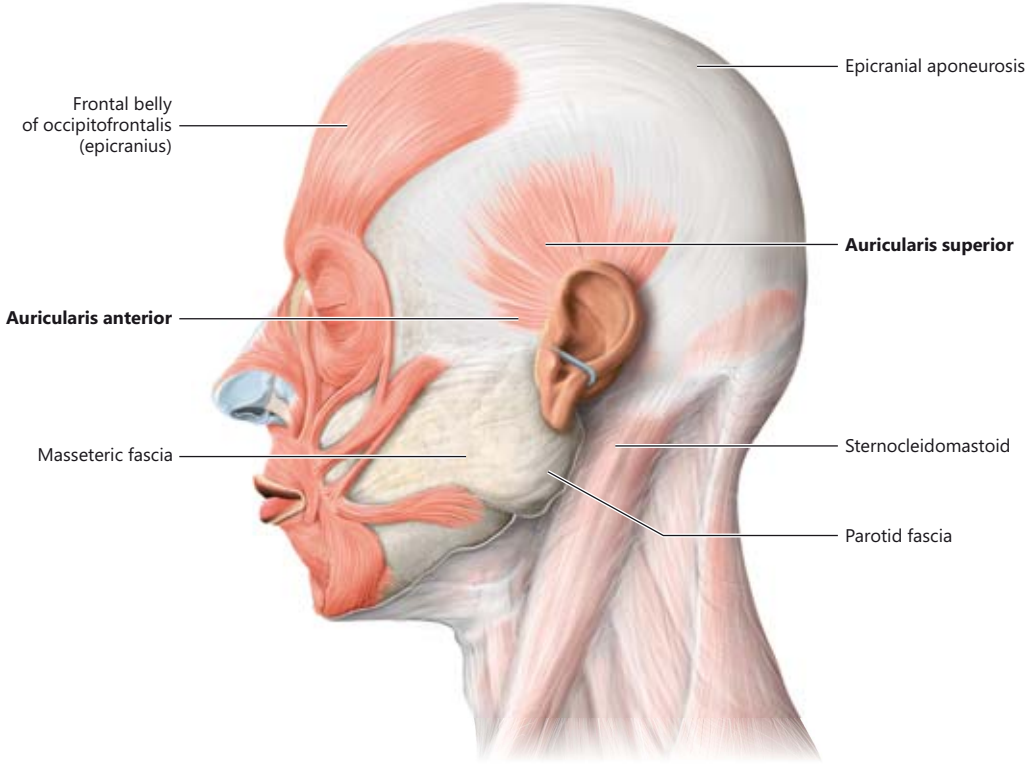


Figure 1.15 - Epicranial aponeurosis and superficial muscles of the head in a lateral view. The muscles of the temporal region are highlighted.

GENERAL ORGANIZATION AND MORPHOLOGY

A lateral, concave surface and a medial, convex surface can be distinguished in the auricle (**Fig. 1.22**).

Lateral surface

In the anteroinferior part of the lateral surface (**Fig. 1.19 a**) there is a depression, called **concha of the auricle**, at the base of which the external acoustic meatus opens; the concha of the auricle is circumscribed forward by the tragus and the root of the helix, backward by the antitragus, upward and backward by the antihelix.

The rest of the auricle develops, especially at the top and back, around the concha of the auricle: an elevated edge, the **helix**, which begins forward at the base of the concha of the auricle and ends backward and downward in the **lobule of the auricle**, and, internally to this, a second relief, the **antihelix**, which ends at the external border of the concha of the auricle with a protrusion, the **antitragus**, can be distinguished.

The helix is divided from the antihelix by two depressions: the first, the **groove of the helix**, is located posterosuperiorly, while the second, the **triangular fossa**, lies between the anterosuperior portion of the antihelix and the posterior border of the anteromedial portion of the helix.

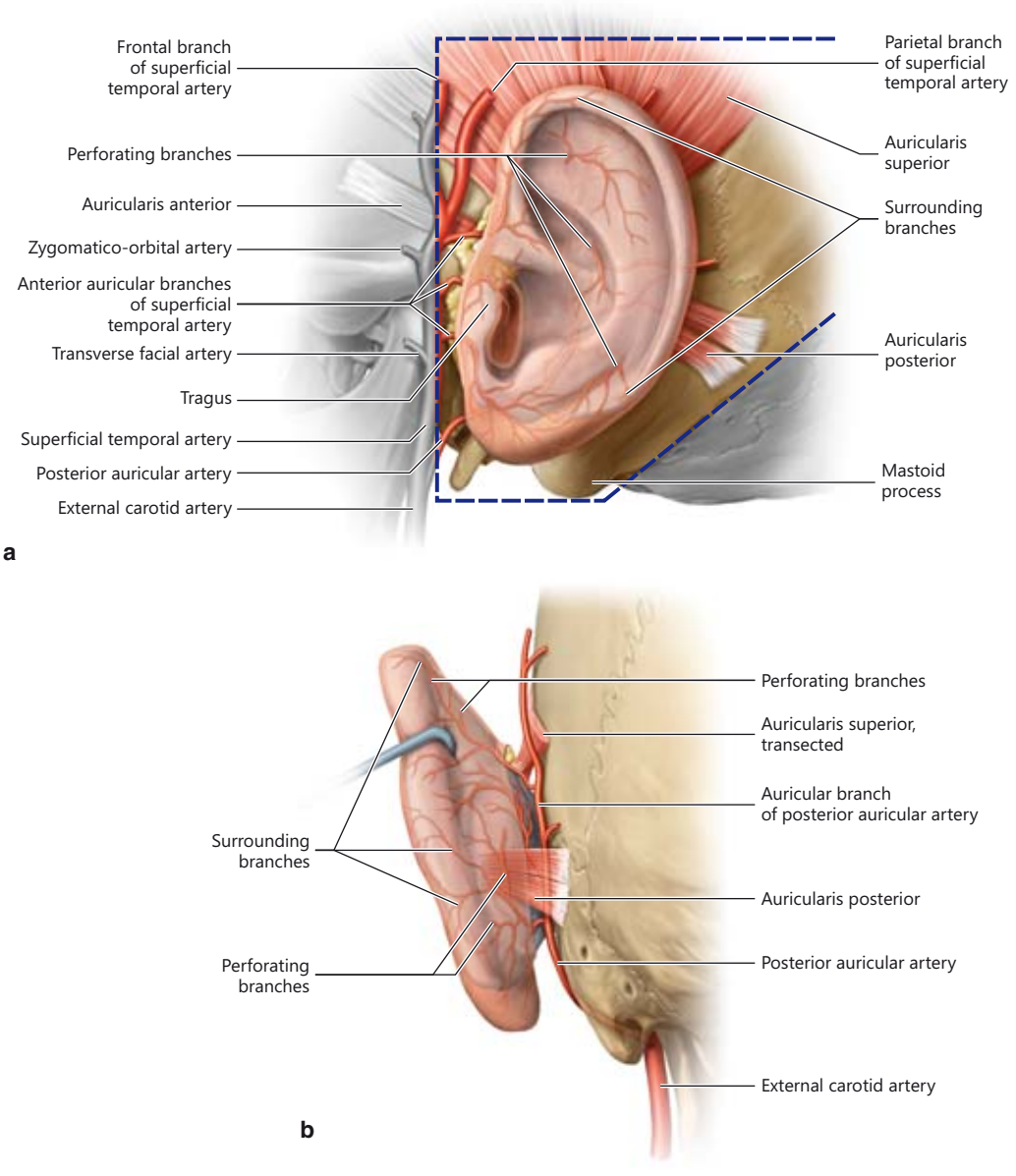


Figure 1.22 - External ear. Arteries and muscles of the auricle in a lateral view (**a**) and a posterior view (**b**) of the left external ear. In **a**, the boundaries of the auriculomastoid region are shown.

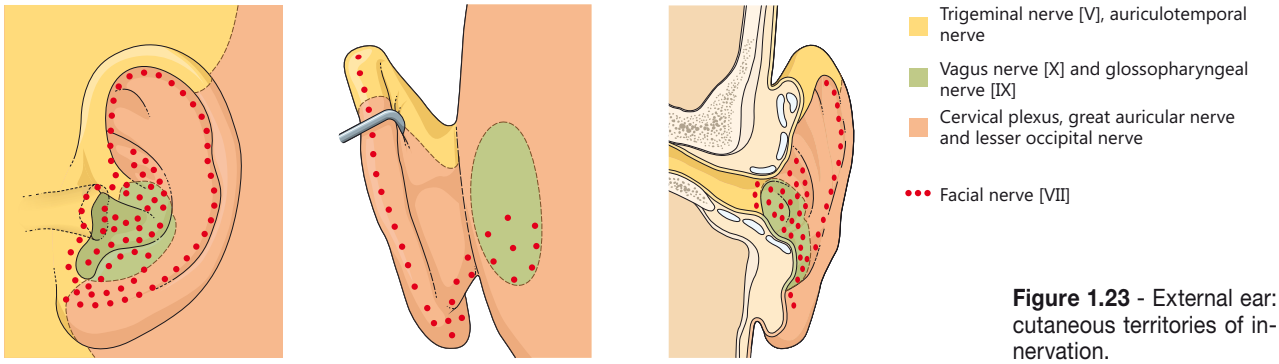


Figure 1.23 - External ear: cutaneous territories of innervation.

A laminar relief, the **tragus**, is observed in front of the anterior border of the concha of the auricle and delimits the opening of the external acoustic meatus.

Medial surface

The medial surface (**Fig. 1.22 b**) of the auricle adheres to the lateral wall of the cranium with its anterior portion. The free part delimits, with the surface of cranium, the **auriculomastoid** (or *retroauricular*) **sulcus**. It has grooves and reliefs corresponding to those of the lateral surface.

STRATIGRAPHIC EXAMINATION

Skin

The skin of the auricle is smooth, thin, not very mobile and glabrous. On the medial surface of the tragus there are, in the adults, stiff hairs, the **tragi**, located almost at the entrance of the external acoustic meatus.

Subcutaneous tissue

On the lateral surface of the auricle, it is thin, but dense, and closely joins the dermis with the perichondrium; on the medial surface, it is looser, so as to allow a certain mobility of the skin.

This layer contains bundles of the **auricularis anterior**, **auricularis superior** and **auricularis posterior** (**Figs. 1.21**, **1.23**) that insert on the lateral border of the epicranial aponeurosis (**Fig. 1.15**) and descend up to the auricle.

Superficial vessels and nerves

- **Arteries** (**Fig. 1.22**): the subcutaneous arteries are branches of the superficial temporal artery (anteriorly) and the posterior auricular artery (posteriorly).
- **Veins**: they follow the subcutaneous arteries.
- **Lymphatic vessels** (**Fig. 1.3**): they drain into the mastoid nodes.
- **Nerves** (**Fig. 1.23**): they are branches of the facial nerve, to the mimic muscles, and branches of the auriculotemporal and great auricular nerves, to the skin.

Skeletal plane

The skeleton of the auricle consists of a lamina of elastic cartilage that repeats the peculiarities of the external shape of the auricle (**Fig. 1.24**). This lamina continues with the cartilage of the external acoustic meatus.

Morphological variations

The auricle has many varieties of shape and implantation on the head. The lower contour of a well-formed auricle slightly surpasses a horizontal line conducted through the base of the external nose; the upper contour is tangent to the horizontal plane passing through the convexity of the eyebrow.

The angle formed by the medial surface of the auricle with the lateral surface of the head (*cephaloauricular angle*) varies with its implantation mode. An angle of 20-30° is considered normal, but it can also reach 90° (handle-ears), or be very small so as to make it look like the auricle is attached to the cranium. ■

Table 1.3 Normal values of cerebrospinal fluid and serum composition *continued*

	Cerebrospinal fluid	*Serum*
Ammonium	30 g dL^{-1}	70 g dL^{-1}
Uric acid	0.24 mg dL^{-1}	5.5 mg dL^{-1}
Urea	4.7 mmol L^{-1}	5.4 mmol L^{-1}
Creatinine	1.1 mg dL^{-1}	1.8 mg dL^{-1}
Phosphate	1.6 mg dL^{-1}	4 mg dL^{-1}
Total lipids	1.5 mg dL^{-1}	750 mg dL^{-1}
Total cholesterol	0.3 mg dL^{-1}	126 mg dL^{-1}
Glucose	60 mg dL^{-1}	90 mg dL^{-1}
Total protein	15-50 mg dL^{-1}	6.5-8.4
Albumin	49-73%	56%
α1 globulin	3-7%	4%
α2 globulin	6-13%	10%
β globulin	9-19%	12%
χ globulin	3-12%	14%
Erythrocytes	0	0

1.2.5 CRANIAL CAVITY: BRAIN

Cranial cavity	It is bounded by the bones of the neurocranium, it houses the cranial meninges (§ 1.2.4) and the brain. It is divided into four compartments.
Cerebral compartment (§ 1.2.5.1)	It is bounded by the calvaria (superiorly and laterally), by the anterior and middle cranial fossae and by the tentorium cerebelli (inferiorly). It accomodates the **telencephalon**, **diencephalon**, **mesencephalon** and **basal nuclei**
Rhombencephalon cavity (§ 1.2.5.2)	It is bounded by the tentorium cerebelli (superiorly), by the clivus and by the posterior surface of the petrous part of the temporal bone (anteriorly) and by the cerebellar fossae of the occipital bone (inferiorly). It communicates with the cerebral compartment through the **foramen ovale of Pacchioni** and is in continuity with the vertebral canal through the **foramen magnum**. It accommodates the **cerebellum**, **pons** and **medulla oblongata**
Hypophysial compartment (§ 1.2.5.3)	Unpaired cavity of the cranial dura mater between the diaphragma sellae of the dura mater and the fundus of the sella turcica of the sphenoid. It accommodates the **pituitary gland** and the **cavernous**, **intercavernous** and **circular sinuses**
Trigeminal cave (or cavity of Meckel) (§ 1.2.5.4)	It is formed by a splitting of the cranial dura mater that lines the cranial base. It accommodates the **trigeminal ganglion**

From a topographic point of view, the **cranial cavity** is subdivided into four compartments of very different sizes, having to accommodate the different parts of the brain:

- *cerebral compartment*: it is the largest and accommodates the prosencephalon and mesencephalon;
- *rhombencephalon cavity* or *cerebellar compartment*: it accommodates the metencephalon and medulla oblongata;
- *hypophysial compartment*: it is small in size and accommodates the pituitary gland;
- *trigeminal cave* (*cavity of Meckel*): dural invagination that accommodates the trigeminal ganglion (ganglion of Gasser) and the origin of the ophthalmic, maxillary and mandibular branches.

The formation of the compartments retraces the development of the supraxial nervous formations that occurs during fetal life (**Fig. 1.43**).

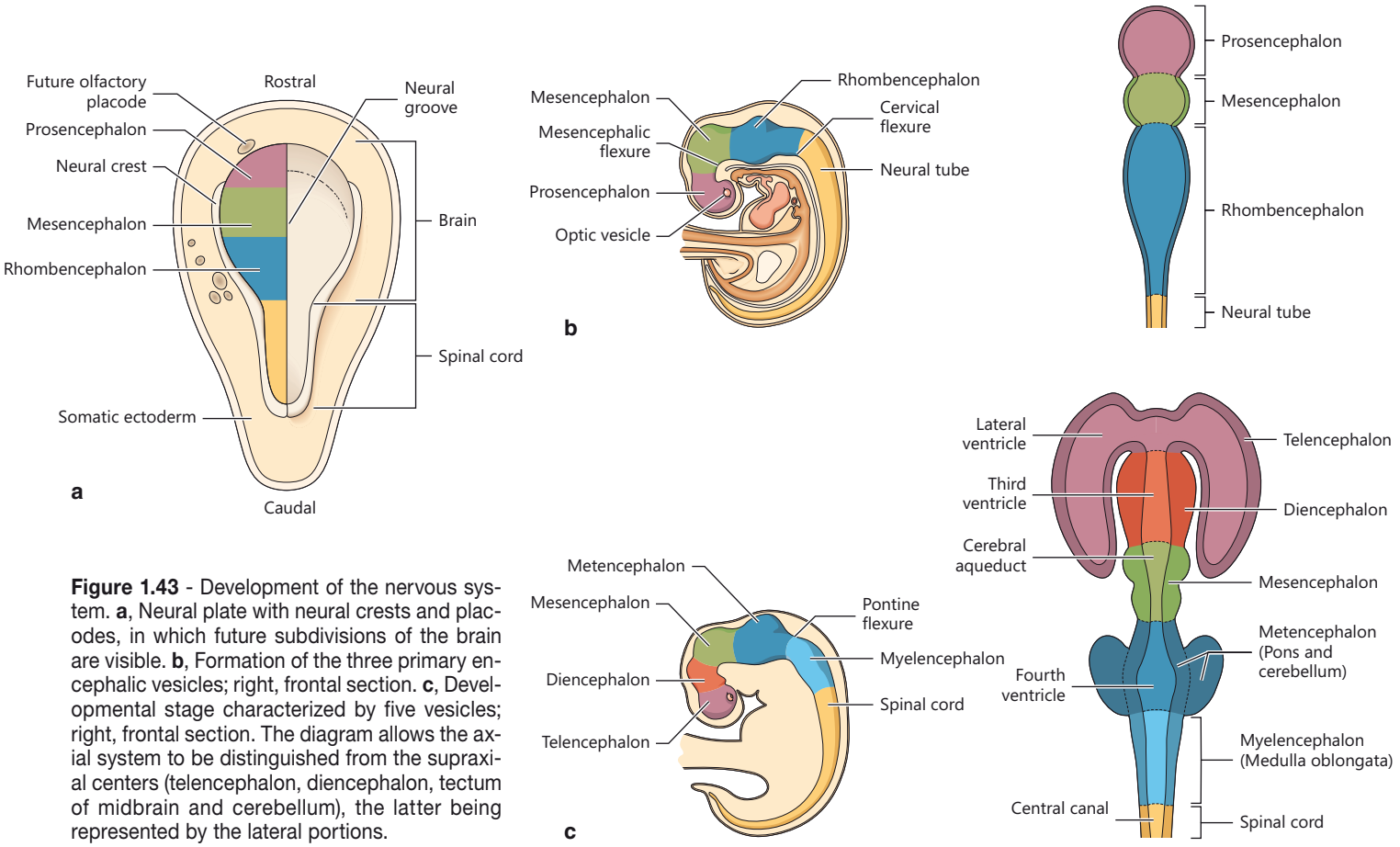


Figure 1.43 - Development of the nervous system. **a**, Neural plate with neural crests and placodes, in which future subdivisions of the brain are visible. **b**, Formation of the three primary encephalic vesicles; right, frontal section. **c**, Developmental stage characterized by five vesicles; right, frontal section. The diagram allows the axial system to be distinguished from the supraxial centers (telencephalon, diencephalon, tectum of midbrain and cerebellum), the latter being represented by the lateral portions.

CEREBRAL COMPARTMENT 1.2.5.1

Cerebral compartment		It is bounded by the calvaria (superiorly and laterally), by the anterior and middle cranial fossae and by the tentorium cerebelli (inferiorly)
Telencephalon		Supraxial formation deriving from the first encephalic vesicle (prosencephalon) and higher integration center of all nervous activities (brain)
Diencephalon		Complex of gray, unpaired and median formations, shaped like a truncated pyramid, located rostrally to the mesencephalon and deeply wedged into the cerebral hemispheres
Mesencephalon (midbrain)		It is the second of the three encephalic vesicles arising from the neural tube
Basal nuclei		Subcortical formations of gray matter belonging to the telencephalon (corpus striatum), to the diencephalon (subthalamic nucleus) and to the mesencephalon (substantia nigra)
Vessels	*Arteries*	They come from the anterior, middle and posterior cerebral arteries and from branches forming the cerebral arterial circle
	Veins	Vessels coming from the white matter of the superficial part of the semioval centrer and from the cerebral cortex flow into the venous network of the cranial pia mater, then into the leptomeningeal venous trunks and into the superior and inferior cerebral veins. Vessels coming from the central gray nuclei, from the walls of the ventricles and from the central part of the semioval center flow into the veins of the septum pellucidum, into the superior thalamostriate vein and into the superior choroid vein, which constitute the roots of the internal cerebral vein, tributary of the great cerebral vein

The **cerebral compartment** (**Fig. 1.44**) accommodates the *prosencephalon – telencephalon* and *diencephalon* – the *mesencephalon* (midbrain) and the *basal nuclei*, a group of gray matter formations belonging to the telencephalon, diencephalon and mesencephalon.

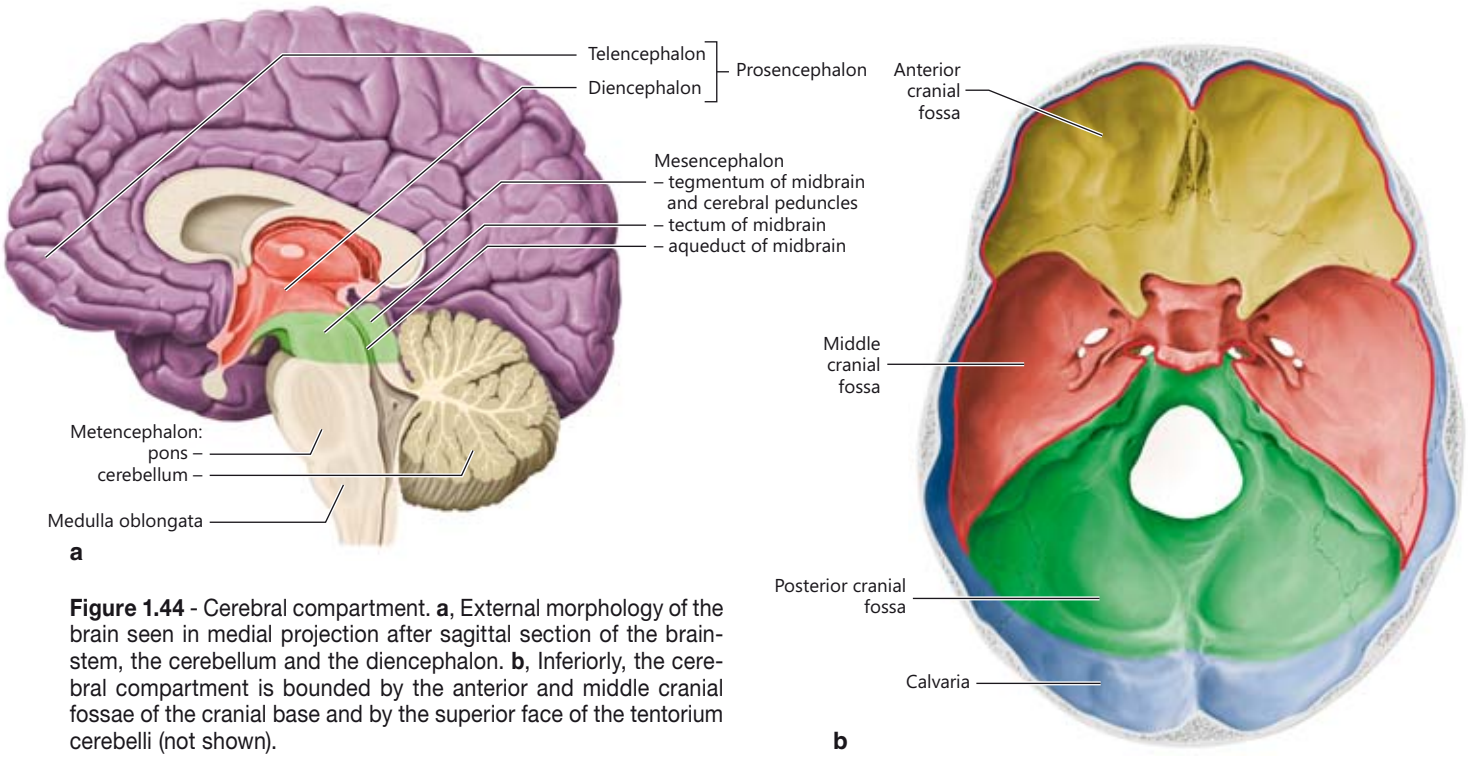


Figure 1.44 - Cerebral compartment. **a**, External morphology of the brain seen in medial projection after sagittal section of the brainstem, the cerebellum and the diencephalon. **b**, Inferiorly, the cerebral compartment is bounded by the anterior and middle cranial fossae of the cranial base and by the superior face of the tentorium cerebelli (not shown).



POSITION, BOUNDARIES AND RELATIONSHIPS

The cerebral compartment is bounded (**Fig. 1.41**):

- superiorly and laterally: by the calvaria;
- inferiorly: by an irregular surface, consisting of the anterior cranial fossa, by the middle cranial fossa and by the superior surface of the tentorium cerebelli.

The falx cerebelli, arranged sagittally, divides it into two halves, right and left, which communicate with each other below the falx and with the rhombencephalon compartment through the foramen ovale of Pacchioni.

Telencephalon

Telencephalon	Supraxial formation deriving from the first encephalic vesicle (prosencephalon) and higher integration center of all nervous activity (brain)		
Structures	**Longitudinal cerebral fissure**	It divides the telencephalon into two **cerebral hemispheres** and accommodates the falx cerebri	
	Cerebral cortex	Gray matter lining characterized by sulci and gyri. The sulci divide the telencephalon into lobes (primary sulci) and gyri (secondary sulci)	
	White matter of the telencephalon	Large mass of white matter consisting of projection myelinated nerve fibers, intrahemispheric and interhemispheric association nerve fibers and projection nerve fibers. It is lined by the cerebral cortex	
	Structures	**Semioval center**	Region of maximum extension of the white matter of the telencephalon
		Extreme, external and internal capsules	Laminae of white matter of the telencephalon between which formations of gray matter belonging to the basal nuclei are interposed
		Interhemispheric association fibers	They connect the right and left hemispheres and include the **corpus callosum**, the **septum pellucidum** and the **fornix**
	Lateral ventricles	Paired, irregularly shaped cavities excavated in the thickness of the cerebral hemispheres. They communicate with the third ventricle through the **interventricular foramen**	

The **telencephalon** is the portion of the brain with the greatest extent in humans. It constitutes the higher integration center of all nervous activities.

GENERAL ORGANIZATION AND MORPHOLOGY



The telencephalon (**Figs. 1.44**, **1.45**) is ovoid in shape with a major sagittal axis and a greater extension of the posterior extremity. Its weight is variable according to gender (from 1180 g in men to 1080 g in women, while the weight of the whole brain is in average 1320 g in men and 1167 g in women). In men, the sagittal diameter measures 17-18 cm, while the transverse diameter is 13-14 cm and the vertical diameter is 12-13 cm; in women, these diameters are about 1 cm lower.

Superior surface

It is convex and is related to the concavity of the calvaria.

Inferior surface

It is very irregular and relates to the anterior and middle cranial fossae and to the superior surface of the tentorium cerebelli. It is largely formed by the cerebral hemispheres but, on the median plane, there are formations belonging to the diencephalon, such as the optic chiasm (chiasma), the tuber cinereum, the infundibulum and the mammillary bodies, and to the mesencephalon (midbrain), such as the posterior perforated substance and the cerebral peduncles.

The telencephalon is composed of a lining of gray matter, the *cerebral cortex*, placed above a large mass of *white matter* that, in turn, contains *formations of gray matter* – represented, in particular, by the corpus striatum – belonging to the basal nuclei.

The **longitudinal cerebral fissure** is median and divides the telencephalon into two *cerebral hemispheres* and accommodates the falx cerebri.

Two *lateral ventricles* are excavated in the thickness of the cerebral hemispheres.

CEREBRAL HEMISPHERES

Each cerebral hemisphere (**Fig. 1.45**) presents three surfaces, three rounded borders and two poles.

Medial surface

It is plane and vertical, limited by the longitudinal cerebral fissure and is related to the falx cerebri.

Superolateral surface

It is convex and corresponds to the calvaria.

Inferior surface

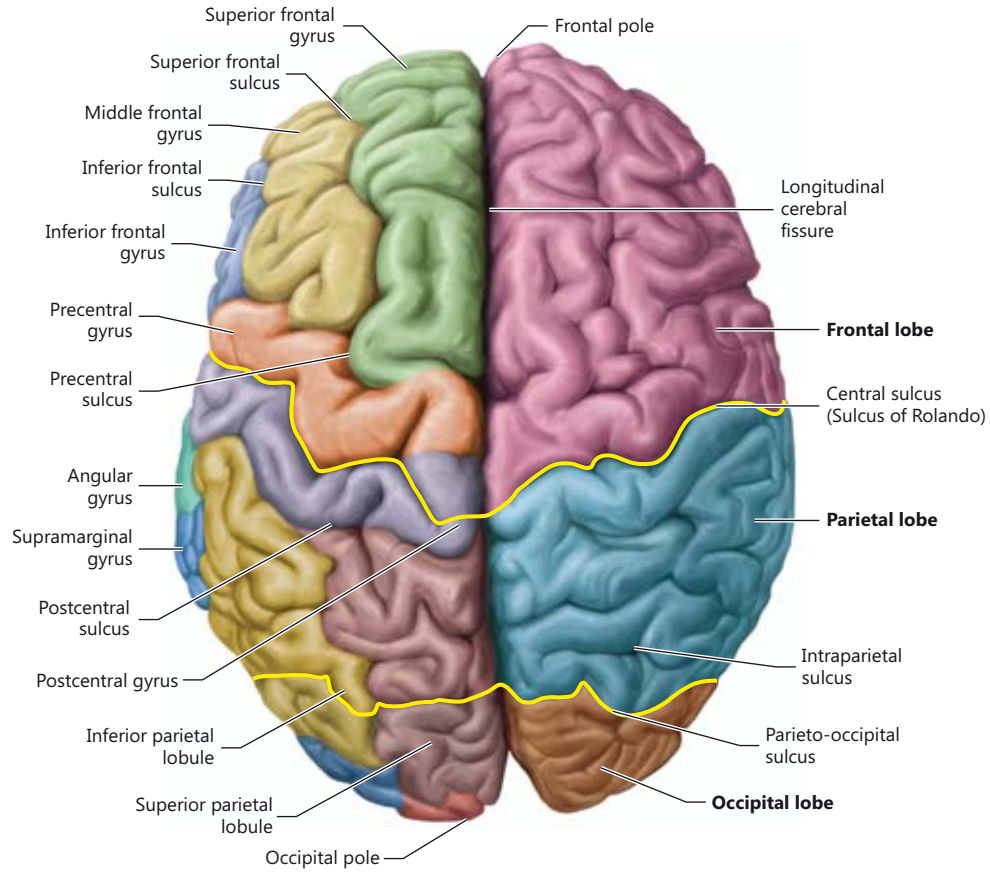
It is the most irregular. It has a deep fissure directed transversely, the *lateral sulcus*, located at the union of its anterior quarter with the posterior three-quarters. The portion situated in front of this fissure belongs to the frontal lobe and is related to the orbital tuber (eminence) of the frontal bone.

Medially, it presents the **olfactory bulb** with the **olfactory tract** resting on the olfactory groove of the ethmoid.

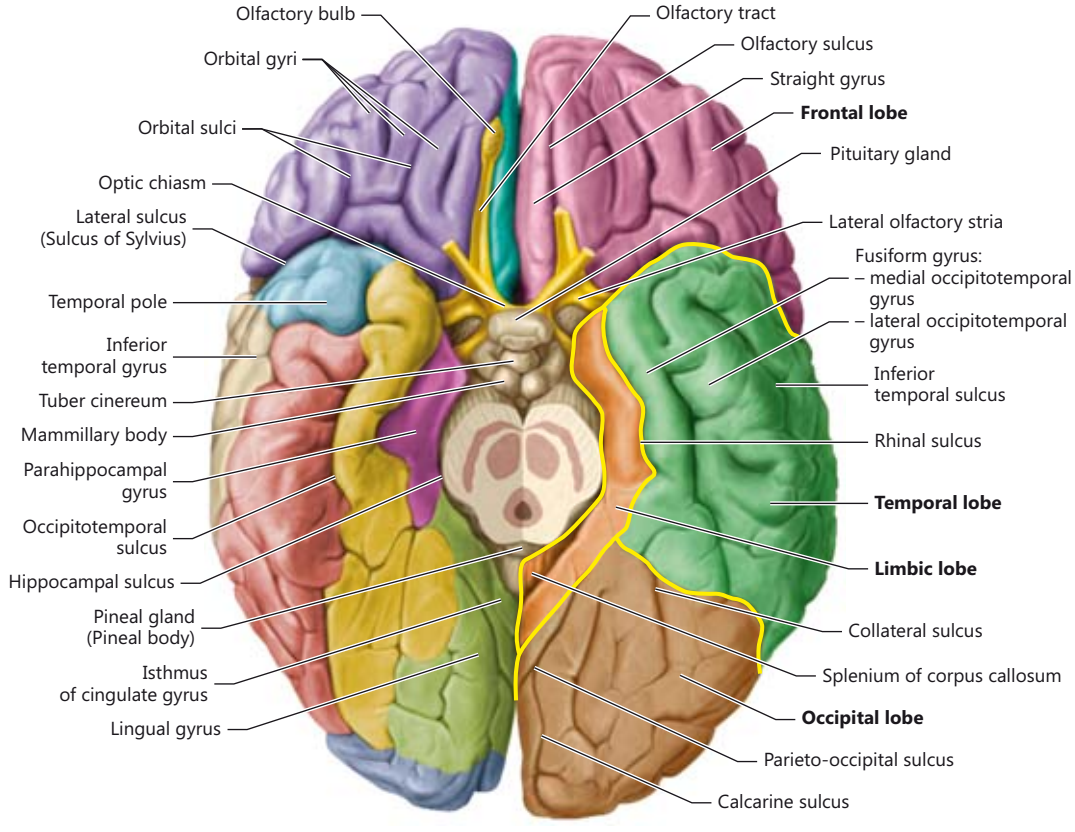
Posteriorly to the lateral sulcus, the inferior surface of the telencephalon is kidney-shaped with the hilum facing medially, occupies the lateral part of the middle cranial fossa and terminates forward with the **temporal pole**; its superior quarter belongs to the occipital lobe, is related to the tentorium cerebelli and terminates with the occipital pole.

Borders

The *superior border* corresponds to the longitudinal cerebral fissure, is convex and has relations with the superior sagittal sinus; the *inferolateral border* separates the superolateral surface from the inferior one; the *inferomedial border* medially delimits the basal surface of the cerebral hemisphere.


Superior frontal gyrus
Superior frontal sulcus
Middle frontal gyrus
Inferior frontal sulcus
Inferior frontal gyrus
Precentral gyrus
Precentral sulcus
Angular gyrus
Supramarginal gyrus
Postcentral sulcus
Postcentral gyrus
Inferior parietal lobule
Superior parietal lobule
Occipital pole
Frontal pole
Longitudinal cerebral fissure
Frontal lobe
Central sulcus (Sulcus of Rolando)
Parietal lobe
Intraparietal sulcus
Parieto-occipital sulcus
Occipital lobe

a


Olfactory bulb
Orbital gyri
Orbital sulci
Optic chiasm
Lateral sulcus (Sulcus of Sylvius)
Temporal pole
Inferior temporal gyrus
Tuber cinereum
Mammillary body
Parahippocampal gyrus
Occipitotemporal sulcus
Hippocampal sulcus
Pineal gland (Pineal body)
Isthmus of cingulate gyrus
Lingual gyrus
Olfactory tract
Olfactory sulcus
Straight gyrus
Frontal lobe
Pituitary gland
Lateral olfactory stria
Fusiform gyrus:
– medial occipitotemporal gyrus
– lateral occipitotemporal gyrus
Inferior temporal sulcus
Rhinal sulcus
Temporal lobe
Limbic lobe
Collateral sulcus
Splenium of corpus callosum
Occipital lobe
Parieto-occipital sulcus
Calcarine sulcus

b

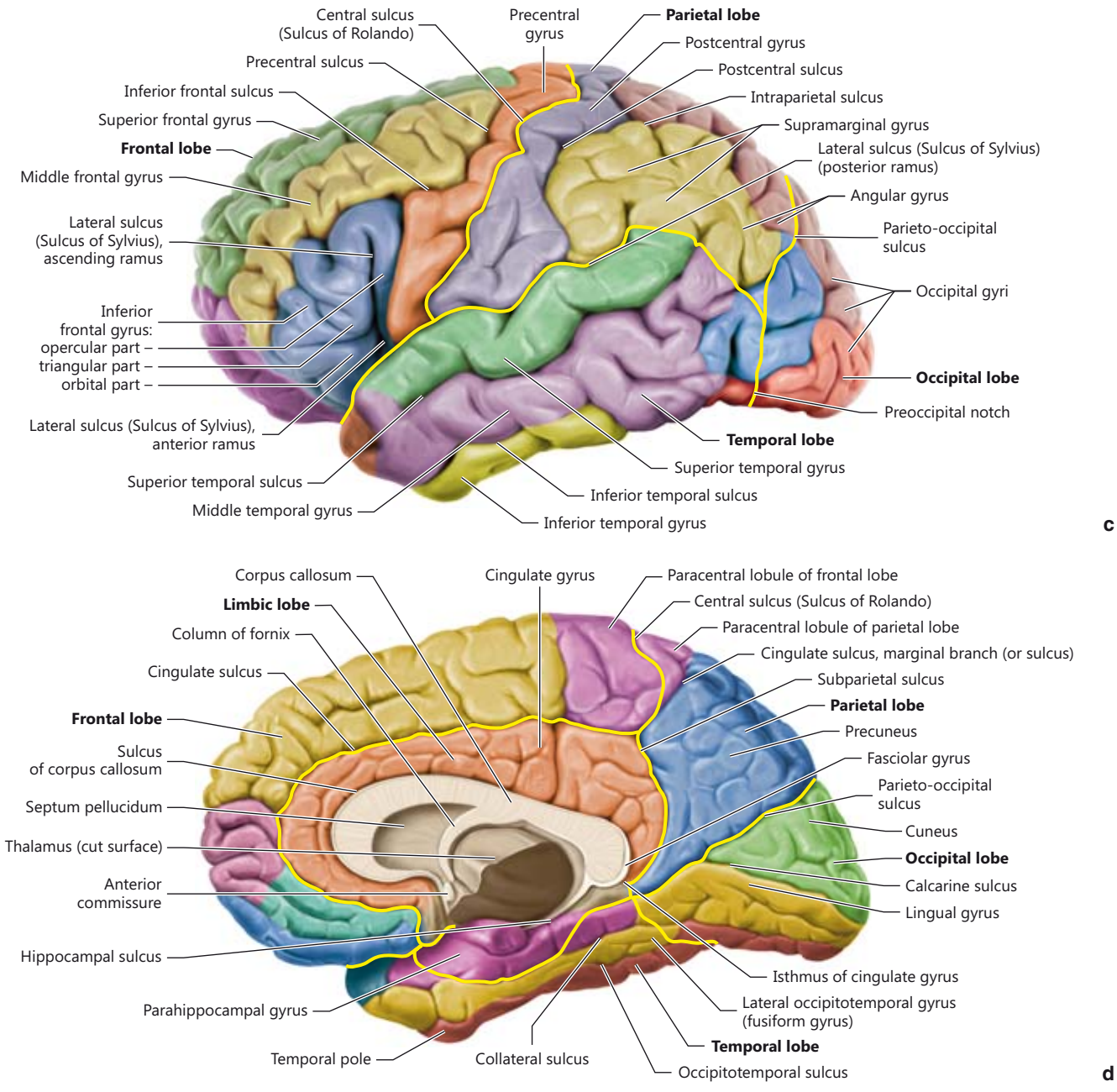


Figure 1.45 - Cerebral hemispheres: external morphology. Spatial division into the different lobes and gyri is shown. **a**, View from above. **b**, Inferior surface. **c**, Superolateral surface. **d**, Medial surface. Yellow lines show the division into lobes.

Poles

They are the **frontal pole** (anterior) and the **occipital pole** (posterior).

CEREBRAL CORTEX

Since birth, the cerebral cortex is characterized by the presence of *sulci*, or fissures, and reliefs, called *gyri*, which widen its extension. The morphology of the sulci and gyri can be different from one individual to another, but also in the same subject as age changes; however, some sulci are constant and identify the boundaries of the various *lobes* on the surface of the telencephalon.

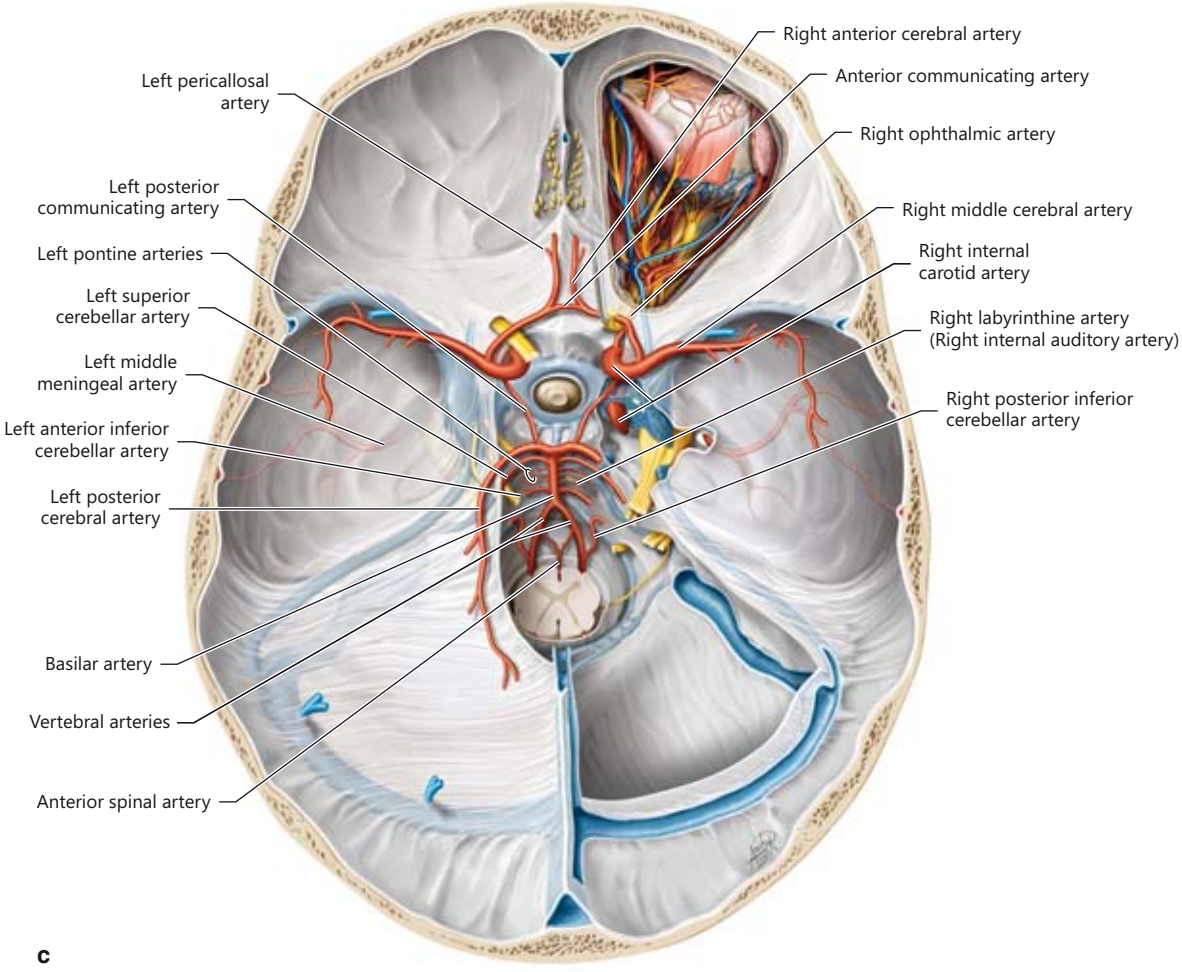


Figure 1.60 - Vessels of the brain: arteries (*continued*). **c**, Circle of Willis (cerebral arterial circle).

– the **posterior cerebral artery** supplies the parahippocampal, lateral occipitotemporal and inferior temporal gyri. It also leads to the cuneus, the lingual gyrus and the inferior and lateral surfaces of the occipital lobe.

Regarding the *deep territory*, the supply depends on the deep arteries that can be organized into three groups (**Fig. 1.61**):

– the anterior group includes branches of the anterior and middle cerebral arteries that distribute to the corpus striatum and the capsules. One of these, the **Charcot's artery of cerebral hemorrhage** runs between the lentiform (lenticular) nucleus and the external capsule and, after traversing the internal capsule, reaches the caudate nucleus;
– the middle group consists of branches of the posterior communicating and choroidal arteries directed to the thalamus;
– the posterior group includes branches from the posterior cerebral arteries directed to the thalamus.

- **Veins**: the vessels from the white matter of the superficial part of the semioval center and from the cortex of the cerebral hemispheres head to the venous network located, superficially, in the cranial pia mater and flow into the leptomeningeal venous trunks and into the superior and inferior cerebral veins (**Fig. 1.40**).

Superior cerebral veins
➲ Fig. 1.64

The vessels from the central gray nuclei, the walls of the ventricles and the central part of the semioval center flow into the **veins of the septum pellucidum**, the **superior thalamostriate vein** and the **superior choroid vein**, which constitute the roots of the **internal cerebral vein**, tributary of the **great cerebral vein** (*vein of Galen*).

Great cerebral vein
➲ Fig. 1.64

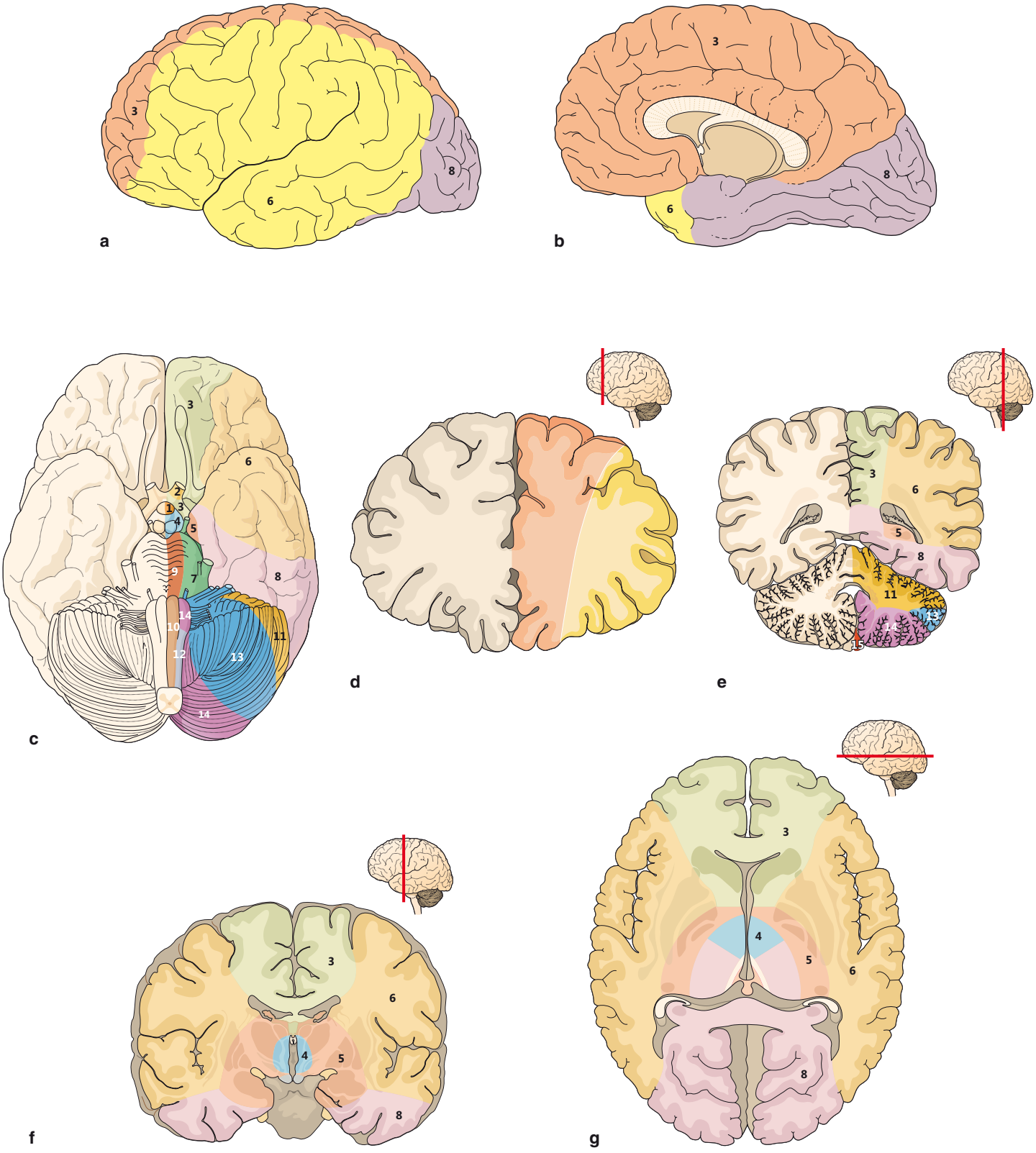


Figure 1.61 - Vessels of the brain: superficial (**a-c**) and deep (**d-g**) territories of supply. **1**, Internal carotid artery; **2**, ophthalmic artery; **3**, anterior cerebral artery; **4**, posterior communicating artery; **5**, anterior choroidal artery; **6**, middle cerebral artery; **7**, pontine arteries, lateral branches; **8**, posterior cerebral artery; **9**, pontine arteries, medial branches; **10**, anterior spinal artery; **11**, superior cerebellar artery; **12**, vertebral artery; **13**, anterior inferior cerebellar artery; **14**, posterior inferior cerebellar artery; **15**, posterior spinal artery.