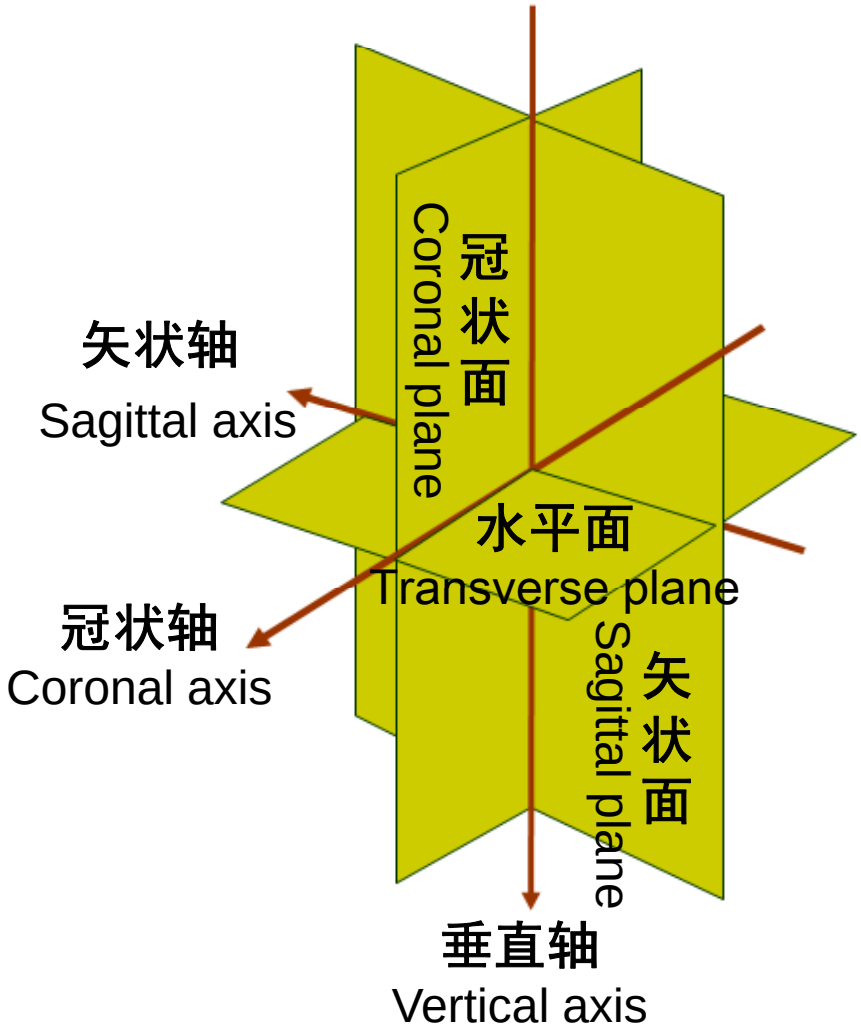
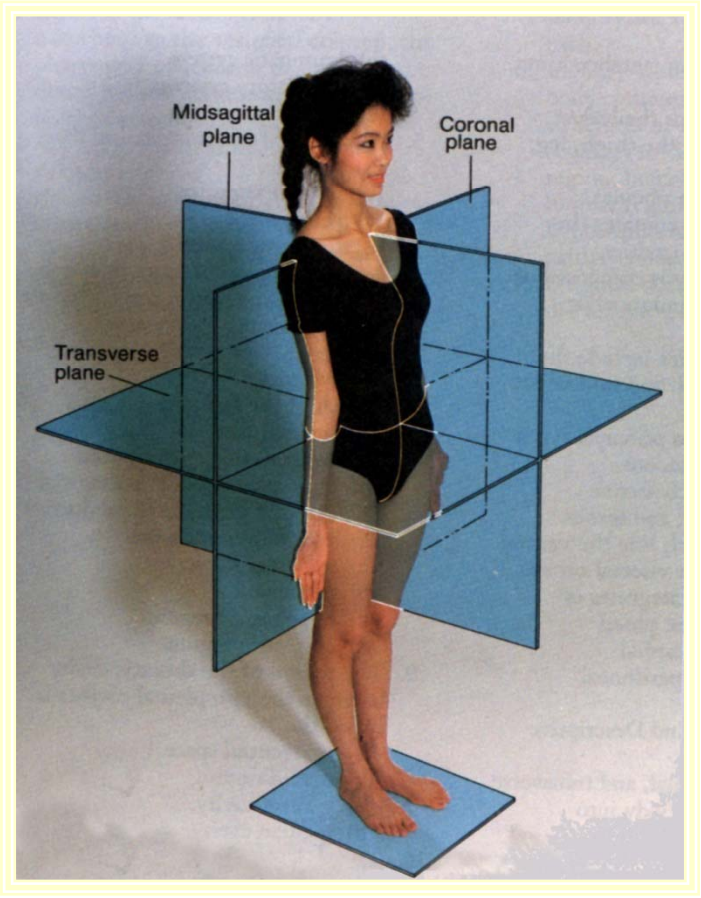
Anatomy of the Nervous System
Part I
神经解剖（一）

Yan Zhang
张研

Axes and planes

人体的轴和面





Anatomical terminology of orientationI

解剖学方位术语

Superior and inferior

Subject to the anatomical position, the cranium is superior and the feet are inferior.

上和下：按解剖学姿势，头居上，足在下。

Anterior and posterior

“Rostral ” is anterior and “caudal” is posterior.

前和后：靠身体嘴侧为前，而靠身体尾侧为后。

Ventralis and dorsalis

腹侧和背侧

Anatomical terminology of orientation

解剖学方位术语

Medialis and lateralis

Subject to the median line, the proximal part is medialis and the distal part is lateralis.

内侧和外侧：以身体的中线为准，距中线近者为内侧，离中线相对远者为外侧。

Interior and exterior

To describe relative spatial relationships of specific structures and cavities. Note that they're different from "medialis" and "lateralis".

内和外：用以表示某些结构和腔的关系，应注意与内侧和外侧区分。

Superficial and deep

Subject to the body surface, the proximal part is superficial and the distal part is deep.

浅和深：靠近体表的部分叫浅，相对深入潜居于内部的部分叫深。

Websites on neuroanatomy

神经解剖学习网站

http://library.med.utah.edu/WebPath/HISTHTML/NEURANAT/NEURANCA.html

Provided by the University of Utah School of Medicine. This website shows the appearance of the central nervous system and provide its sections by the sagittal/coronal/transverse planes. Click the names under the atlas (in bold) and the red arrows will direct you to corresponding structures. The vivid and interactive mode will help beginners a lot.

由犹他大学医学院提供的教育资源。该站从中枢神经系统的外观、矢状位、冠状位、横断面及综合情况来介绍中枢神经解剖组织。学习者只要点击图谱下面的组织名称（粗体字样），就可以在图谱上见到红色箭头标示。该教育站点的优点是提供了逼真的组织结构，全面而简洁交互式的学习模式往往能给人以深刻的学习印象。

Websites on neuroanatomy

神经解剖学习网站

http://www.med.harvard.edu/AANLIB/home.html

A whole-brain atlas provided by Keith A. Johnson and J. Alex Becker of Harvard Medical School. It's collected mainly by MRI and supplemented by CT and SPECT of brain samples both in good health and with prevalent diseases such as cerebrovascular diseases, brain tumors, degenerative diseases and infectious central nervous system-related diseases. One can watch the sections dynamically and refer to clinical cases, which makes it a fine choice for clinical neuroscience researchers.

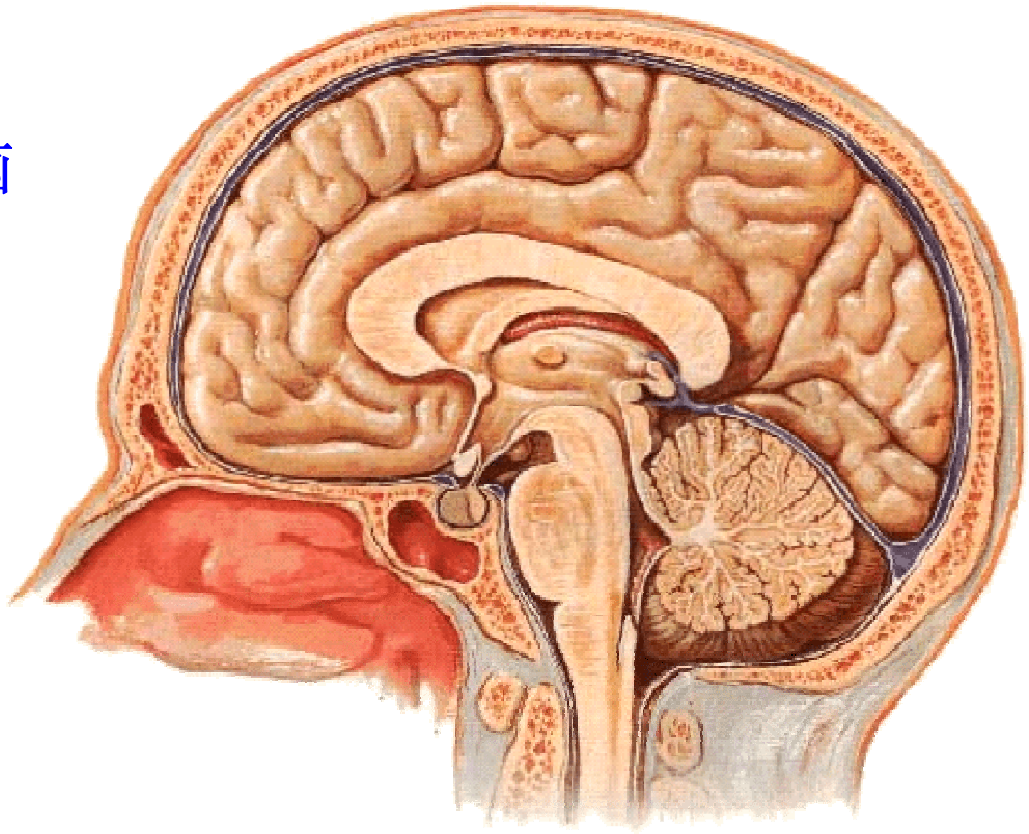
由哈佛医学院的Keith A. Johnson和J. Alex Becker创建的全脑影像图谱。其中主要以颅脑MRI成像为主，辅以CT和SPECT功能成像，比较全面地介绍了正常脑图和一些常见疾病的脑图，如脑血管病、脑肿瘤、变性疾病和中枢感染性疾病。它的最大优点是可以随意动态截取断层观看各层特征，还给以临床实例介绍，是临床神经科学工作者不错的选择。

Central nervous system

中枢神经系统

The brain
脑

- Telencephalon 端脑
- Diencephalon间脑
- Cerebellum 小脑
- Brain stem 脑干



Blood–brain barrier

血脑屏障

血脑屏障是一个高度选择渗透的屏障，它将循环的血液与中枢神经系统脑细胞外液分割开来。血脑屏障由紧密连接的毛细血管内皮细胞构成。

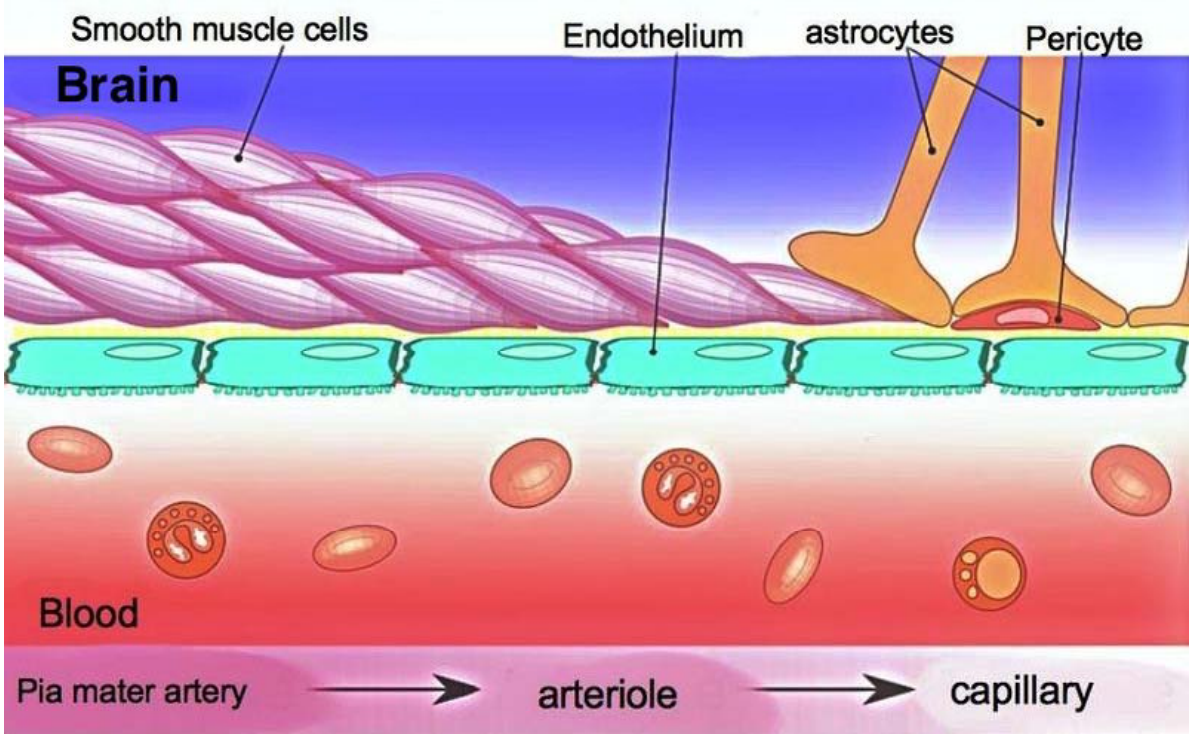
The **blood–brain barrier** (**BBB**) is a highly selective permeability barrier that separates the circulating blood from the brain extracellular fluid in the CNS. The blood–brain barrier is formed by capillary endothelial cells, which are connected by tight junctions.

20世纪初发现，给动物静脉注射台盼蓝涂料以后，全身组织都着色，而脑和脊髓则不着色。以后陆续发现很多药物和染料注入动物体后都有类似的分布情况。这些事实都启示人们想到有保护脑组织的“屏障”存在。向鸡胚注入谷氨酸后，发现谷氨酸能迅速进入鸡胚的脑组织，但在成年鸡脑中则很难进入。初生儿脑毛细血管的通透性远较成年人为高。以上事实说明血脑屏障结构功能的完善是随动物个体发育的完善而形成的。

In early 20th century, researchers found that intravenous injection of trypan blue to animals led to whole-body staining except for the brain and spinal cord. Later, similar distributions are found in more animals injected with other drugs and dyes. These observations suggested the existence of a barrier protective toward the brain. Entrance of glutamate acid into the brain injected to the chicken embryo is proved easier than to adult chicken, and brain blood capillaries of neonatal infants shows higher permeability than adults. These together shows that the blood-brain barrier develops and matures along with the individual development.

血脑屏障允许水、一些气体和脂溶性分子的被动扩散和一些对神经功能重要的分子（如葡萄糖和氨基酸）的选择性运输。另外，血脑屏障可能通过P-糖蛋白介导的主动运输阻挡一些亲脂性的可能的神经毒素。

The blood–brain barrier allows the passage of water, some gases and lipid soluble molecules by passive diffusion, as well as the selective transport of molecules such as glucose and amino acids that are crucial to neural function. On the other hand, the blood–brain barrier may prevent the entry of lipophilic, potential neurotoxins by way of an active transport mechanism mediated by P-glycoprotein.



星形胶质细胞是血脑屏障的形成所必须的。血脑屏障在毛细血管中发生，由毛细血管周围的紧密连接构成，这种连接在其他循环中不出现。上皮细胞限制微小物体（如细菌）和大的或亲水性分子向脑脊液的扩散，同时允许小的疏水性分子（如O2、CO2和激素）的扩散。屏障中的细胞借由特定的蛋白主动运输代谢产物（如葡萄糖）。

Astrocytes are necessary to create the blood–brain barrier. The blood–brain barrier occurs along all capillaries and consists of tight junctions around the capillaries that do not exist in normal circulation. Endothelial cells restrict the diffusion of microscopic objects (e.g., bacteria) and large or hydrophilic molecules into the cerebrospinal fluid (CSF), while allowing the diffusion of small hydrophobic molecules (O_2, CO_2, hormones). Cells of the barrier actively transport metabolic products such as glucose across the barrier with specific proteins.

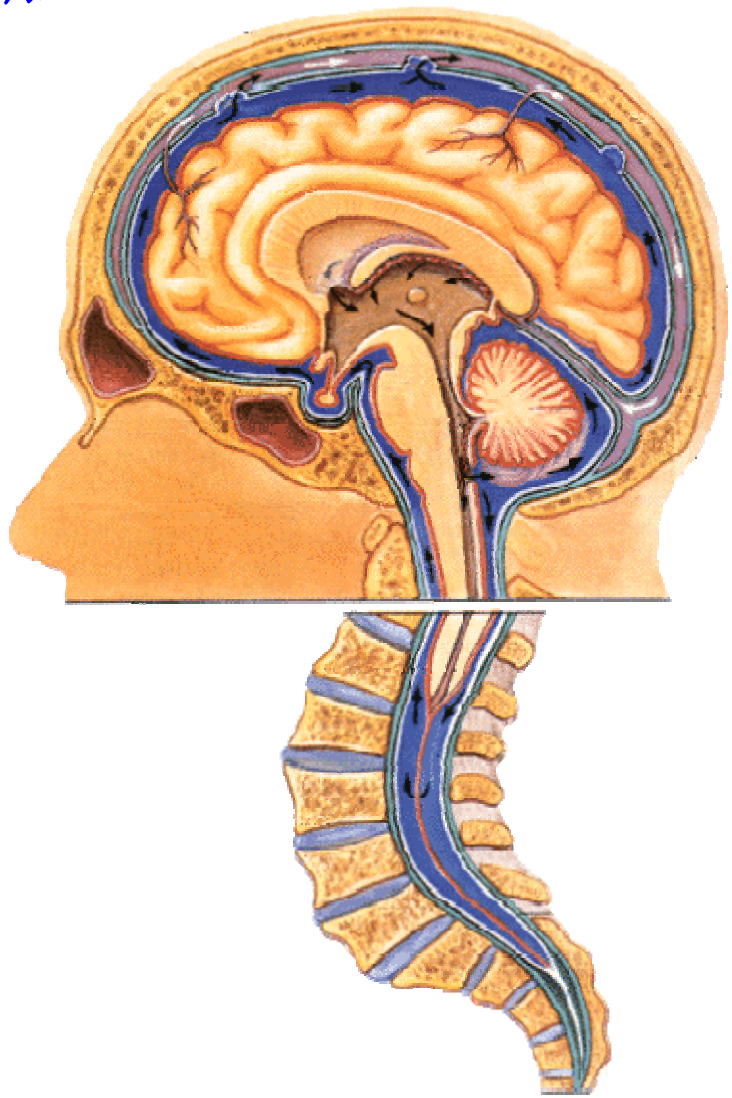
The meninges of brain and spinal cord
脑脊膜

The spinal cord and brain are surrounded by three membranes, the meninges. Named from the outside inward they are the **dura mater**, **arachnoid**, and **pia mater**.

脊髓和脑由脑脊膜包围，由三层构成，从外到内依次是硬膜、蛛网膜和软膜。

Subarachnoid space
蛛网膜下腔

- Position: lies between pia and arachnoid maters containing cerebrospinal fluid
- 位置：软膜和蛛网膜之间，含脑脊液

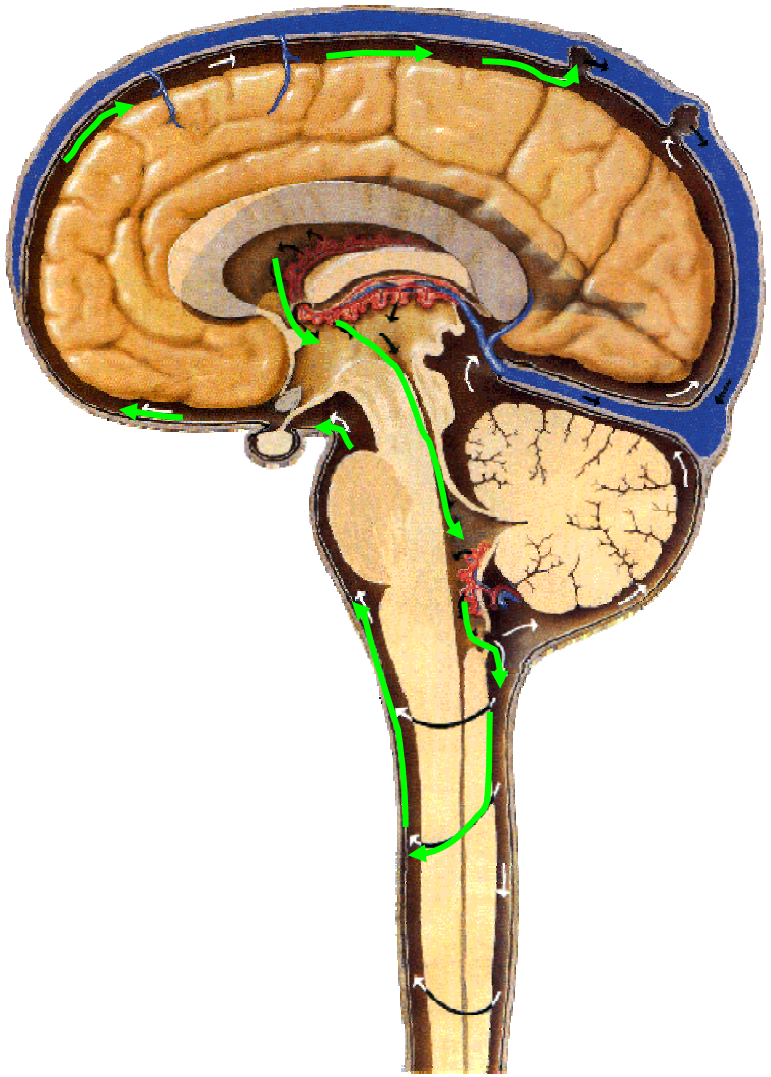


- **Terminal cistern** : the largest part of subarachnoid space extending from termination of spinal cord to level of S2, where it is occupied by **nerves of cauda equina**, so it is the best site for a lumbar puncture.
- **终池**：蛛网膜下腔最大的空间，从脊髓末端延伸至骶椎第二节，被马尾神经占用，是腰椎穿刺的最佳位点。

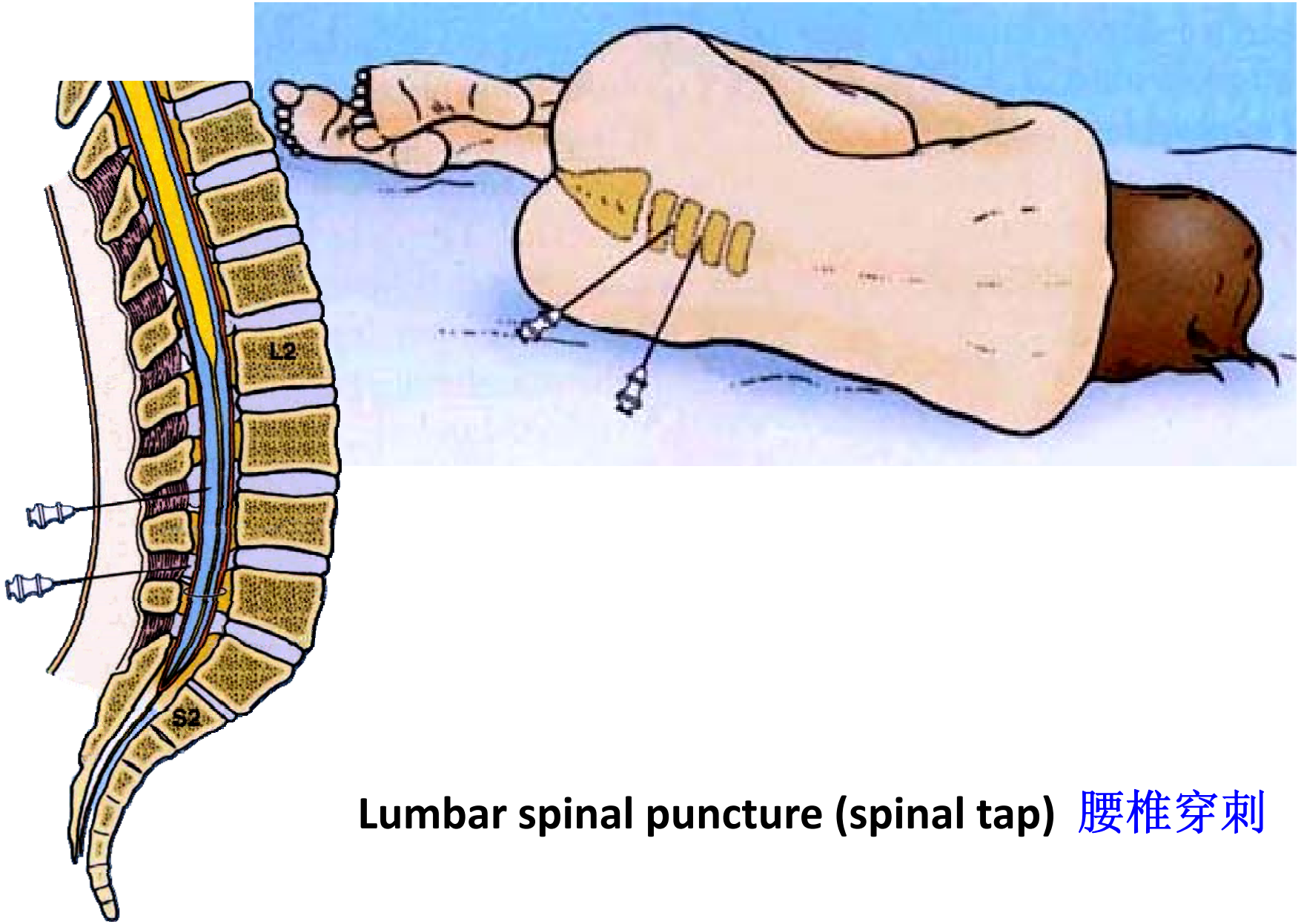
Circulation of cerebrospinal fluid (CSF)

脑脊液

- Cerebrospinal fluid is a clear colorless fluid, which acts as a transport medium for nutrients and vaster products and provides a protective fluid cushion for the central nervous system.
- 脑脊液是无色澄清液体，是营养物质和其他物质的运输介质，为中枢神经系统提供保护性液体缓冲。



- Production: produced by the **choroids plexuses** within the lateral, third and fourth ventricles.
- 产生：由侧脑室、第三脑室和第四脑室的脉络丛产生

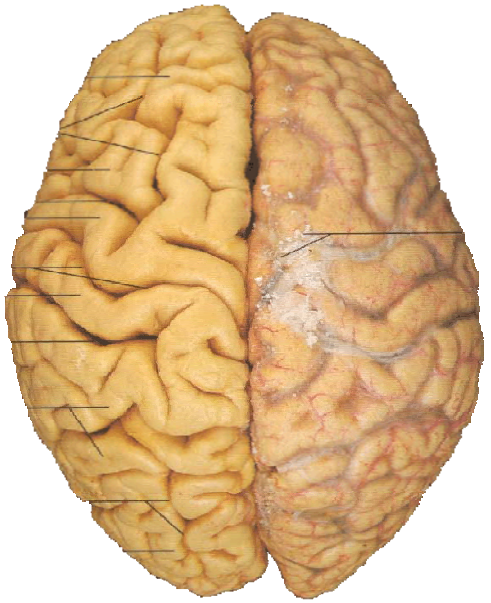


Lumbar spinal puncture (spinal tap) 腰椎穿刺

The telencephalon

端脑

- The telencephalon consists of right and left **cerebral hemisphere**, partially separated by **cerebral longitudinal fissure**.
- 端脑由左右**大脑半球**构成，部分由**大脑纵裂**隔开。

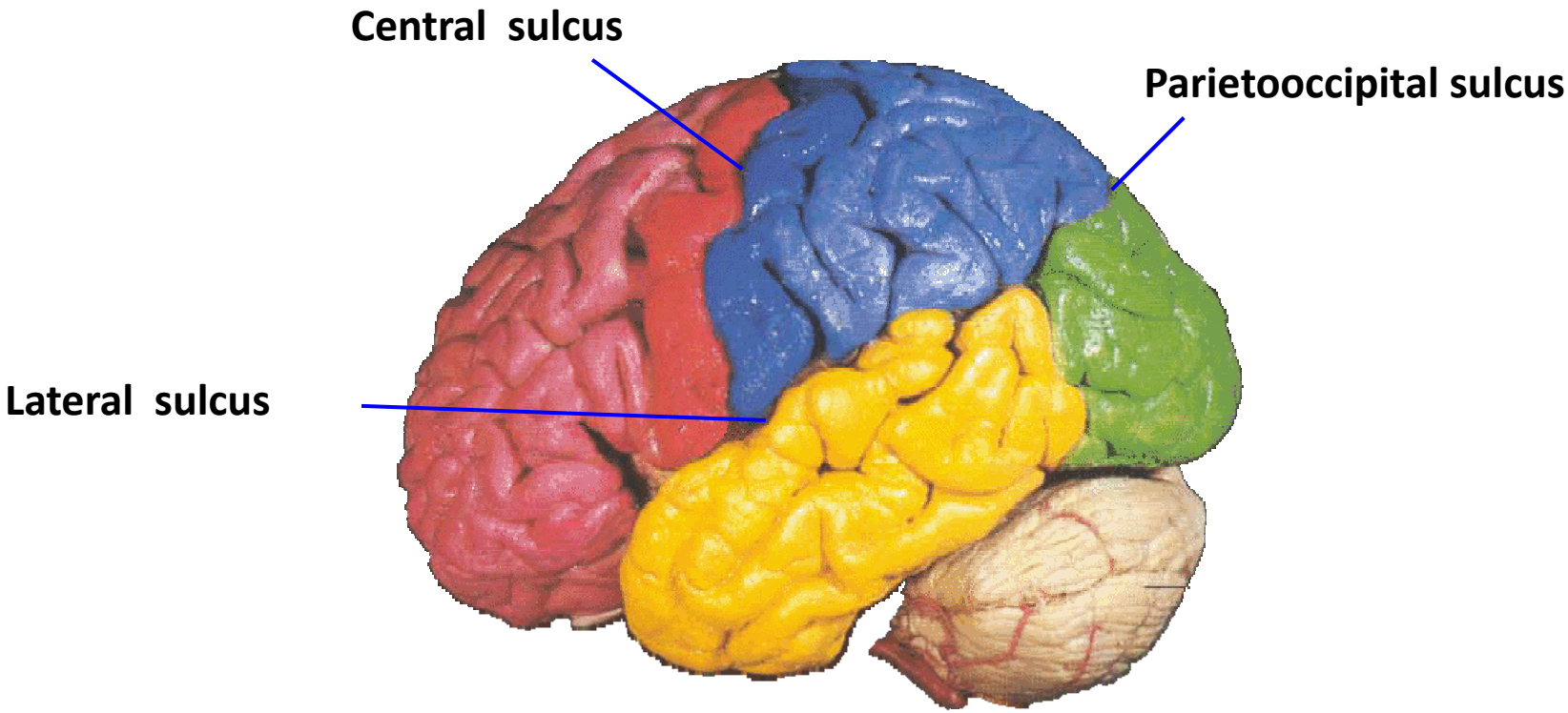


- The **cerebral transverse fissure** intervenes between the hemispheres and the cerebellum.
- **大脑横裂**隔开大脑半球和小脑。

- Each hemisphere has three surfaces: **superolateral**, **medial** and **inferior**.
- 每个大脑半球有三个表面：**上外侧面**、**内侧面**和**下表面**。

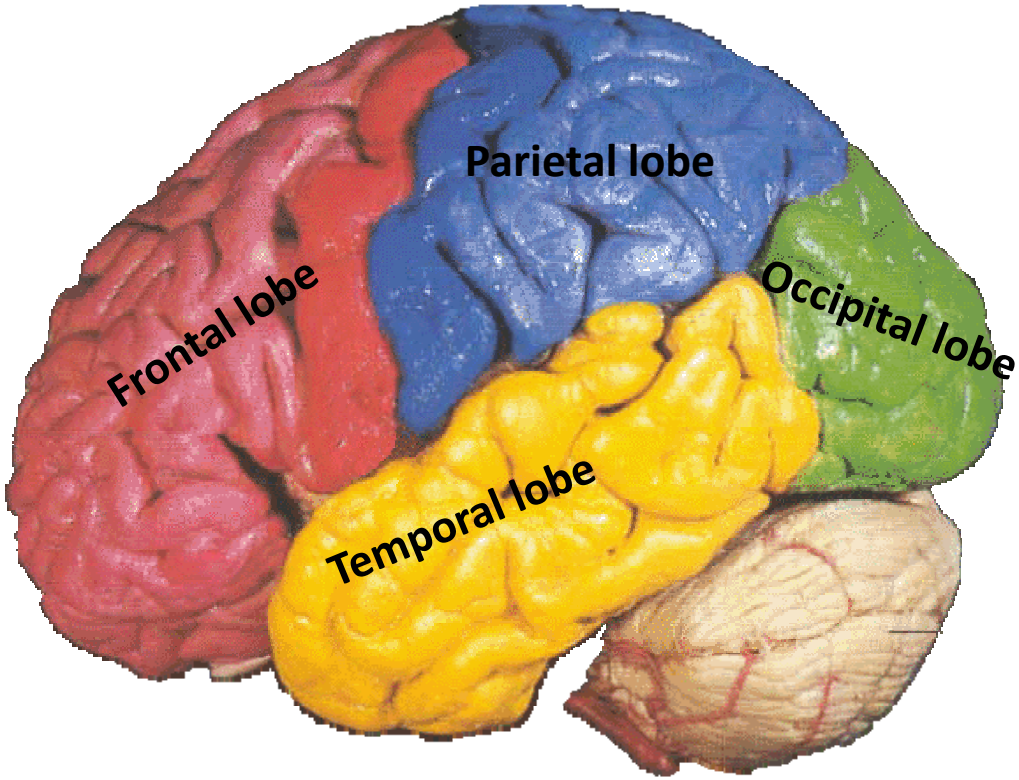
Three principal sulci
脑沟

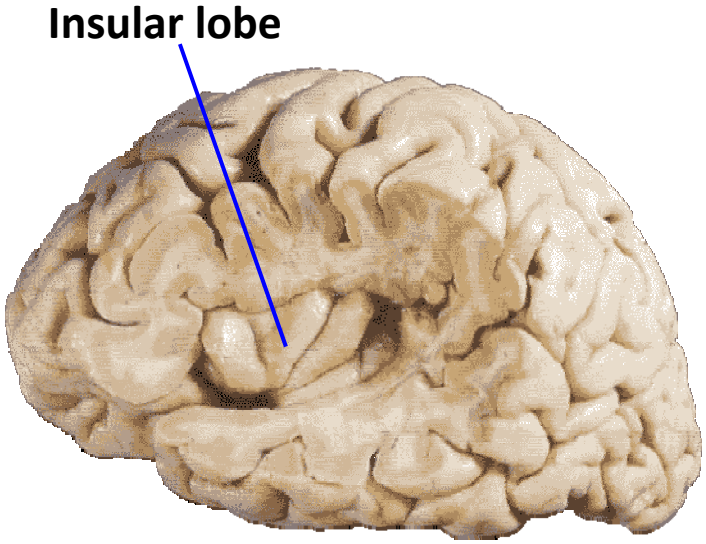
- **Central sulcus** 中央沟
- **Lateral sulcus** 外侧沟
- **Parietooccipital sulcus** 顶枕沟



Five lobes
脑叶

- Frontal lobe 额叶
- Parietal lobe 顶叶
- Temporal lobe 颞叶
- Occipital lobe 枕叶
- Insular lobe 岛叶





Coarse position

大体位置

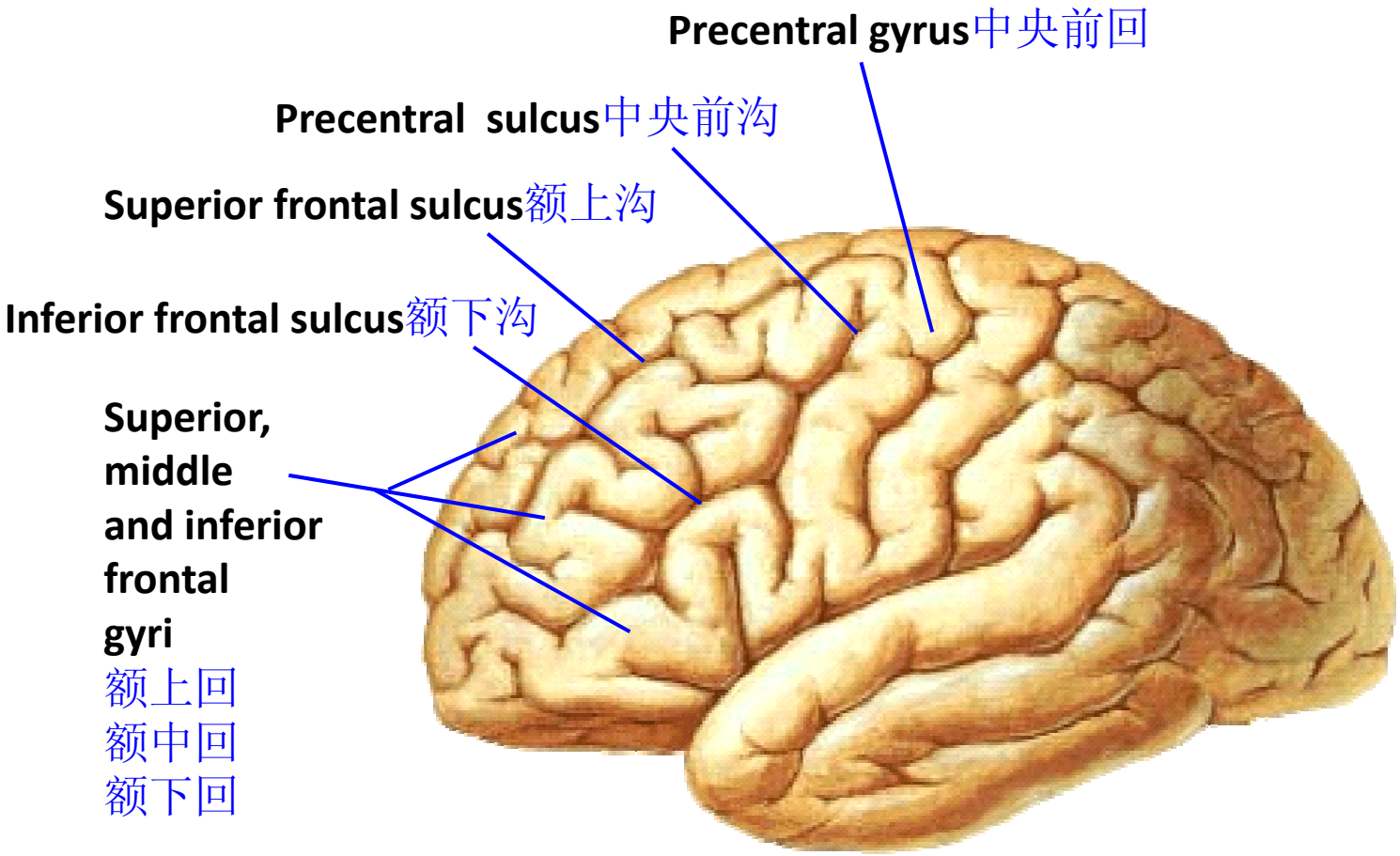
Sulci and gyri of superolateral surface
上外侧面沟回

Frontal lobe 额叶:

- **Precentral sulcus** 中央前沟
- **Superior frontal sulcus** 额上沟
- **Inferior frontal sulcus** 额下沟
- **Precentral gyrus**中央前回
- **Superior frontal gyrus** 额上回
- **Middle frontal gyrus** 额中回
- **Inferior frontal gyrus** 额下回

Sulci and gyri of superolateral surface

上外侧面沟回



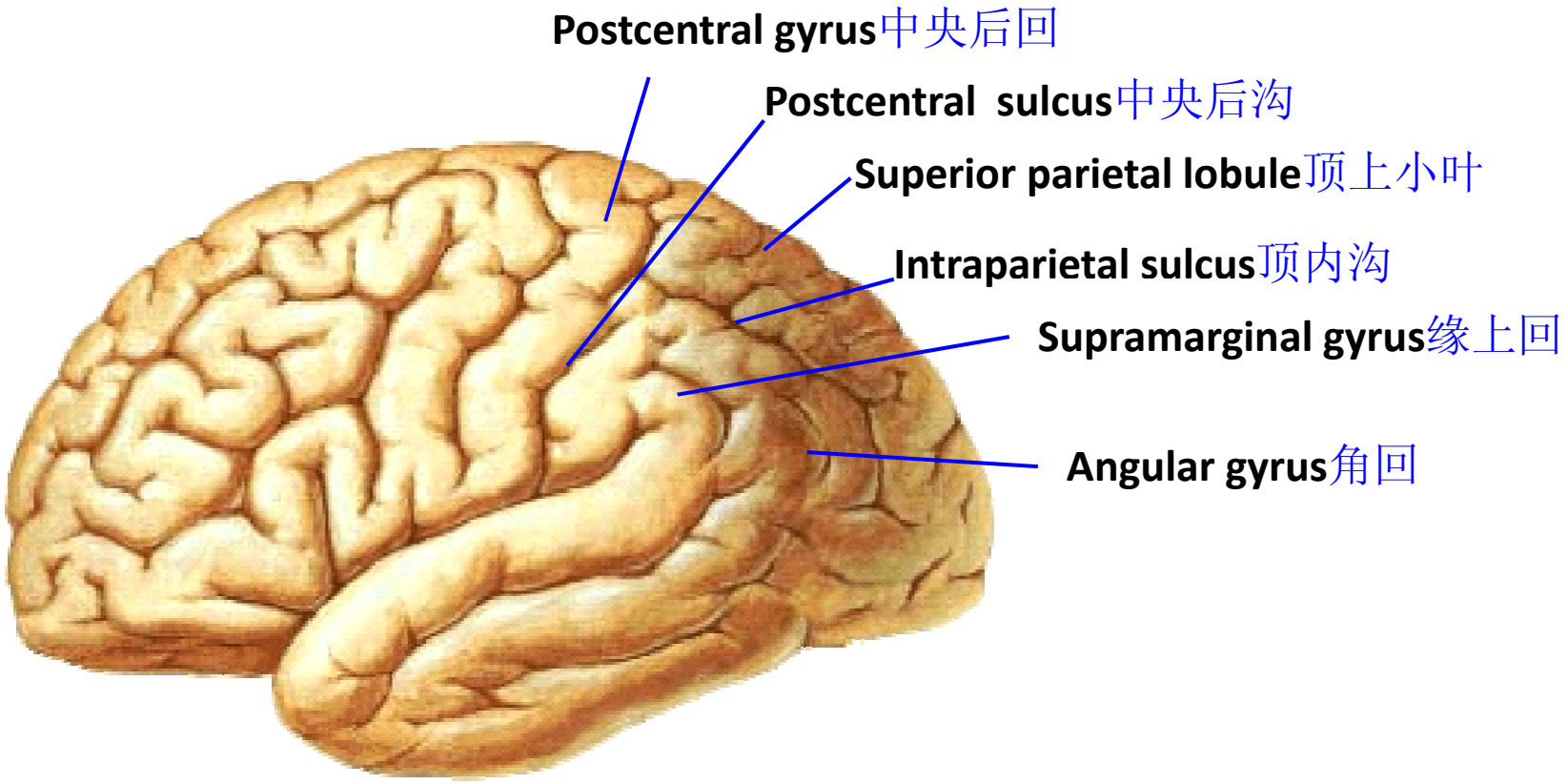
Sulci and gyri of superolateral surface
上外侧面沟回

Parietal lobe 顶叶:

- **Postcentral sulcus** 中央后沟
- **Postcentral gyrus**中央后回
- **Intraparietal sulcus** 顶内沟
- **Superior parietal lobule** 顶上小叶
- **Inferior parietal lobule** 顶下小叶
- **Supramarginal gyrus** 缘上回
- **Angular gyrus** 角回

Sulci and gyri of superolateral surface

上外侧面沟回

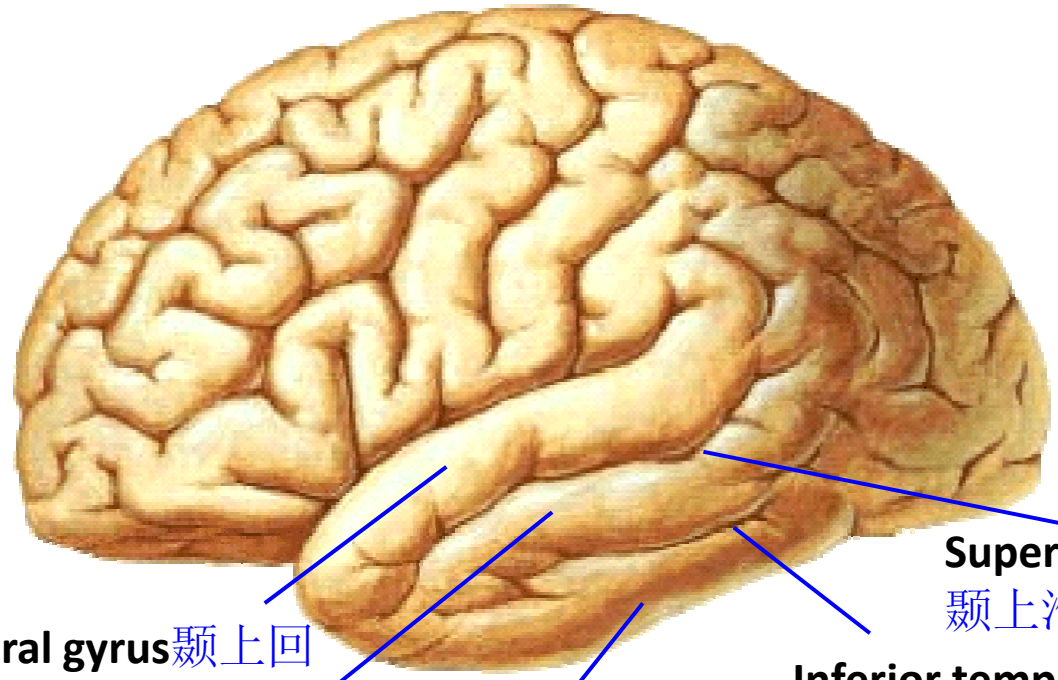


Sulci and gyri of superolateral surface
上外侧面的沟回

Temporal lobe 颞叶:

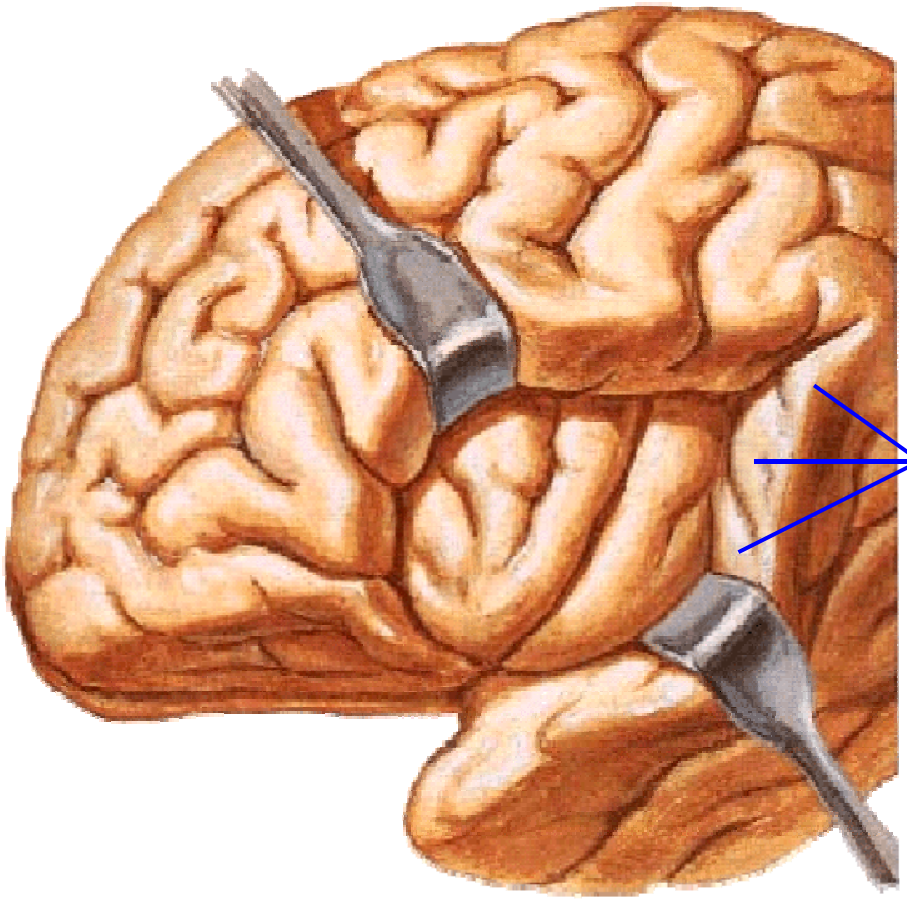
- **Superior temporal sulcus** 颞上沟
- **Inferior temporal sulcus** 颞下沟
- **Superior temporal gyrus** 颞上回
- **Middle temporal gyrus** 颞中回
- **Inferior temporal gyrus** 颞下回
- **Transverse temporal gyri** 颞横回

Sulci and gyri of superolateral surface
上外侧面的沟回



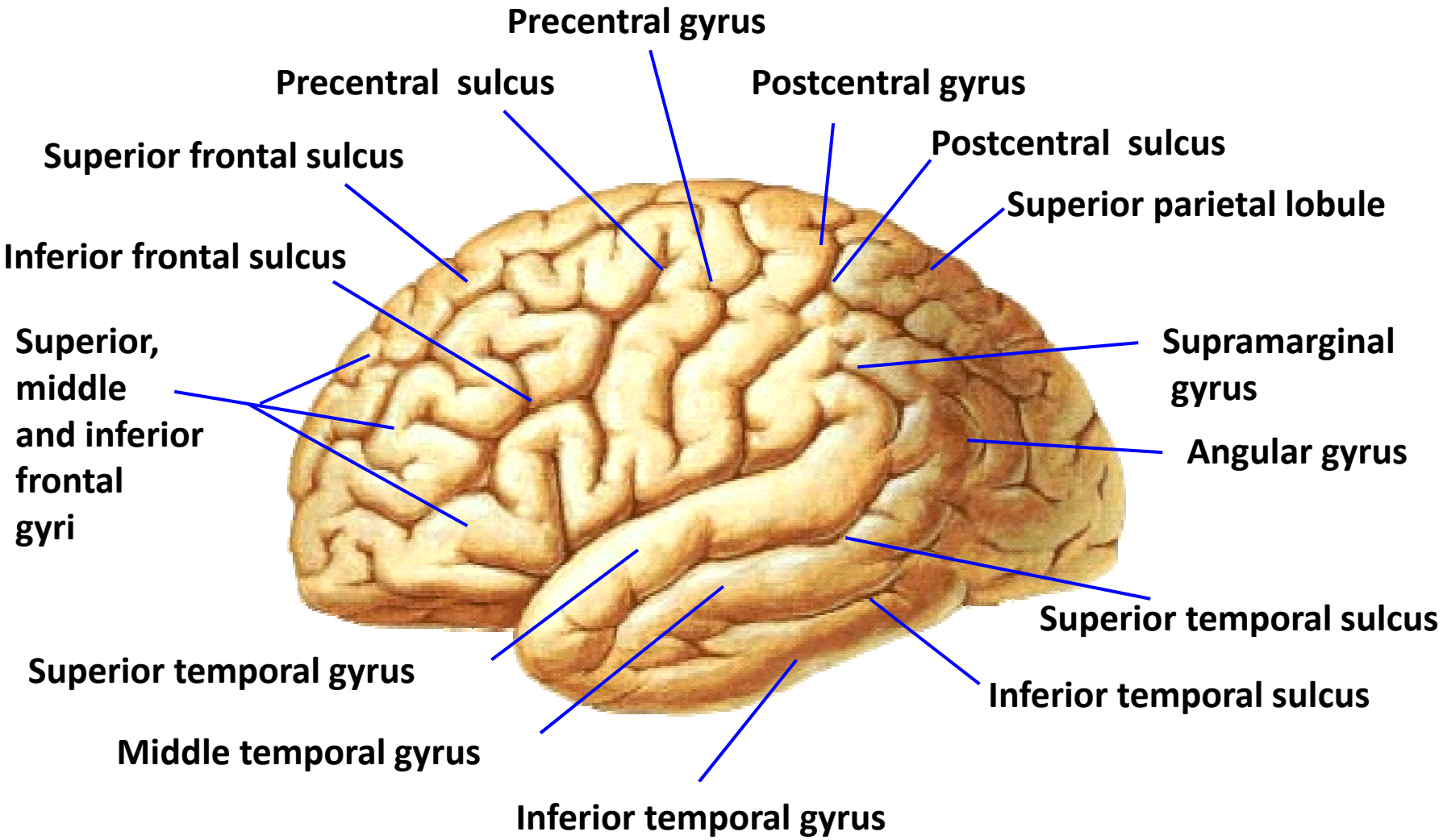
Sulci and gyri of superolateral surface

上外侧面沟回

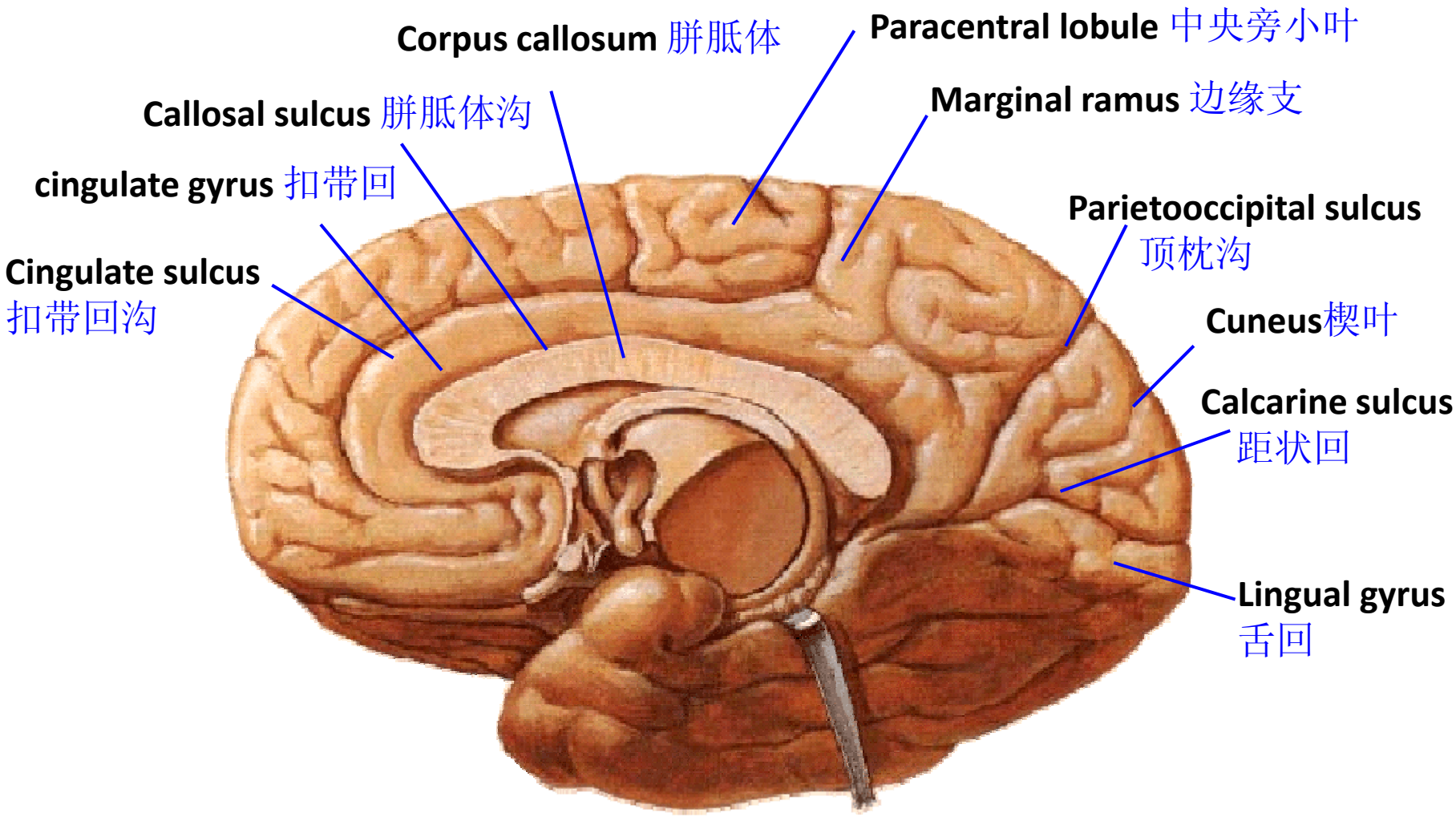


Transverse temporal gyri 颞横回

Sulci and gyri of Superolateral surface



Sulci and gyri of medial surface
内侧面沟回

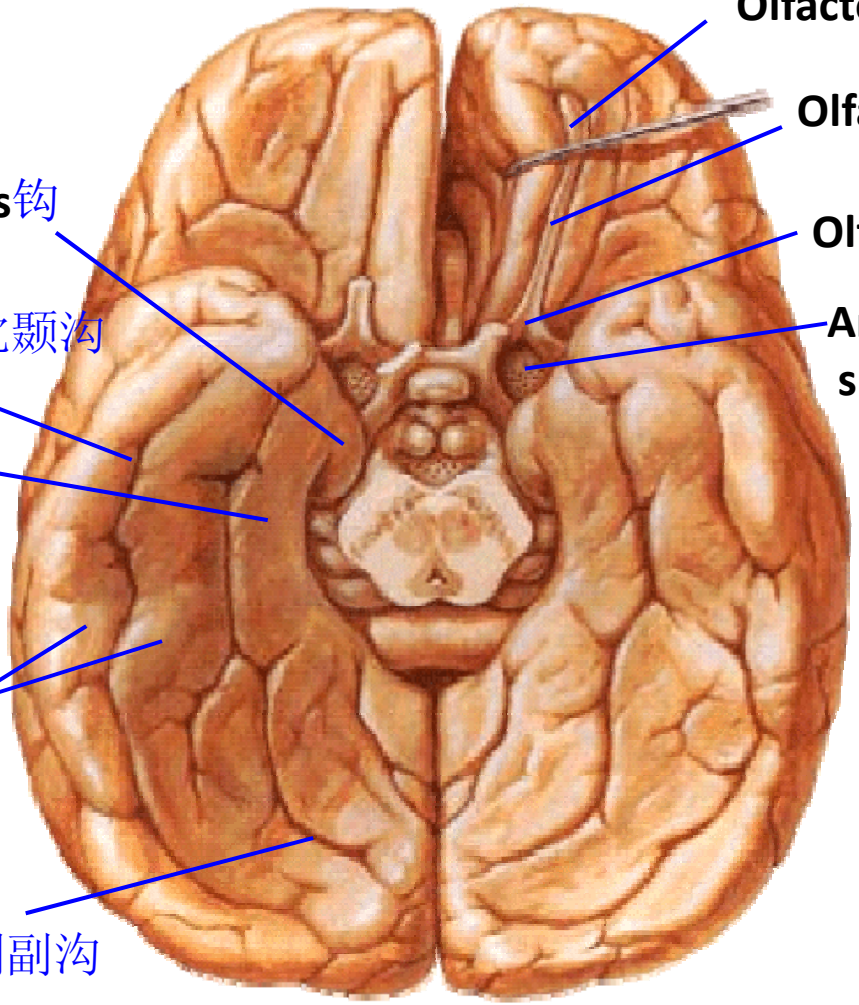


Sulci and gyri of inferior surface
内侧面沟回

- Olfactory bulb 嗅球
- Olfactory tract 嗅束
- Olfactory trigone 嗅三角
- Anterior perforated substance 前穿质
- Collateral sulcus 侧副沟
- Occipitotemporal sulcus 枕颞沟
- Medial occipitotemporal gyrus 枕颞内侧回
- Lateral occipitotemporal gyrus 枕颞外侧回
- Hippocampal sulcus 海马沟
- Parahippocampal gyrus 海马旁回
- Uncus 钩
- Hippocampus 海马
- Dentate gyrus 齿状回

} Hippocampal formation 海马结构

Inferior surface
下表面



Olfactory bulb嗅球

Olfactory tract嗅束

Uncus钩

Olfactory trigone嗅三角

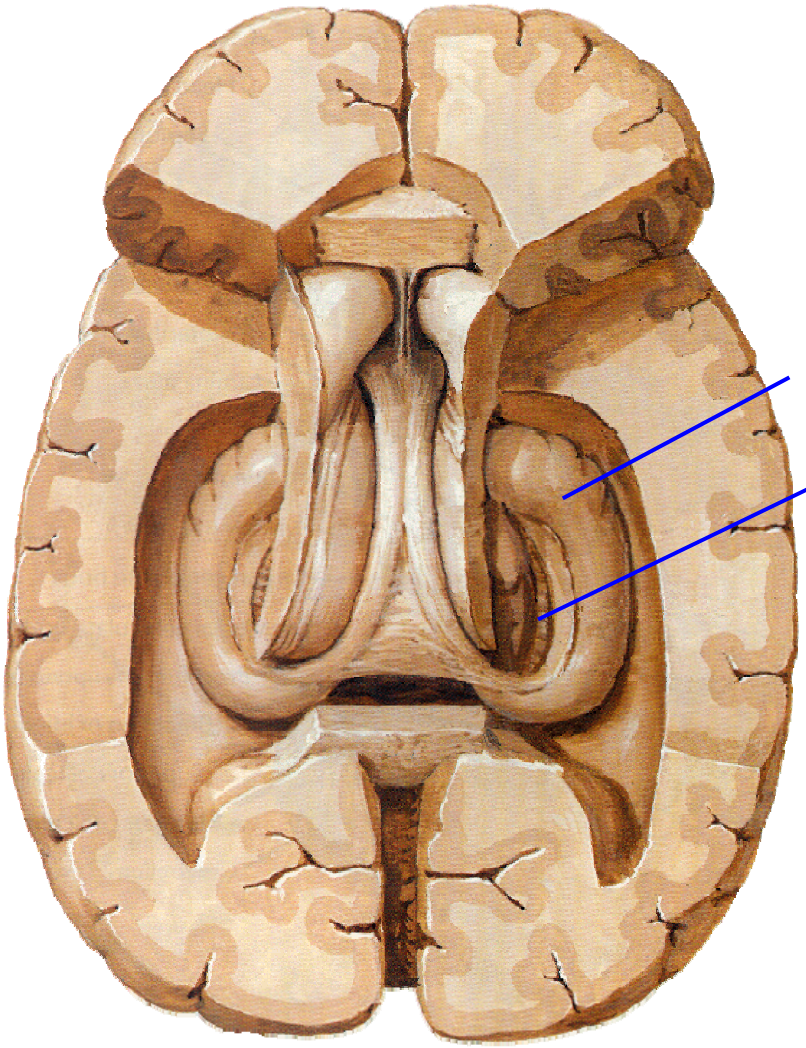
Occipitotemporal sulcus枕颞沟

Anterior perforated substance前穿质

Parahippocampal gyrus海马旁回

Medial and lateral occipitotemporal gyri枕颞内侧回

Collateral sulcus侧副沟


Hippocampus海马
Dentate gyrus齿状回
Hippocampal formation
海马结构

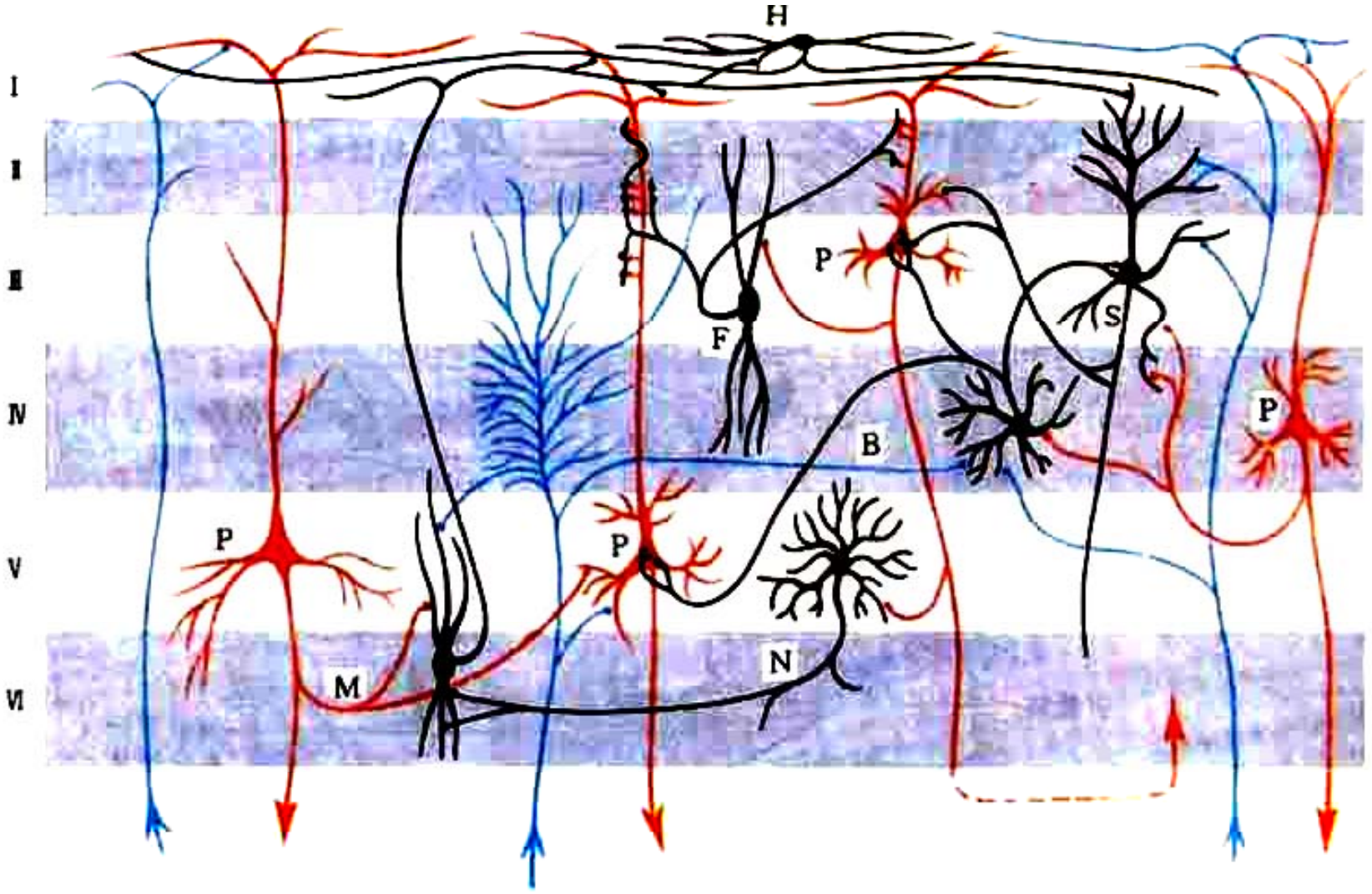
Histology of the cerebral cortex
大脑皮层组织学

- **Archicortex** 原皮质
  (hippocampal formation
  海马结构)
- **Paleocortex** 古皮质
  (rhinencephalon 嗅脑)

3 cell layers
3细胞层

- **Neocortex** 新皮质
  (most of cerebral cortex
  多数大脑皮层)

6 cell layers
6细胞层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Equipotentality theory and functional brain mapping theory

脑功能整体论与定位论

根据E. Smith 一八六二年所得到的公元前十七世纪的古代文献记载，古埃及人于公元前二五〇〇年就已经注意到脑部受伤和行为障碍的关系。该古代文献所记述的四十八个病例中，有八个是头部或脑部受伤的患者。古埃及学者对这些患者的观察纪录可以说是有关脑部功能定位的最早文字纪载。

According to an ancient literature of 17th century B.C. found by E. Smith in 1862, the Egyptians noticed the correlation of brain lesion and motor dysfunction in 2500 B.C.. 8 of 48 cases recorded in the literature had head or brain injury, making it the earlist documentation of sectorization of brain functions.

虽然考古学家在欧美洲、非洲和南太平洋一些岛屿上也发现了史前期的钻孔颅骨，而且有些学者认为，颅骨切开术于当时业已存在，但由于缺乏文字记载，无法确定这些钻孔的颅骨是否牵涉到脑部外科手术。

While archaeologist found drilled skulls in Europe, America, Africa and islands in South Pacific Ocean and there is academic avocation for the existence of cranial drilling techniques, it remains uncertain if these drilled skulls had any concern with brain surgery.

根据古希腊历史的记载，希腊人于公元前四世纪已认识到脑组织在心智功能上所扮演的角色。Hippocrates（430～379 B.C.）便是其中一个最具代表性的学者。当时，他们已察觉到一侧大脑半球的损伤会引起对侧肢体的痉挛或抽搐。

According to ancient Greek literatures, the Greeks, of whom Hippocrates (430-379 B.C.) is the most representative, noticed the significant role of the brain in mental functions in 4th century B.C. They realized that a hemisphere lesion could lead to contralateral spasms.

到了公元二世纪，Galen（130-200 A. D.）不但对脑的解剖结构有较详尽的描述，亦提出了精神气体（psyche gas）学说。此学说认为营养物质由胃肠道通过静脉进入肝脏，形成自然精神。自然精神又通过纵隔，流经心脏，与肺部的物质混合而成为有生命的精神。此生命精神最后储存于脑室。后来的学者根据此精神气体说，认为一切心理历程或精神功能皆定位于脑室，此即所谓脑室定位说。脑室定位学说虽然没有实验或临床上的证据，却支配了脑部功能定位学说达数世纪之久。

Till 2th century, Galen (130～200 A.D.) not only made a detailed description of brain anatomy but also raised a psyche gas hypothesis, which claimed that nutrients flowed into the liver through gastrointestinal tracts, forming nature spirits eventually stored in the ventricles. This is further supplemented by the ventricle location theory, which lacked experimental or clinical evidences but still dominated the functional brain mapping theory for centuries.

脑功能定位学说(Functional brain mapping theory)的早期代表人物是F. J. Gall（1758～1828）和J. C. Spurzheim（1776～1832）。Gall和Spurzheim认为：心理历程与大脑皮质有很密切的关系；人类各种不同的心理历程，并非由单一的器官（如松果体pineal gland ）所支配．不同的心理历程是由大脑皮质不同的部位所掌管；皮质的发展情况直接影响了颅骨的形状，皮质较发达的地方，颅骨突起，代表该部位所支配的心理历程或有关的行为倾向较强，低陷的颅骨代表该区管辖的功能或行为倾向较弱。所以，只要观察颅骨的外表凹凸的程度，即透过所谓颅检查术（Cranioscopy）就可以推知个体各方面行为倾向的强弱。而这种研究颅骨外表特征与心理功能的学说，Spurzheim名之为颅相学（**Phrenology**）

As a representative of the functional brain mapping theory, F.J.Gall(1758-1828) believed that mental processes are closely related to the cortex, and various mental processes are not dominated by single organs such as the pineal gland. Distinctive mental processes are dominated by deffrernt parts of the cortex, and the development of the cortex directly affected the shape of the skull, with developed and strongly-functioned parts protruding the skull and vice versa, making it an approach named cranioscopy to infer individual behavior tendency and thus giving birth to phrenology(named by Spurzheim).

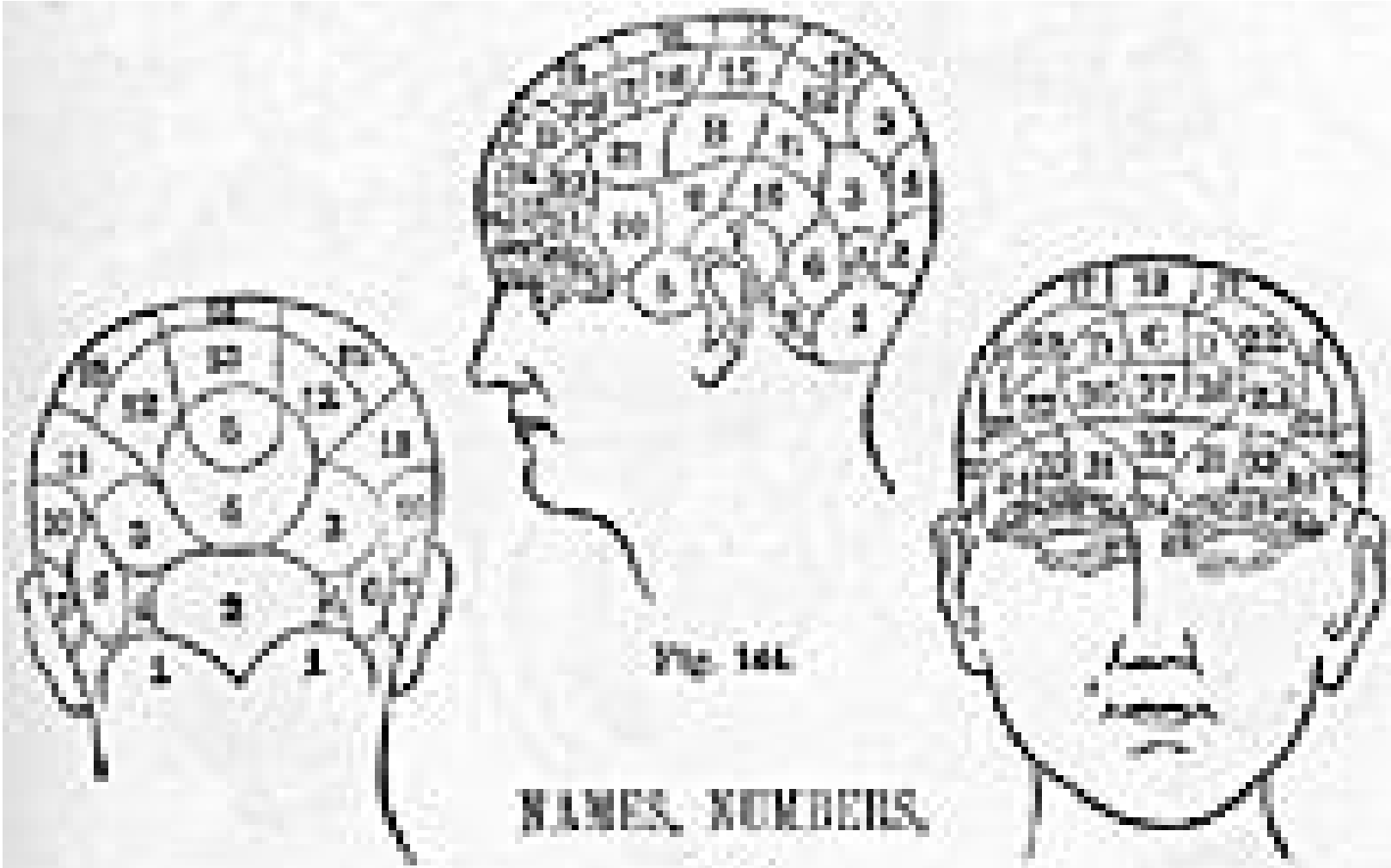


Fig. 144.

NAMES, NUMBERS,

AND

LOCATION OF THE ORGANS.

颅相学虽然风行一时，但是很快就被人们所扬弃。因为没有证据显示颅骨外表的特微与颅骨内腔或脑皮质的性质有密切的关系，更因为颅相学所提出的心理历程或性格倾向，如仁爱、高尚精神、壮烈性等，都很难下一个确切的定义，更不用说如何客观地予以量化了。如果Gall和Spurzheim当时能把研究重点放在脑部组织本身的结构，例如脑回或脑沟的结构上，同时又能注重可以客观量度的行为，则神经心理学史或须重写。不过，Gall和Spurzheim在神经心理学上亦有不可抹煞的贡献，例如，他们强调皮质的重要性，认识到皮质细胞与皮质下结构的联系，以及两半球乃由连合部所连接等。但很可惜这些看法当时都被忽视，人们都把注意力集中在反对颅相学上去了。

Phrenology was soon abandoned after a short-term prevalence due to the lack of evidences and profound definitions and quantifications of mental processes and traits. Gall and Spurzheim missed crucial discoveries via brain anatomic structure findings such as sulci and gyri and measurable behaviors while they still layed stress on the cortex and the relations of cortex and subcortex cells as well as the commissure junctions of the hemispheres, which was submerged by the tides against phrenology.

在反对颅相学的学者当中，以P. Flourens（1794～1867）最具影响力。Flourens认为大脑是以整体的方式发挥功能的，心理功能并不像Gall和Spurzheim所说的那样，是由于个别特定的部位支配的。Flourens切除鸡和鸽子等的部分中枢神经系统，观察其手术后行为的变化情况。他发现，手术后功能缺损的程度与所切除的脑组织的多寡有密切关系。若所有的脑组织都被切除，则一切功能当尽告丧失；但若只切除部分则可全面恢复所有的功能。Flourens因此认为脑功能并无特殊的定位，所有功能在大脑都占有同样广阔的区域。这种看法后来由Lashley予以发扬，主张大脑的每一个区域对任何行为都具有同样的支配能力，此即后来所称的等势说（equipotentality）（脑功能整体论）。不过Flourens把鸽子和鸡所得的实验结果，概推到人类大脑的功能，这是很难使人信服的，因为人类大脑的结构与鸽子和鸡的大脑实在是相距太远。

P. Flourens(1794-1867) was of best influence against phrenology, who held the view that the brain functioned as a whole. His surgeries of partial CNS ablations of chickens and pigeons proved a correlation of lesion levels and ablation amounts, on the basis of which he inferred that the brain functions are not specifically localized but they occupy same amounts of areas, which is further promoted by Lashley that every part of the brain had the same capability to dominate behaviors, namely equipotentality, despite of the giant structural gap of human and bird brains.

一八六一年P. Broca（1824～1880）发表了他有名的个案研究论文，提供了很多有力证据，说明额叶左侧第三额回的后部（现称为Broca区）与语言表达有极密切的关系。此发现在神经心理学史上留下了光辉的一页。

Broca还有下述四方面的贡献：

•详尽地描述了在发音与理解方面正常，但在言语表达方面有障碍的病例；

•以运动性失语症（aphemia）命名此语言障碍；

•指出了运动性失语症的脑部定位；

•详尽地阐述了语言偏侧于左半球的概念。

毫无疑问，Broca的研究报告可以说是为神经心理学的发展开创了一个新纪元，对脑神经行为的研究方向有了不可抹煞的影响。

In 1861 P. Broca(1824-1880) published his famous research paper providing powerful evidences of correlation of posterior left frontal lobe(now named Broca's area) and language. He also gave a detailed description of cases with normal pronunciation and comprehension and verbal expression disorder, namely aphemia, localized the pathological brain lesions, and claimed the dominance of the left hemisphere in language, together making him remarkable in neuropsychology and neuronal behavior researches.

继Broca之后，Carl Wernicke（1848～1904）又发现近颞上回处（今称Wernicke区）一旦受损，患者就会失去理解语言的能力。同时，联系Broca区与Wernicke区的纤维（即弓状束）若被切断，亦会导致语言障碍。Wernicke更进一步指出，能定位的功能大部份仅属较基本简单的感觉运动功能，较复杂的心理历程靠联合神经纤维联系大脑的各部位，由于许多不同的基本功能整合而成。换言之，复杂的心理历程并不定位于大脑的某一特定部位。这种看法，大大地超越了早期狭窄的功能定位说。这与二十世纪初J. Hughling-Jackson（1835～1911）所提出的阶层组织论颇为近似。

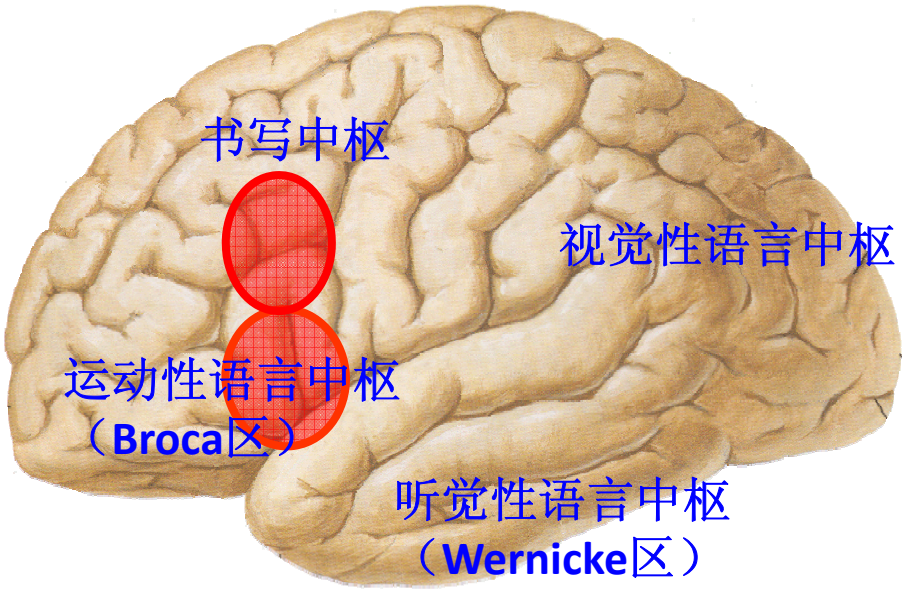
Following Broca, Carl Wernicke(1848-1904) found that once the proximal superior temporal gyrus(now named Wernicke's area) was impaired, the patient would lose the ability for language comprehension. The cut off of fibers between Broca's area and Wernicke's area led to language disorders. He pointed out that functions able to be localized are basic motor and sensory functions, complexed functions are dependent on fibers connecting different parts of the brain and their integration. This is similar to Hughling-Jackson's opinions.

Language area 语言中枢

It is dominant in left hemisphere in right-handed person.
在右利手人群中有左半球优势

- **Motor speech area**
- 运动性语言中枢
  - Located in posterior portion of inferior frontal gyrus
  - 位于额下回后部
  - Damage: motor aphasia
  - 损害：运动性失语

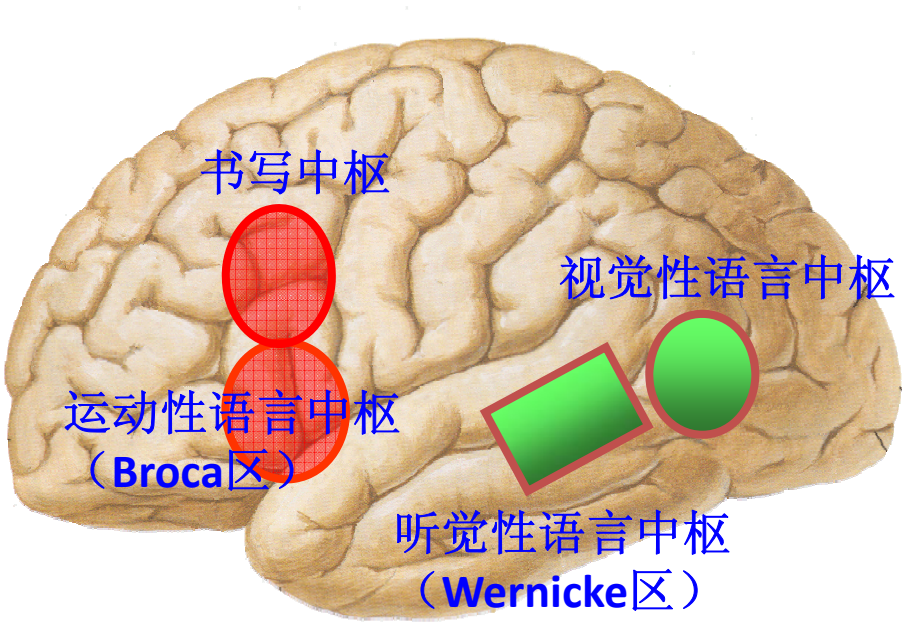
- **Writing area**
- 书写中枢
  - Located in posterior portion of middle frontal gyrus
  - 位于额中回后部
  - Damage: agraphia
  - 损害：失写症



Language area 语言中枢

- **Auditory speech area**
- 听觉性语言中枢
  - Located in posterior portion of superior temporal gyrus
  - 位于颞上回后部
  - Lesion: sensory aphasia
  - 损害：感觉性失语

- **Visual speech area**
  视觉性语言中枢
  - Located in angular gyrus
  - 位于角回
  - Lesion: alexia
  - 损害：失读症



Hughling-Jackson的阶层组织论认为，人类的神经系统至少是由三个从低到高的功能阶层组成的。较基层的功能在大脑中有特定的部位。基层的功能如简单的感觉运动功能互相联系形成较高层次的心理活动。换言之，高级的心理功能是建立在许多较基层的功能之上的，因此，高级心理功能不局限于大脑的某个特定部位，而是分散于大脑不同的区域。故能牵涉到大脑各个不同的部位，每个部位对语言功能都负有特殊的任务。所以问题不在于语言功能定位于何处，而在于不同部位对复杂的语言功能到底负有甚么样的特殊任务。由此可见，倘若非优势半球受损，病人除发生空间知觉障碍之外，其语言功能是否会因无法应用空间概念而受损，就很值追究了。Hughling-Jackson的理论很有创见，无怪乎学者们将其尊为近代神经学之父。

Hughling-Jackson proposed the evolutionary organization of the nervous system in three levels: a lower, a middle, and a higher. Lower functions localize specifically to certain brain regions and a set of them forms higher functions, thus higher functions are distributed to various brain regions responsible for certain functional parts, which won him “the father of modern neurology”. It remains unclear if language is impaired except for spatial perception disorders after the non-dominant hemisphere is damaged.

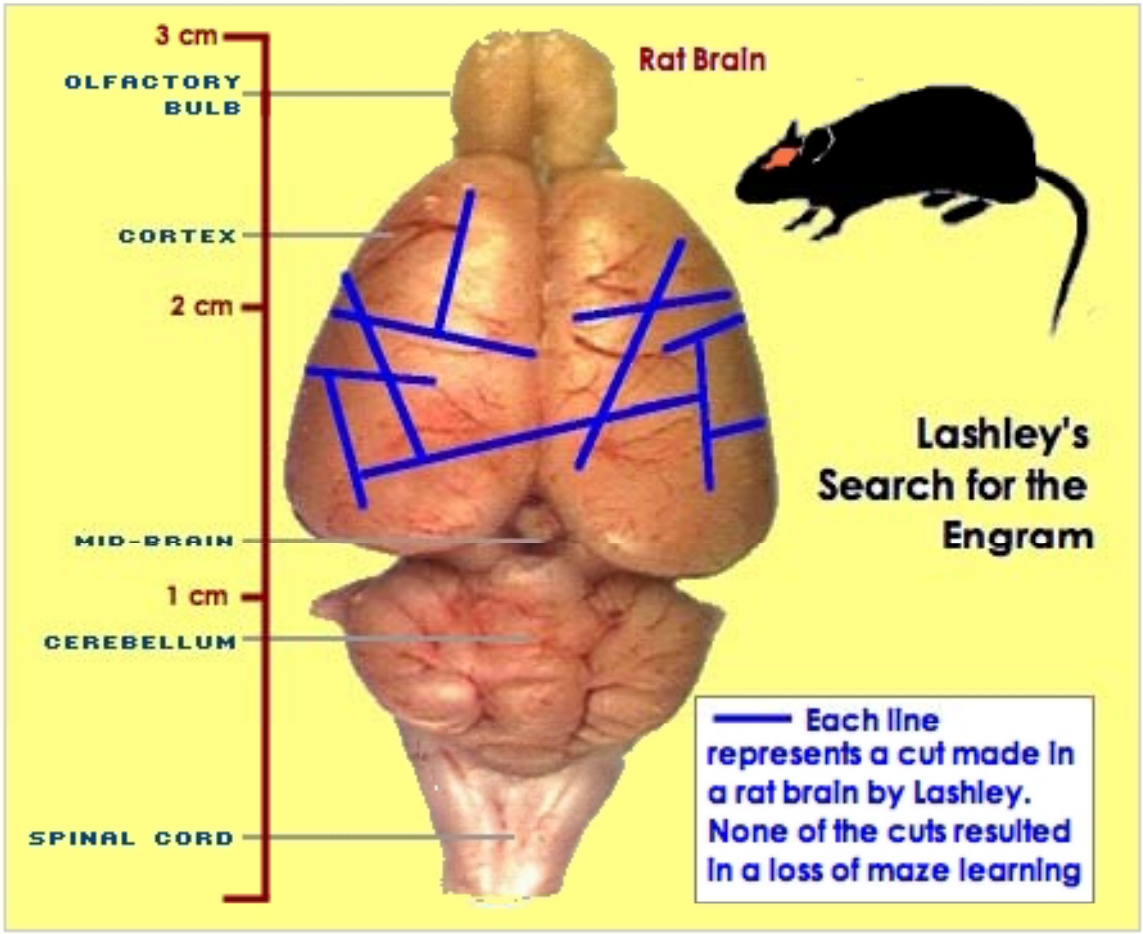
Karl Lashley‘s Search for the Engram (globalization)

Karl Lashley关于印迹的研究（整体论）

Karl Spencer Lashley
(1890-1958)

Cortical cuts 皮质切割
Tissue ablation 组织切除

Equipotentality 等潜
Mass Action 整体活动



Brenda Milner and H.M. (localization)

Brenda Milner and H.M. （定位论）

- Hippocampus formation

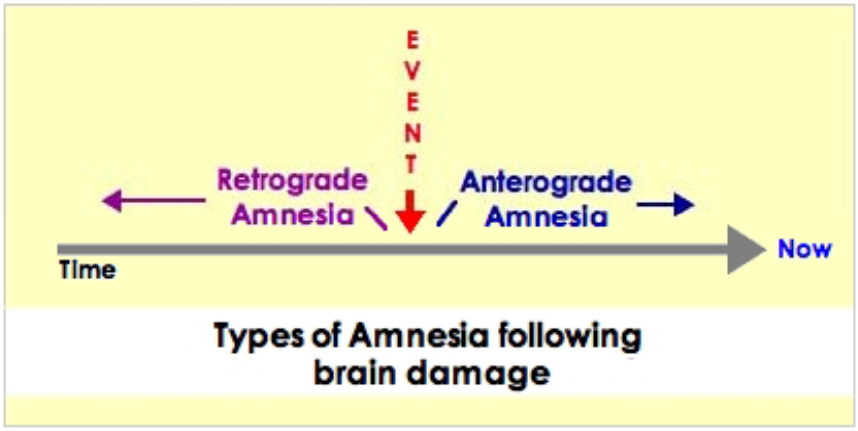
  海马结构

- Amygdala

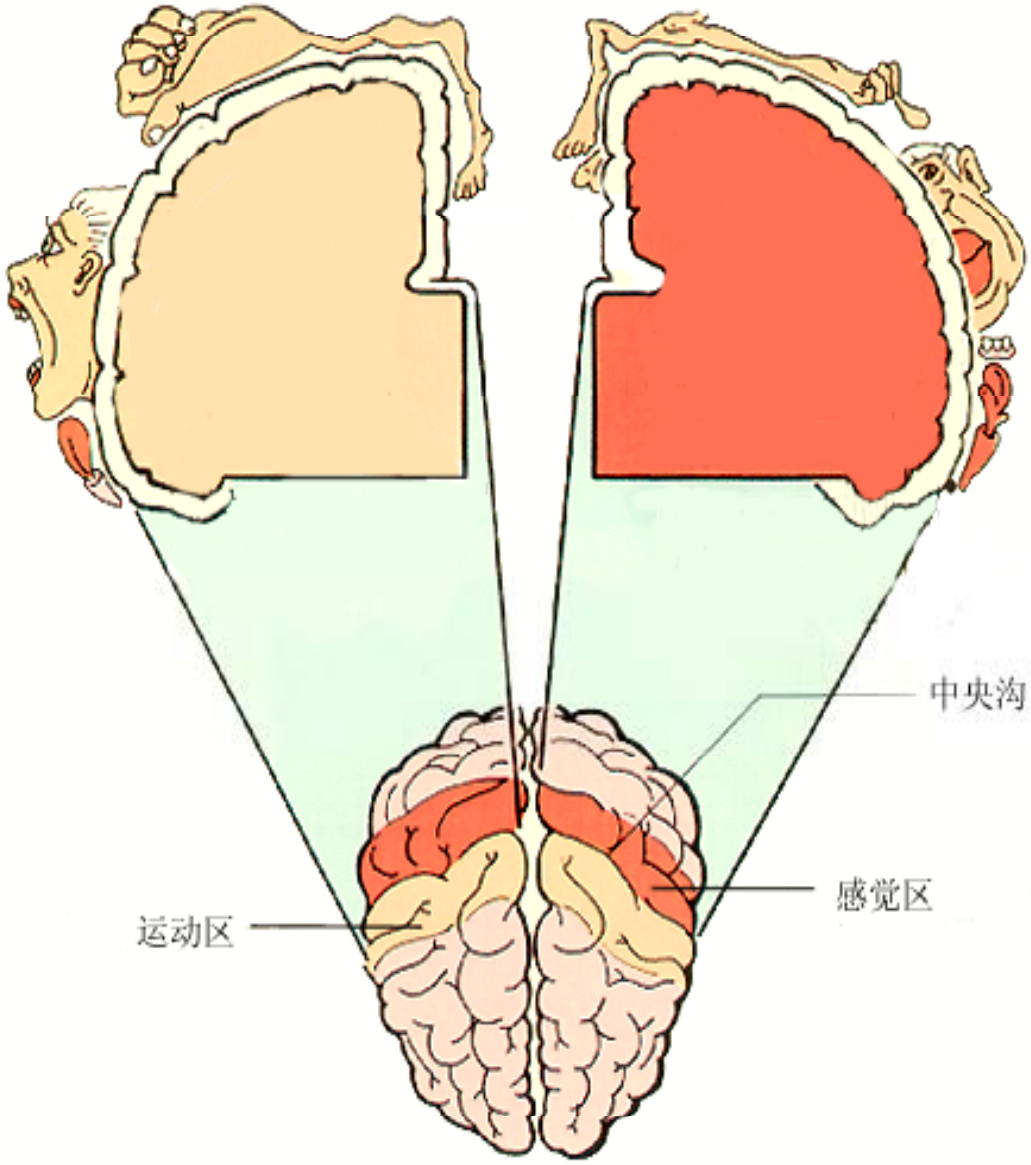
  杏仁核

- Parts of tempo

  部分颞叶

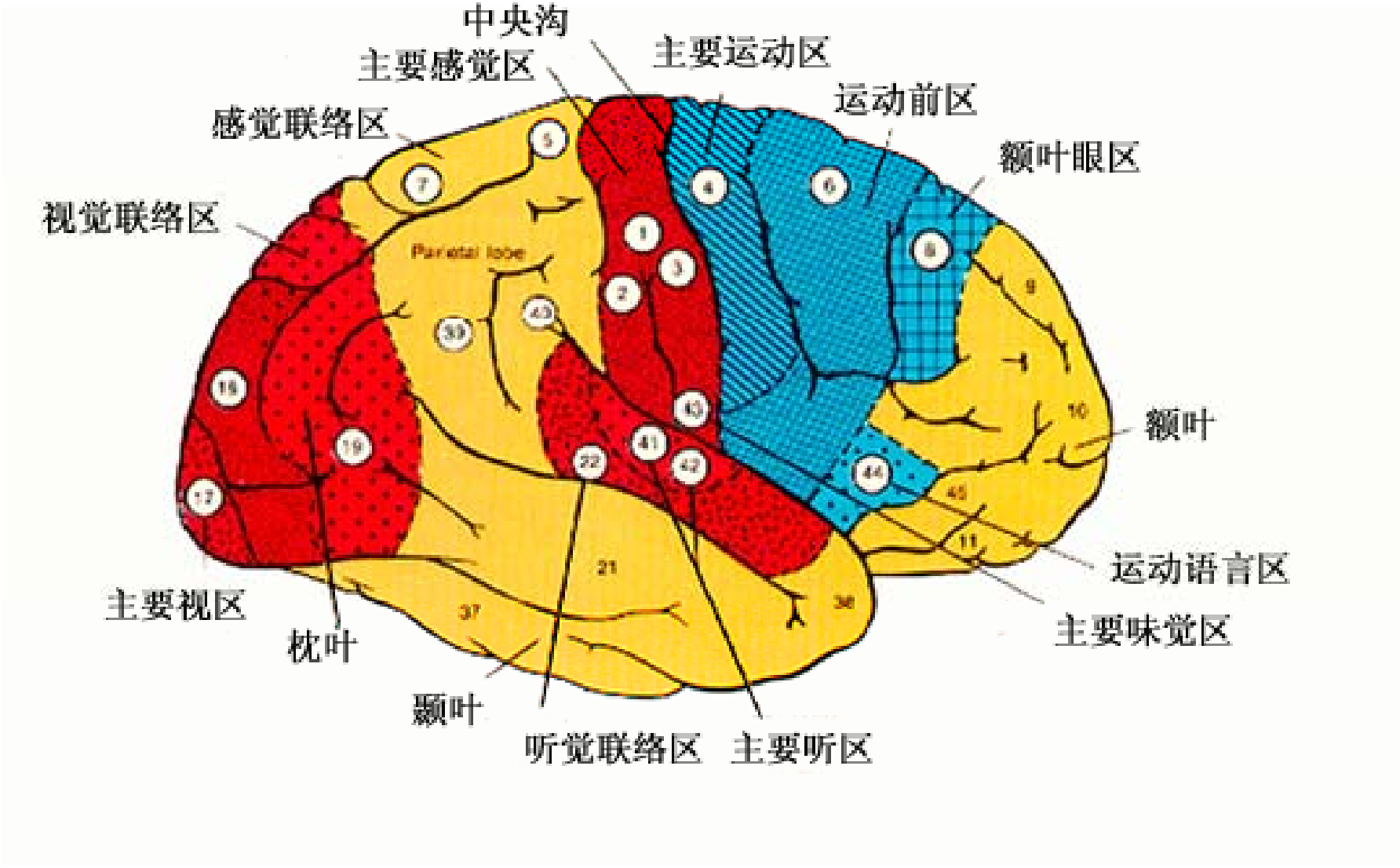


- No effect on intellect & language functions
  对智力和语言功能无效
- Massive **anterograde amnesia** and moderate **retrograde amnesia**
  大量顺行性遗忘和中等逆行性遗忘
- Normal short-term memory, but unable to transfer new short-term memory into long-term memory
  正常短期记忆，但不能把短期记忆转化为长期记忆
- Few or no new learning of **declarative memories** but Intact **procedural memory**
  少或无新的陈述性记忆，完整的程序性记忆


中央沟
感觉区
运动区

Sectorization of the brain

大脑皮层功能分区



White matter 白质

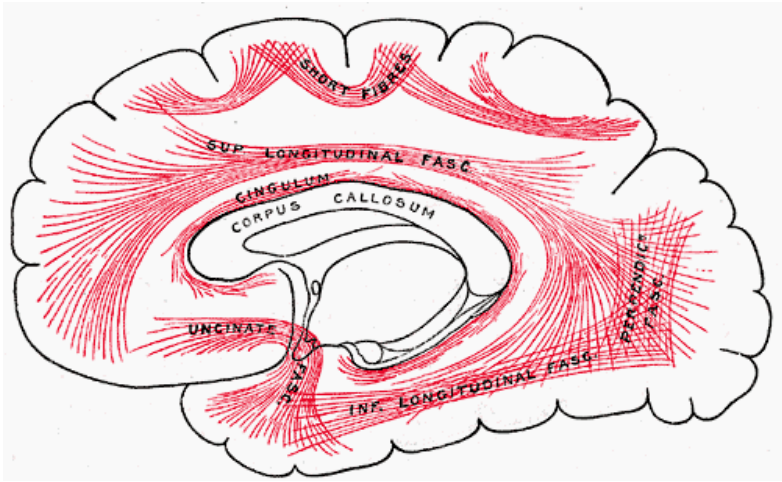
Association fibers

联络纤维

Run between gyri within the same hemisphere

联络同侧半球脑回

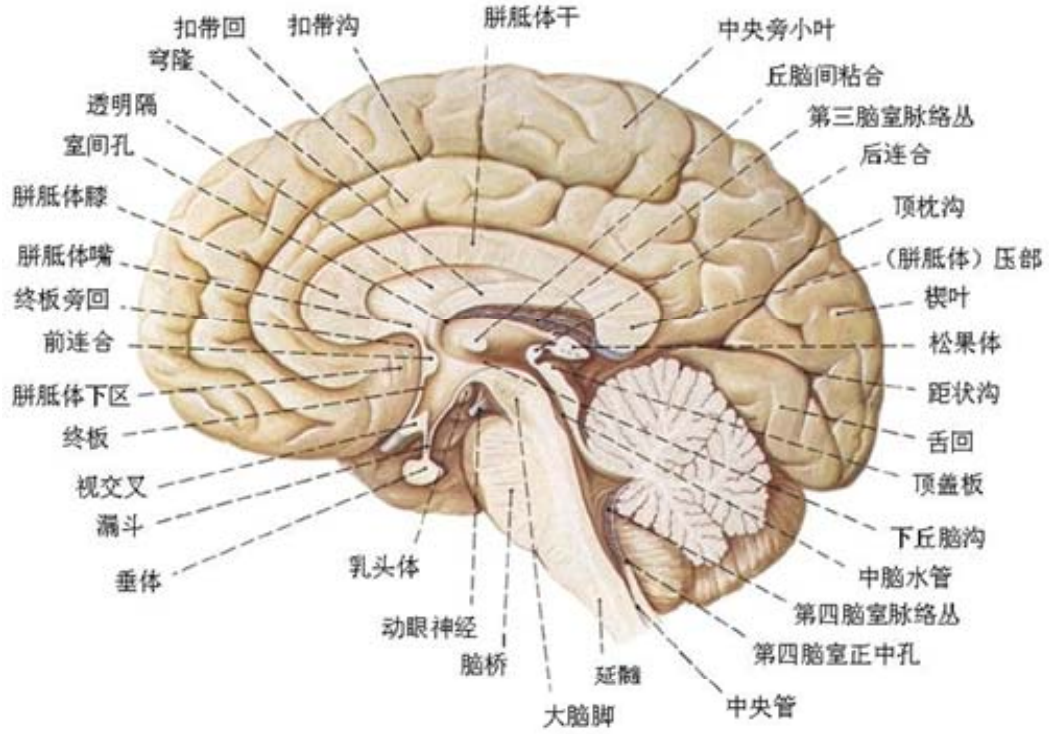
- Cerebral arcuate fibers
  大脑弓状纤维
- Superior longitudinal fasciculi
  上纵束
- Inferior longitudinal fasciculi
  下纵束
- Uncinate fasciculus 钩束
- Cingulum 扣带



Commissural fibers 连合纤维

run between left and right hemisphere 联络左右半球

- Corpus callosum胼胝体:
  rostrum胼胝体嘴, genu胼胝体膝, trunk胼胝体干, splenium胼胝体压部
- Anterior commissure 前连合
- Fornix and commissure of fornix 穹隆和穹隆连合



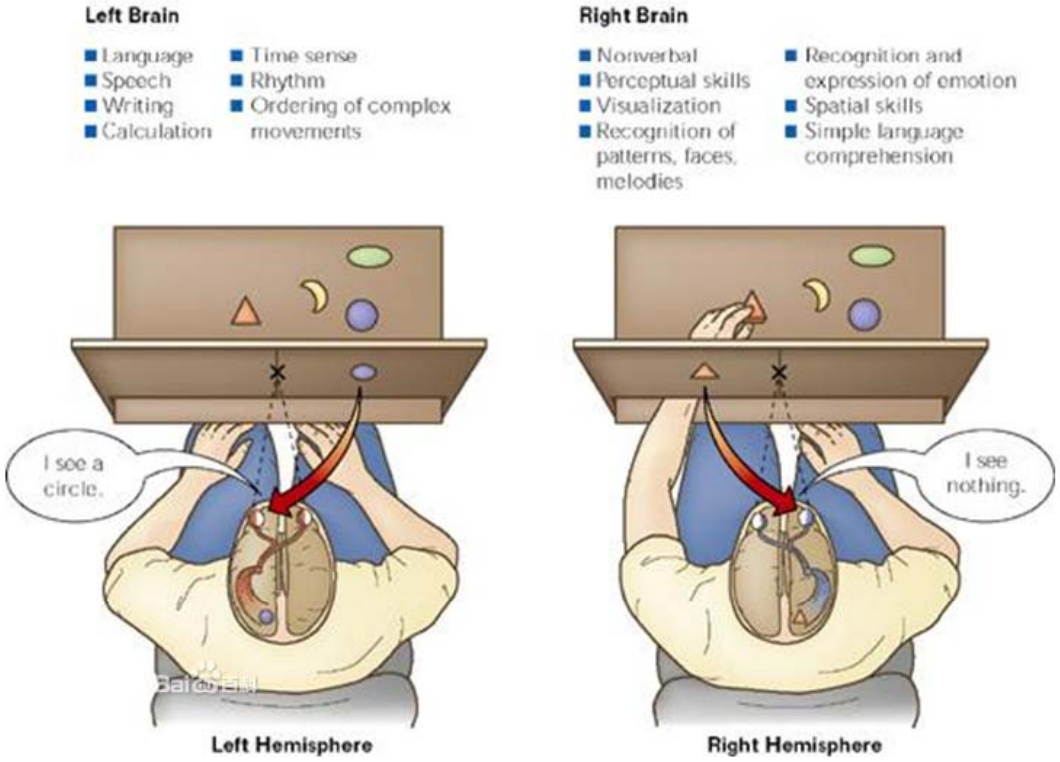
脑的正中矢状断

Function of the corpus callosum: the split brain

胼胝体功能-裂脑人实验

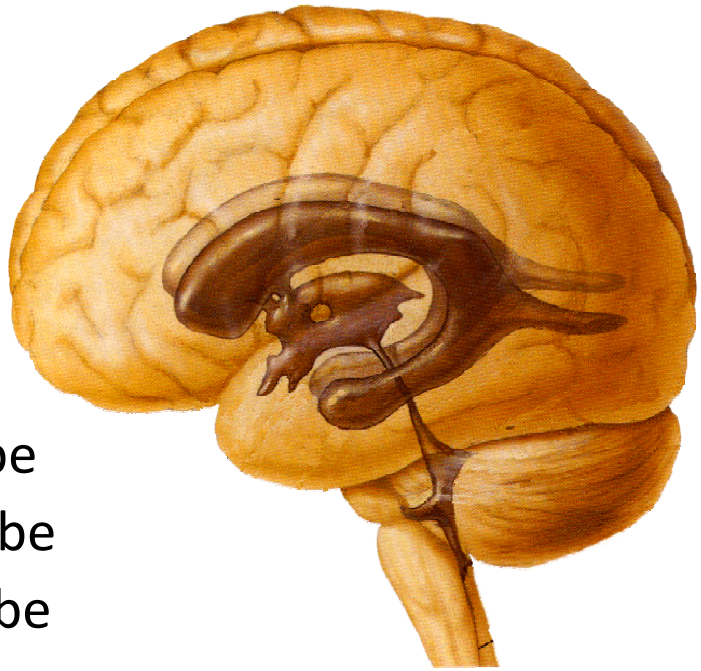
Researchers have adopted corpus callosotomy to treat epilepsy patients failing in drug therapy since the 1940s, resulting in cease of epilepsy and permanent segregation of the two hemispheres unable to communicate and coordinate with each other.

上世纪40年代起，科学家对药物治疗无效的癫痫病人采用切断胼胝体的办法。这么一来，癫痫病发作虽然停止了，但大脑两半球却被分割开来，“老死不相往来”，不仅信息不通，连行动也互不配合，于是形成了所谓的“裂脑人”。



Internal structures
内部结构

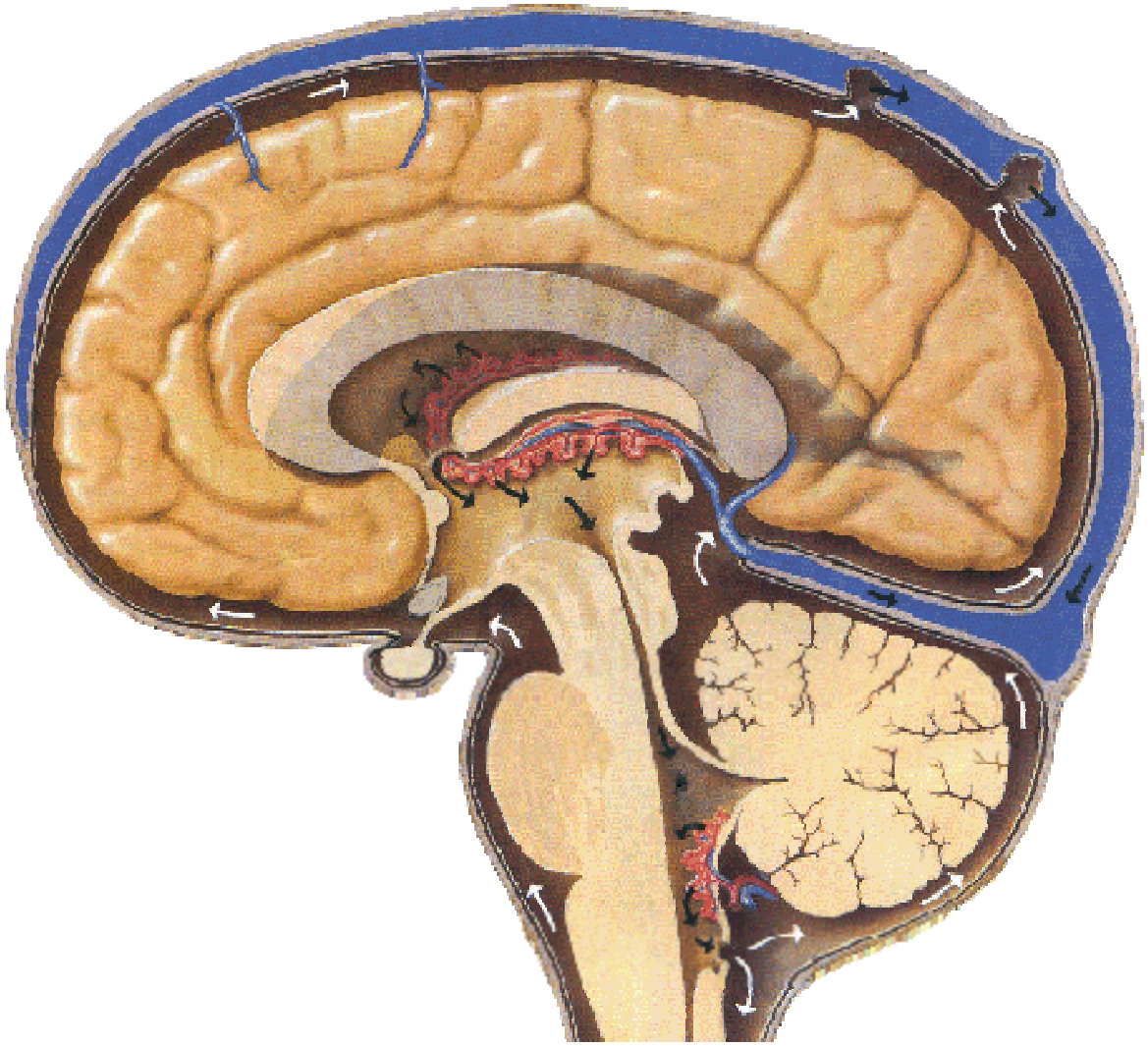
Lateral ventricle 侧脑室



- Position: located in cerebral hemispheres
- 位置：大脑两半球内部
- Four parts
  - Central part: lies in parietal lobe
  - Anterior horn: extends into frontal lobe
  - Posterior horn extend into occipital lobe
  - Inferior horn: extend into temporal lobe
- 四部分
  - 中间：在顶叶内
  - 前角：延展至额叶
  - 后角：延展至枕叶
  - 下角：延展至颞叶

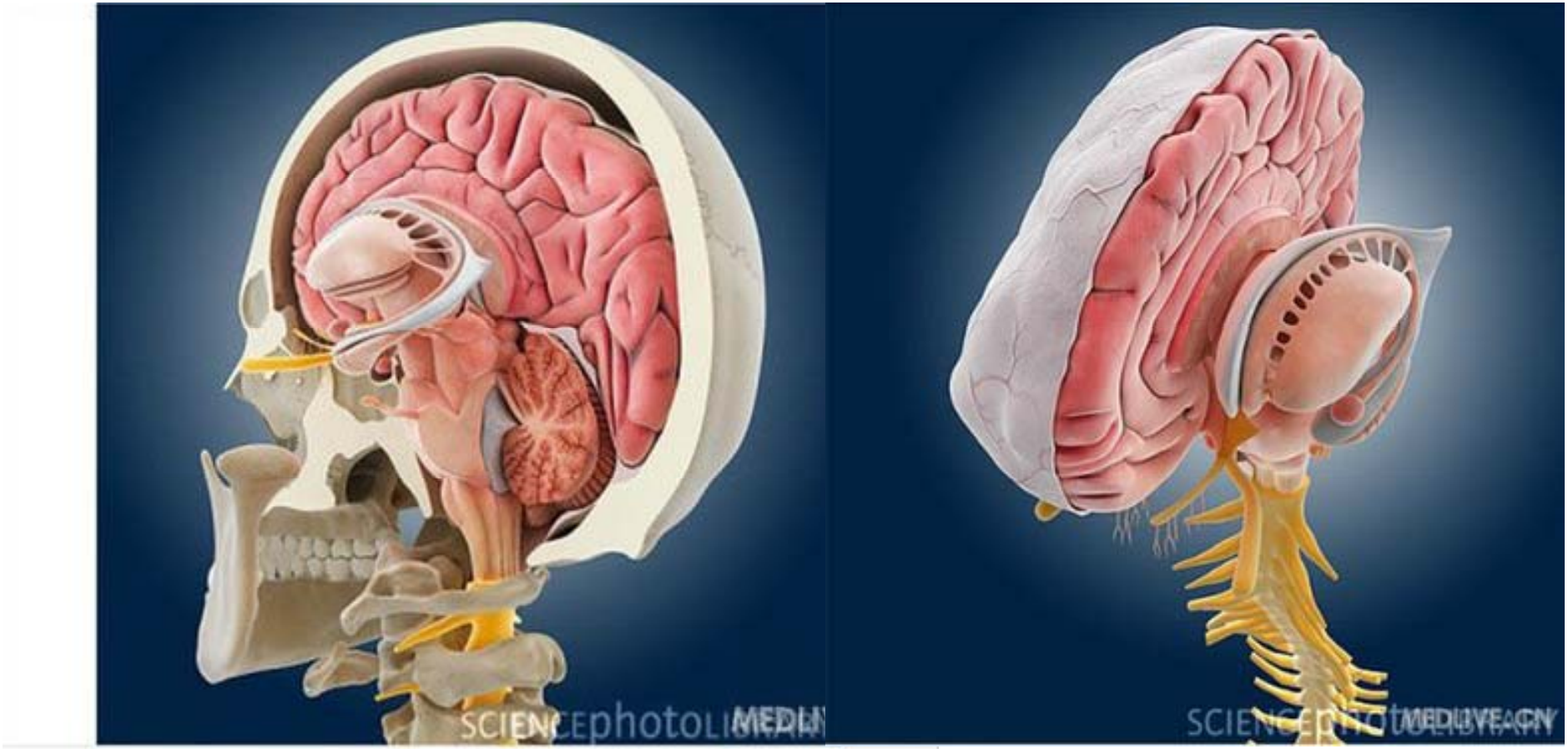
- **Communication** 通讯

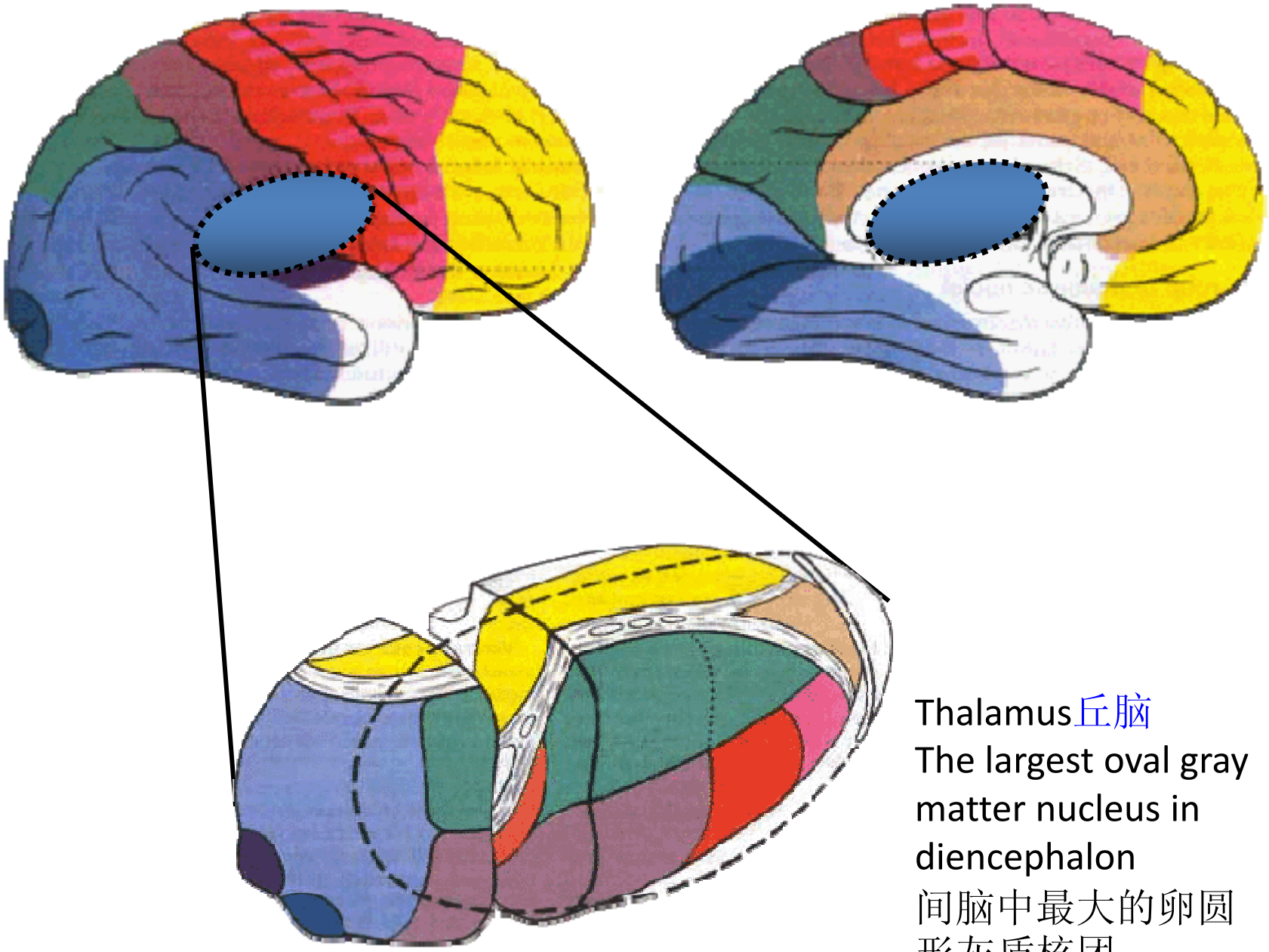
lateral ventricle → interventricular foramen → third ventricle
侧脑室 → 室间孔 →第三脑室



The diencephalon

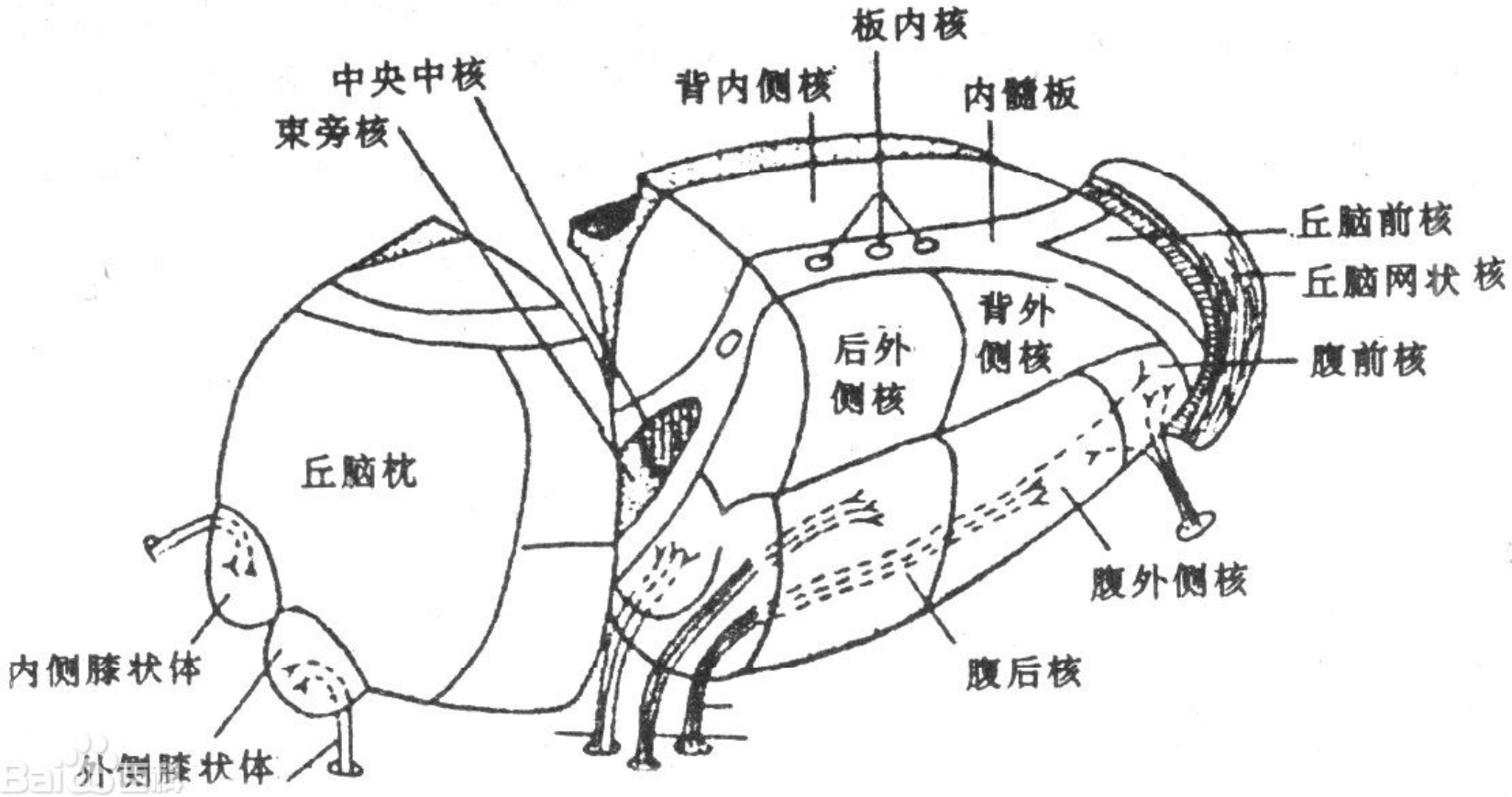
间脑





Thalamus丘脑
The largest oval gray matter nucleus in diencephalon
间脑中最大的卵圆形灰质核团

Thalamus 丘脑


板内核
中央中核
背内侧核
内髓板
束旁核
丘脑前核
丘脑网状核
背外侧核
后外侧核
腹前核
丘脑枕
腹外侧核
腹后核
内侧膝状体
外侧膝状体

Functions of the thalamus
丘脑的功能

丘脑是感觉传导的接替站，除嗅觉外，各种感觉的传导通路均在丘脑内更换神经元，而后投射到大脑皮层。在丘脑内，只对感觉进行粗糙的分析与综合，在大脑皮层才对感觉进行精细的分析与综合。丘脑向大脑皮层的投射分为两大系统，即特异投射系统与非特异投射系统。

The thalamus is an intermediate station of sensory conduction. Besides olfaction, many sensory pathways substitute neurons and project to the cerebral cortex here. Coarse analysis and integrations happens in thalamus and further fine processes are conducted in the cortex. The thalamus project specifically and non-specifically to the cortex.

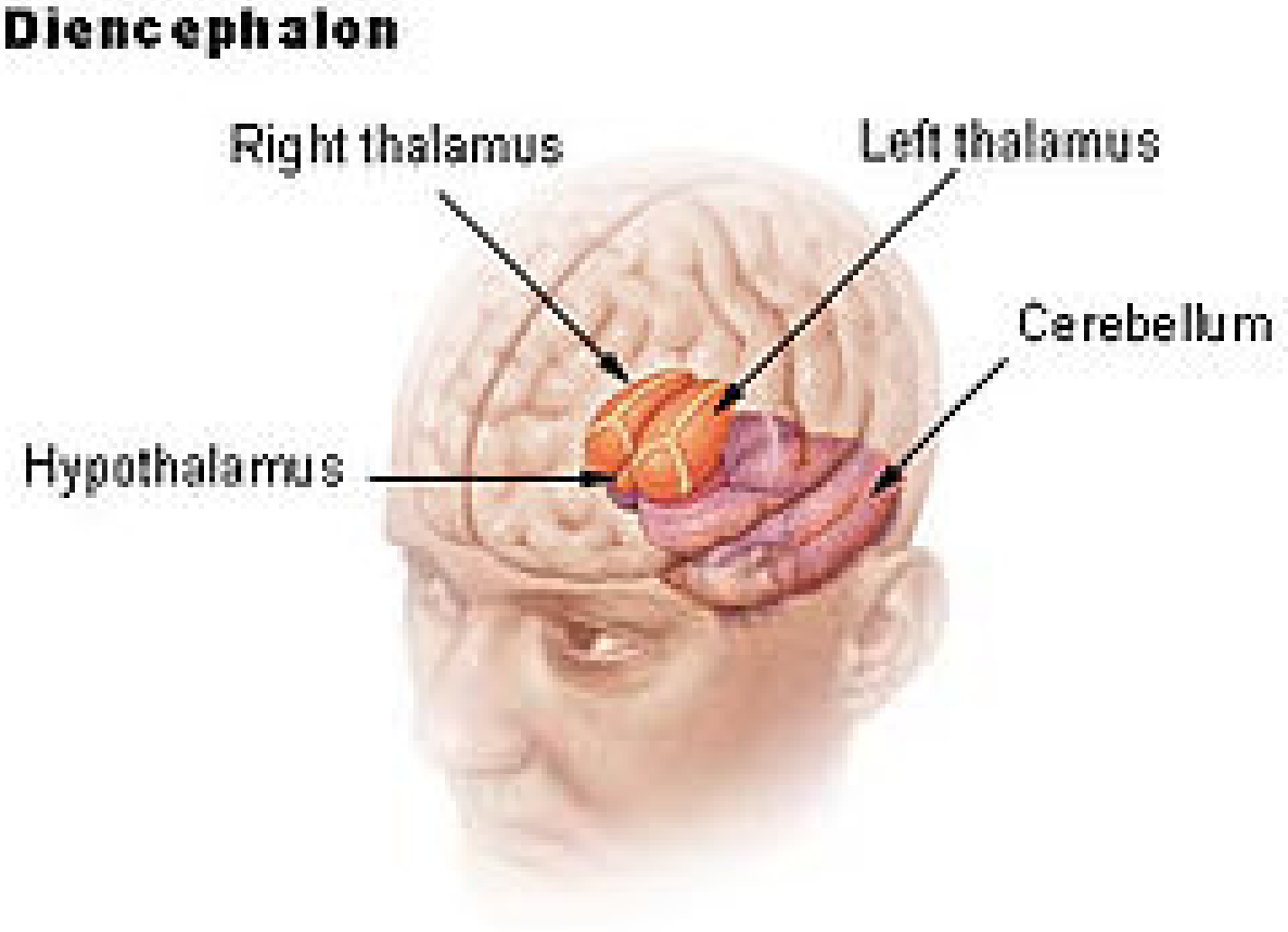
特异投射系统是指丘脑的外侧核、外侧膝状体、内侧膝状体投射到大脑皮层的纤维联系。一般经典的感觉传导通路就是通过丘脑的特异投射系统而后作用于大脑皮层的。由丘脑到大脑皮层的特定区域，是点对点的投射关系，每种感觉的传导都有其专一的途径。

The specific projection system refers to the fiber connections from lateral thalamus nuclei, lateral geniculate nucleus and medial geniculate nucleus projecting to the cerebral cortex. These are classical point-to-point specific sensory conduction pathways.

非特异投射系统是指由丘脑内侧核群弥散地投射到大脑皮层广泛区域的纤维联系。感觉传入的非特异投射系统对维持大脑皮层的觉醒状态有重要作用。各种的传入冲动越多，经过侧支进入脑干网状结构的冲动也越多，从而对大脑皮层的上行唤醒作用越强，皮层的兴奋状态越好，对特异投射系统上传产生的感觉也就越完善。因此，感觉传入的特异投射系统与非特异投射系统，在功能上是相互依赖而不可分割的。

The non-specific projection system is the vast extensive fiber connections medial thalamus nuclei projecting to the cortex. The sensory afferent non-specific projecting system assists cortex consciousness. The more afferent impulsions, the more impulsions via collateral branches into the brainstem, the stronger cortex wakening and excitation, the more detailed afferent sensations to the specific projection system. Thus, the specific and non-specific system are indivisible.

Hypothalamus 下丘脑

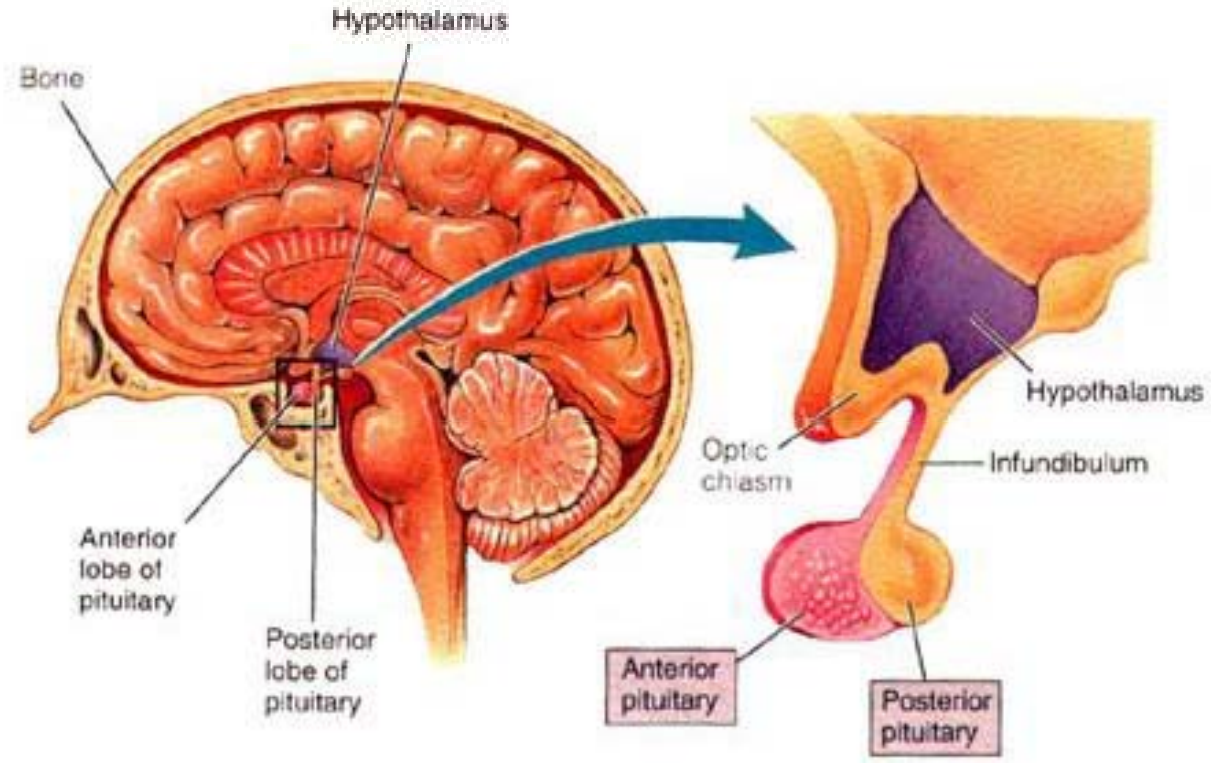


Functions of hypothalamus下丘脑的功能

是调节内脏活动和内分泌活动的较高级神经中枢所在，又称丘脑下部。下丘脑腺体调节体温、血糖、水平衡、脂肪代谢、摄食习惯、睡眠、性行为、情绪、荷尔蒙（例如：肾上腺素及皮质醇）的制作，以及自主神经系统。它接收从自主神经系统而来的讯号，并决定相应的行动。当人类遇到恐惧或兴奋的事情，身体的自主神经系统会向视丘下部腺体发出讯号，从而使身体加速心跳和呼吸、瞳孔扩张，并增加血液流量，以使身体能够及时作出相应的行动。虽然它在身体占有极为重要的地位，但它的体积只有整个脑部不足1%的空间。

Center of regulations of visceral and endocrine activities. Regulates body temperature, blood glucose, water balance, fat metabolism, diet habits, sleep, sexual behaviors, emotions, hormone generation(such as epinephrine and cortisol) and automatic nervous system. It receives signals from the automatic nervous system and decide corresponding behaviors. When people are faced with fear or excitement, the automatic nervous system gives signals to the hypothalamus, causing heart rate increase, breathe increase, pupil dilation and blood flow increase to act correspondingly. It only occupies 1% of the body volume while it plays a key role in body metabolism.

Functions of hypothalamus下丘脑的功能

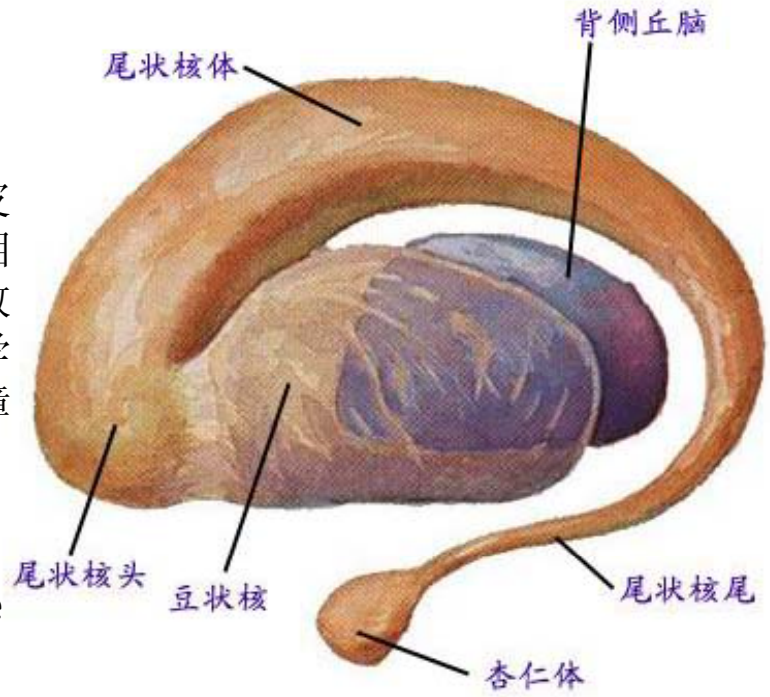


Basal nuclei 基底核

- **Corpus striatum** 纹状体
  - **Lentiform nucleus** — **Globus pallidus** 苍白球 — **paleostriatum** 旧纹状体
  - 豆状核 — **putamen** 壳 — **Neostriatum** 新纹状体
  - **Caudate nucleus**
  - 尾状核
- **Claustrum** 屏状核
- **Amygdaloid body** 杏仁体

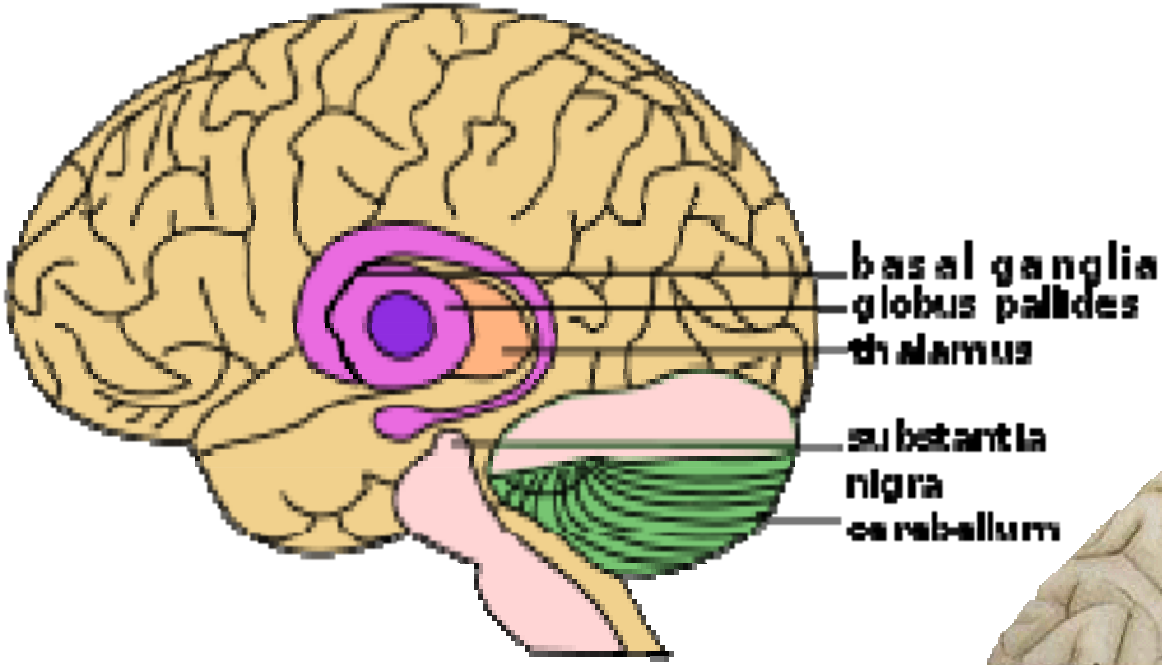
是大脑深部一系列神经核团组成的功能整体。它位于大脑皮质底下一群运动神经核的统称，与大脑皮层，丘脑和脑干相连。目前所知其主要功能为自主运动的控制、整合调节细致的意识活动和运动反应。它同时还参与记忆，情感和奖励学习等高级认知功能。基底核的病变可导致多种运动和认知障碍，包括帕金森氏症和亨廷顿氏症等。

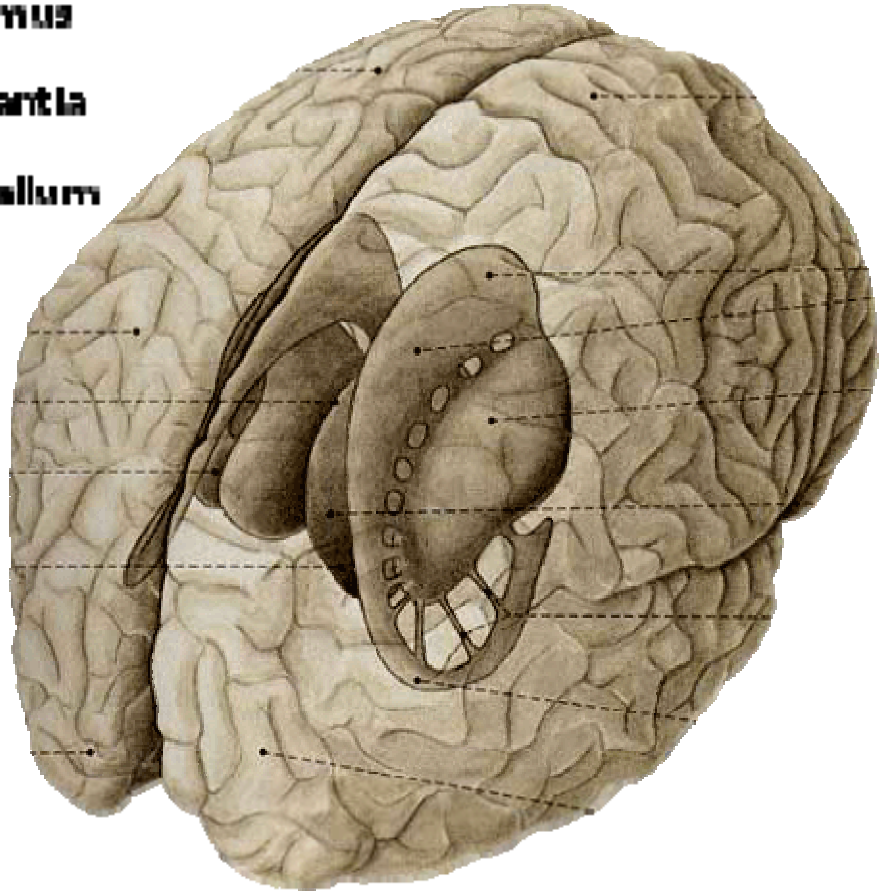
A set of functional nuclei deep in the brain. It lies under the cortex and connect with the cortex, thalamus and brainstem. Play a role in controlling autokinetic movement, integration fine conscious, motor activities and advanced cognitive functions such as memory, emotions and reward learning. Lesions of basal ganglia can result in various motor and cognition disorders such as Parkinson's disease and Huntington's disease.



基底核

Basal Ganglia and Related Structures of the Brain

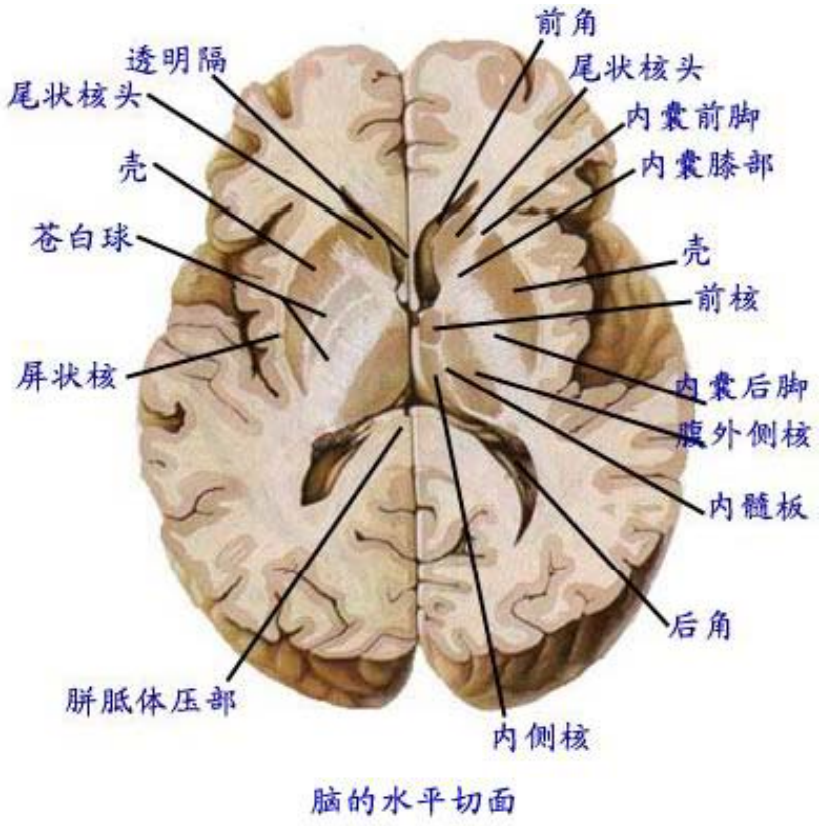




Internal capsule内囊

Three parts 三部分

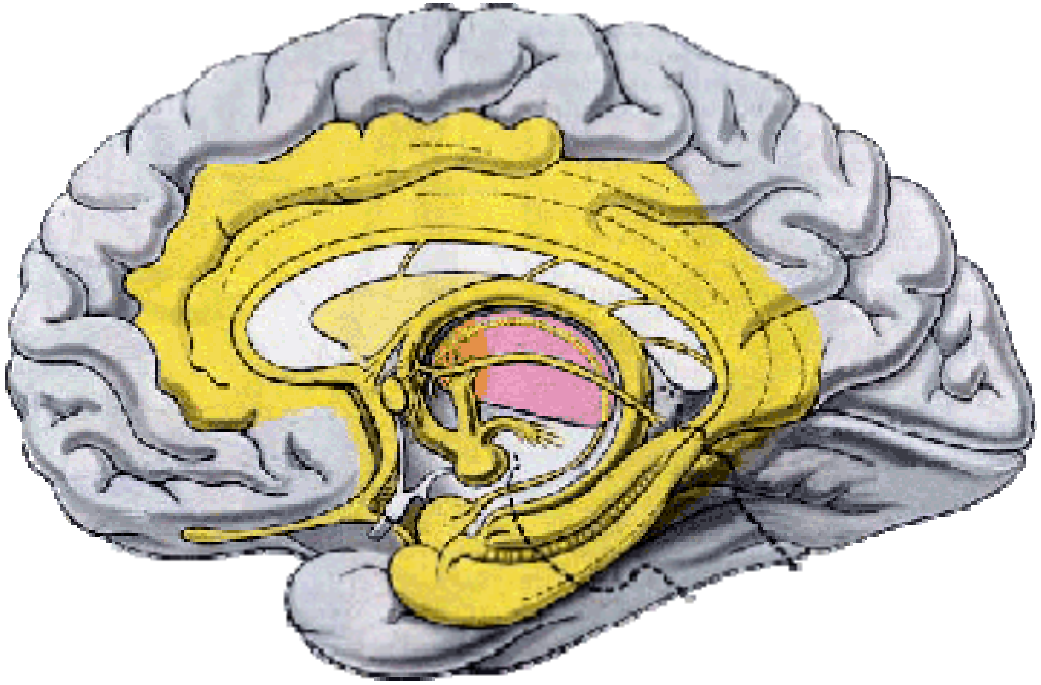
- **Anterior limb of internal capsule** 内囊前脚
  - Lies between caudate nucleus and lentiform nucleus
  - 位于尾状核和豆状核之间
  - Containing frontopontine tract and anterior thalamic radiation
  - 由额桥束和前丘脑辐射组成
- **Genu of internal capsule** 内囊膝
  - Is angle at which anterior and posterior limbs meet
  - 前后肢连接处角
  - Containing corticonuclear tract
  - 由皮质延髓束组成
- **Posterior limb of internal capsule** 内囊后脚
  - Lies between thalamus and lentiform nucleus
  - 位于丘脑和豆状核之间
  - Contain **corticospinal tract**, **corticorubral tract**, **central thalamic radiation**, **parieto-occipito-temporo-pontine tract**, **acoustic radiation** and **optic radiation**
  - 由皮质脊髓束、皮质红核束、中丘脑辐射、顶枕颞脑桥束、听辐射和视辐射组成



脑的水平切面

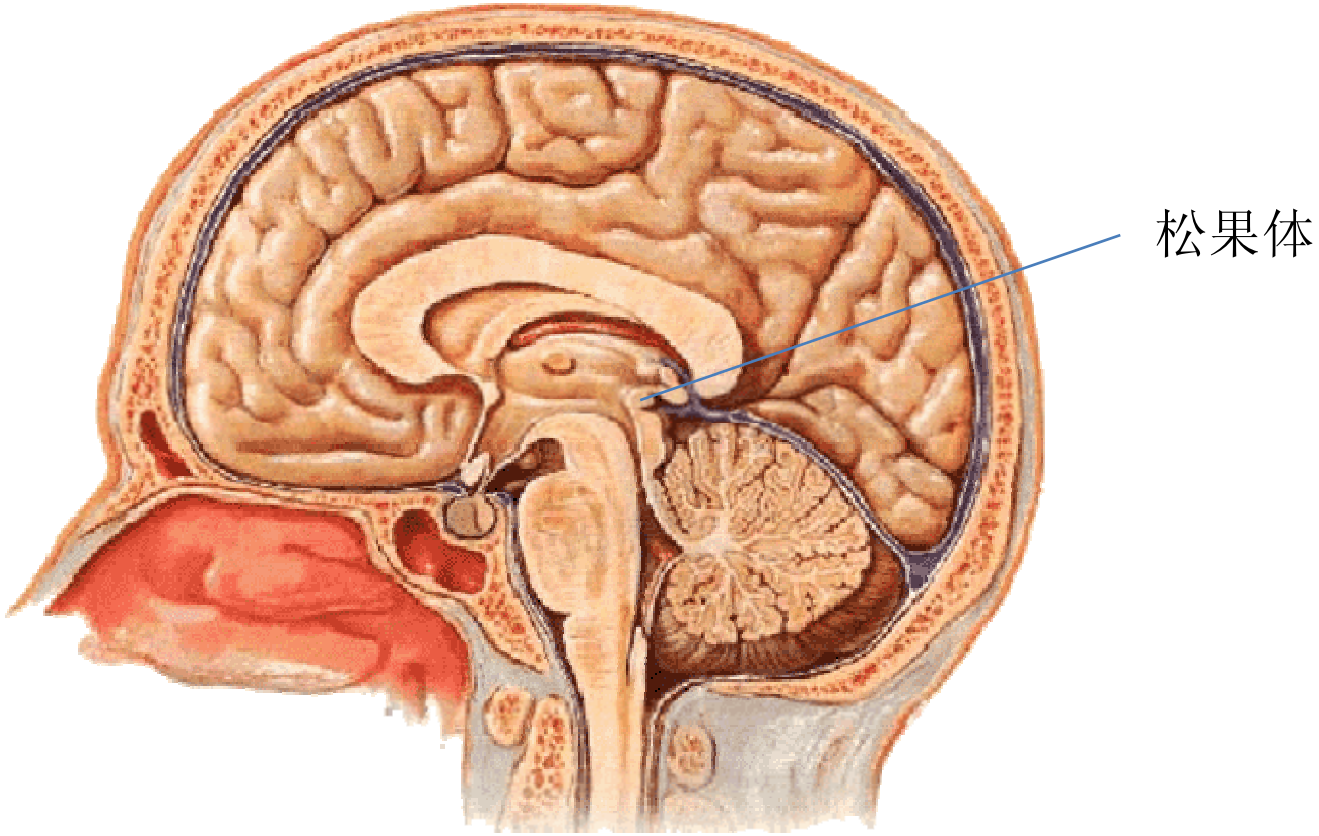
Limbic system 边缘系统

- Composition 构成
  - **Limbic lobe边缘叶**: includes septal area隔区, cingulated gyrus扣带回, parahippocampal gyrus旁海马回, hippocampus海马, dentate gyrus齿状回, temporal pole颞极, anterior part of insular lobe 岛叶and so on
  - **Associated subcortical nuclei关联的皮质下核团:** amygdaloid body杏仁体, septal nuclei隔核, hypothalamus下丘脑, epithalamus上丘脑, anterior nucleus group of thalamus丘脑, tegmentum of midbrain中脑被盖部
- Function: concerned with visceral activities, olfaction, emotion and memory, so this system is called 'visceral brain'.
  功能：与内脏活动、嗅觉、情感和记忆有关，又称“内脏脑”



Pineal body 松果体

- locates in posterosuperior to thalamus, attached by stalk to posterior part of roof of third ventricle.
- 位于丘脑后上方，第三脑室顶后部柄附于其上
- A small endocrine gland in vertabrate brains incharge of melatonin, a hormone regulating sleeping/waking patterns and circadian rhythm functions (seasonal).
- 是一个位于脊椎动物脑中的小内分泌腺体。它负责制造褪黑素，一种会对醒睡模式与(季节性)昼夜节律功能的调节产生影响的激素。



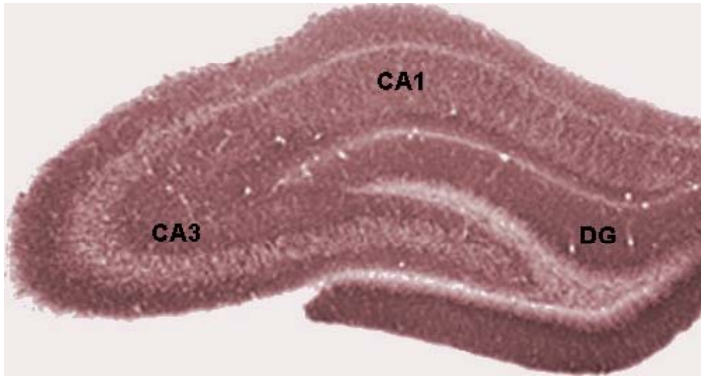
Why choose hippocampus to study LTP

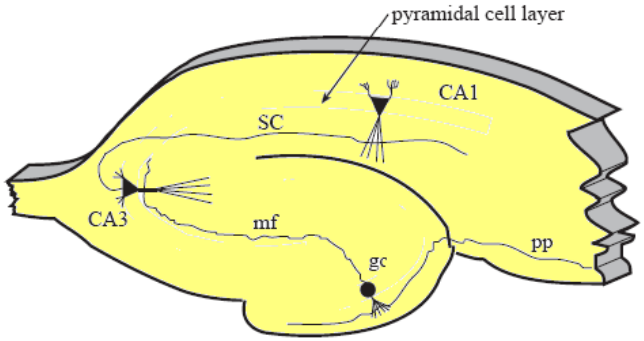
选择海马结构研究LTP的理由

- The relative simplicity of its neural architecture

  相对简单的神经架构
- Synaptic responses could be monitored with extracellular recording electrodes

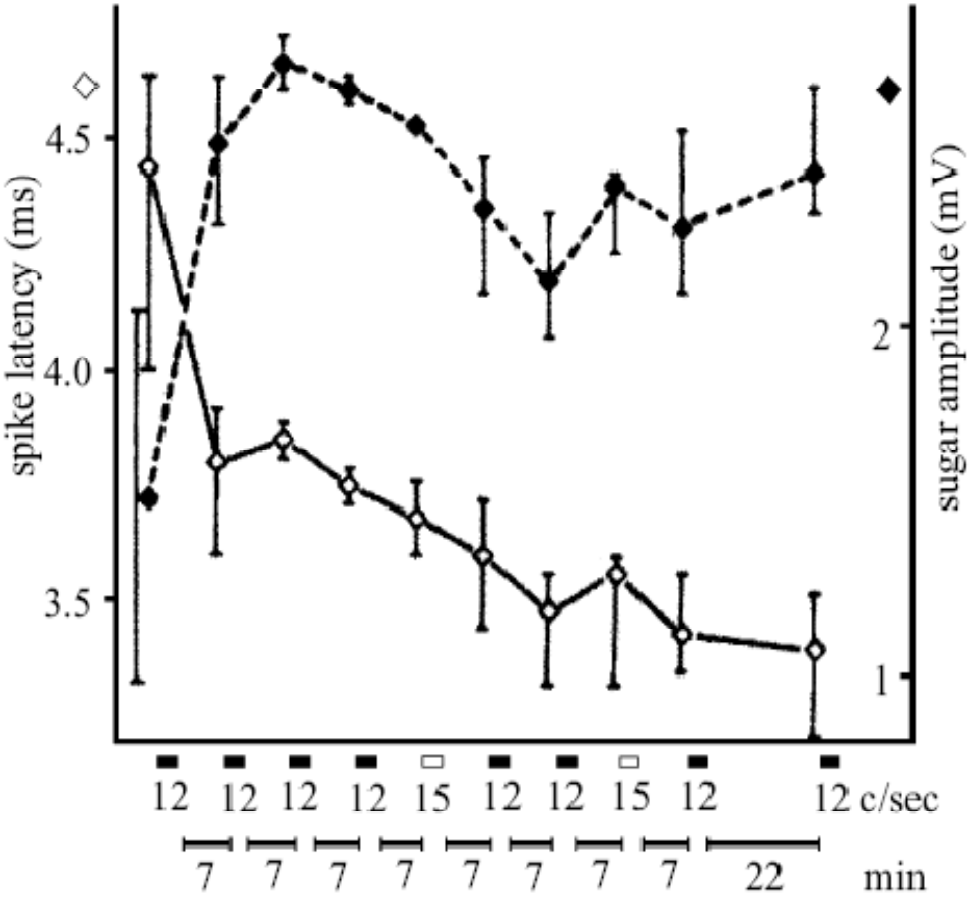
  突触响应可以由细胞外电极操控





The discovery of LTP

LTP的发现



- the amplitude increased rapidly to a new maintained potentiated level

振幅快速增至新的可维持的加强的水平

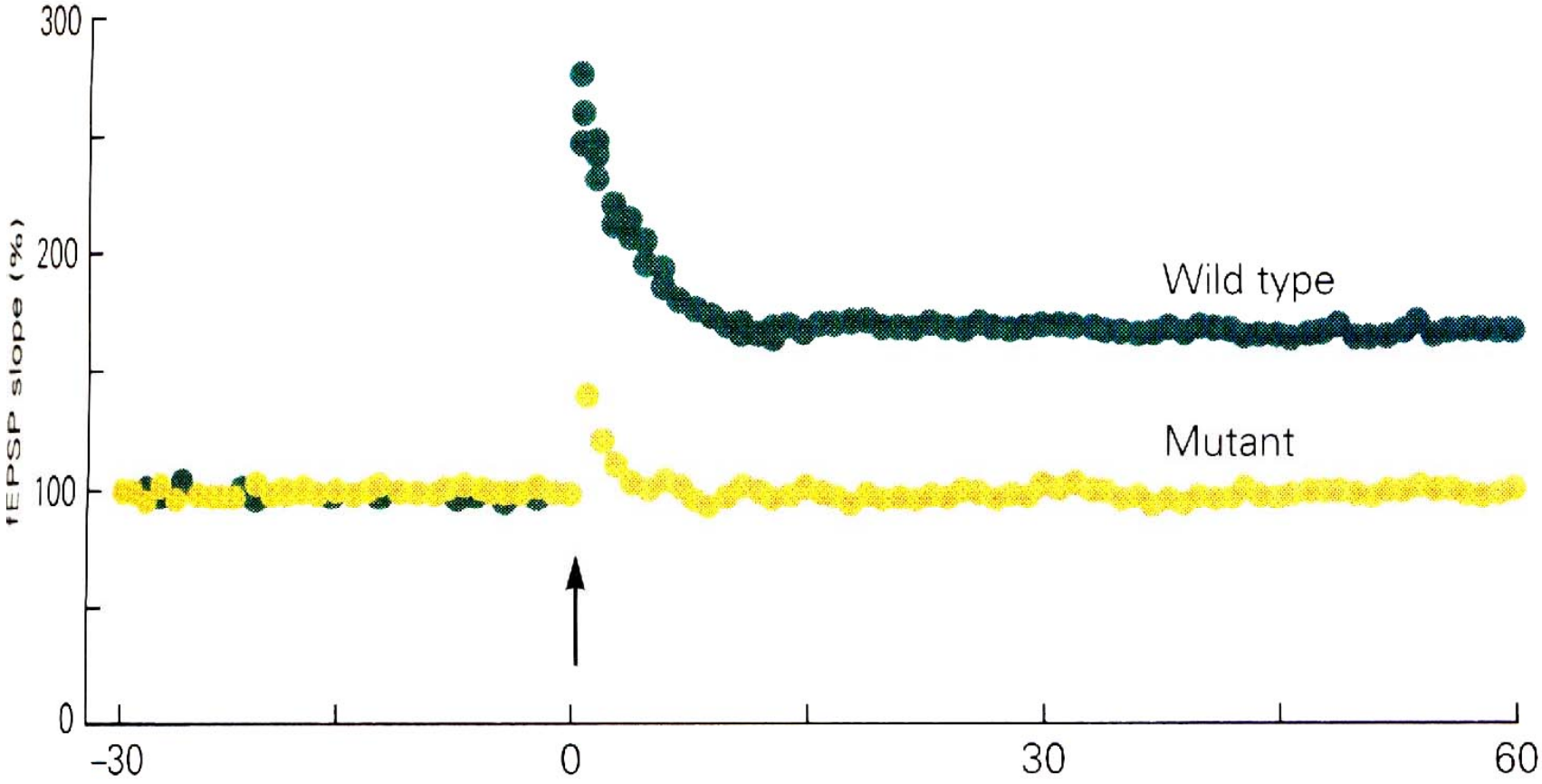
- the latency decreased progressively to a new and apparently stable low level

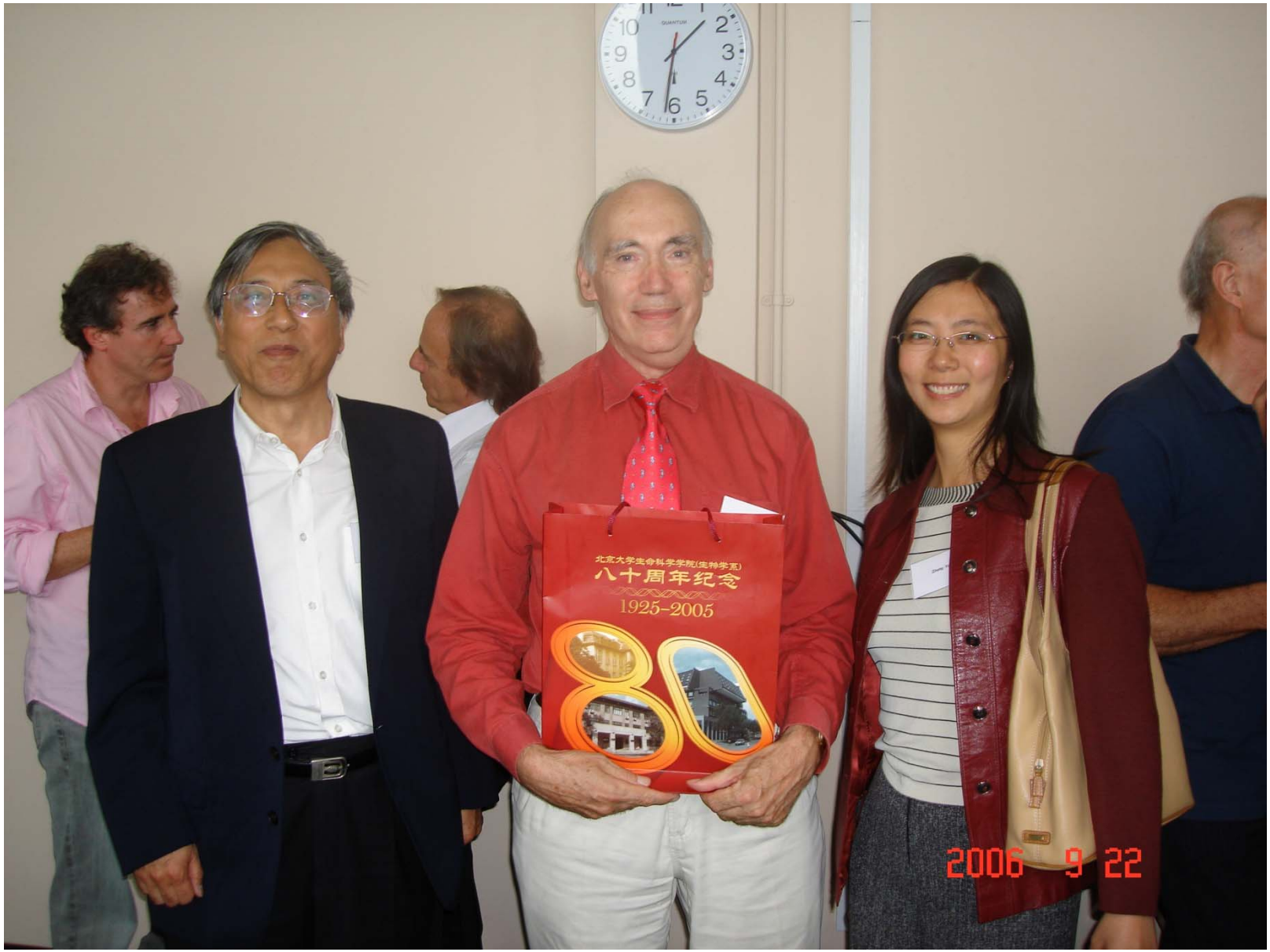
延迟渐进地减至新的显然稳定的低水平

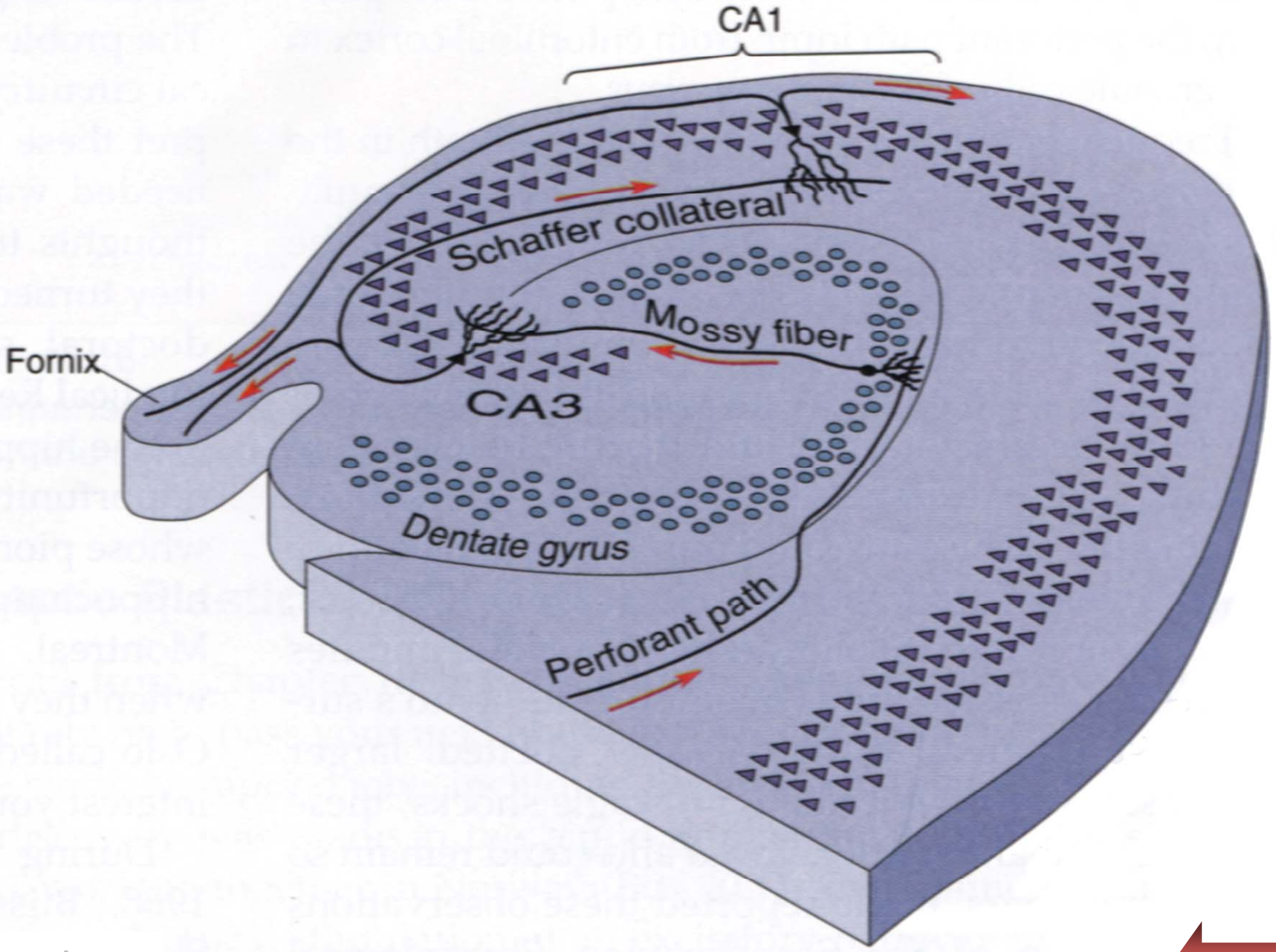
Such modest stimulation can produce so immediate, so profound, and so persistent an effect **T.V.P.Bliss**

温和刺激可以产生立即、深刻、持久的效果

A LTP defect in the Schaffer collateral pathway

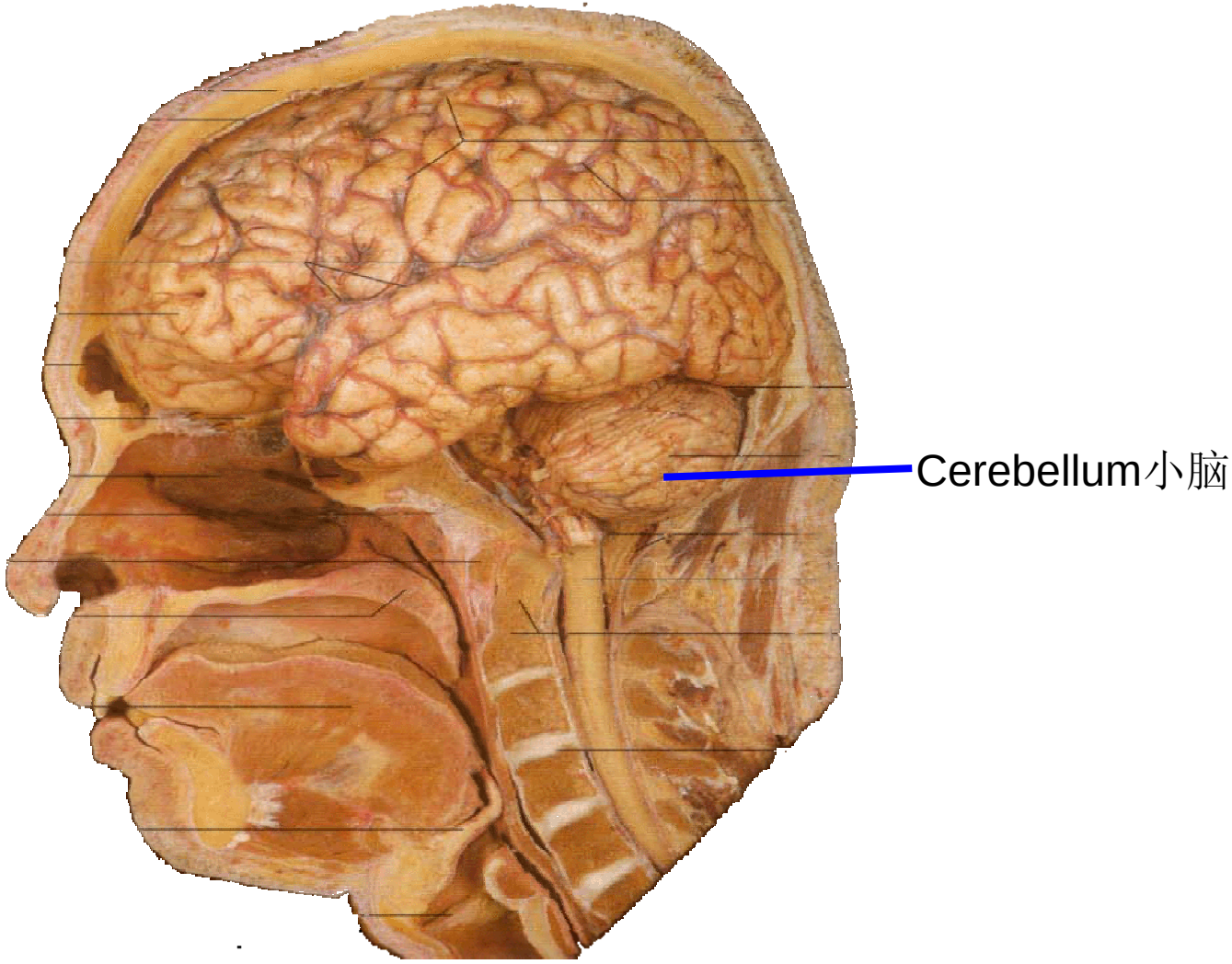



北京大学生命科学学院(生物学系)
八十周年纪念
1925-2005
80
2006 9 22


CA1
Schaffer collateral
Mossy fiber
Fornix
CA3
Dentate gyrus
Perforant path

return

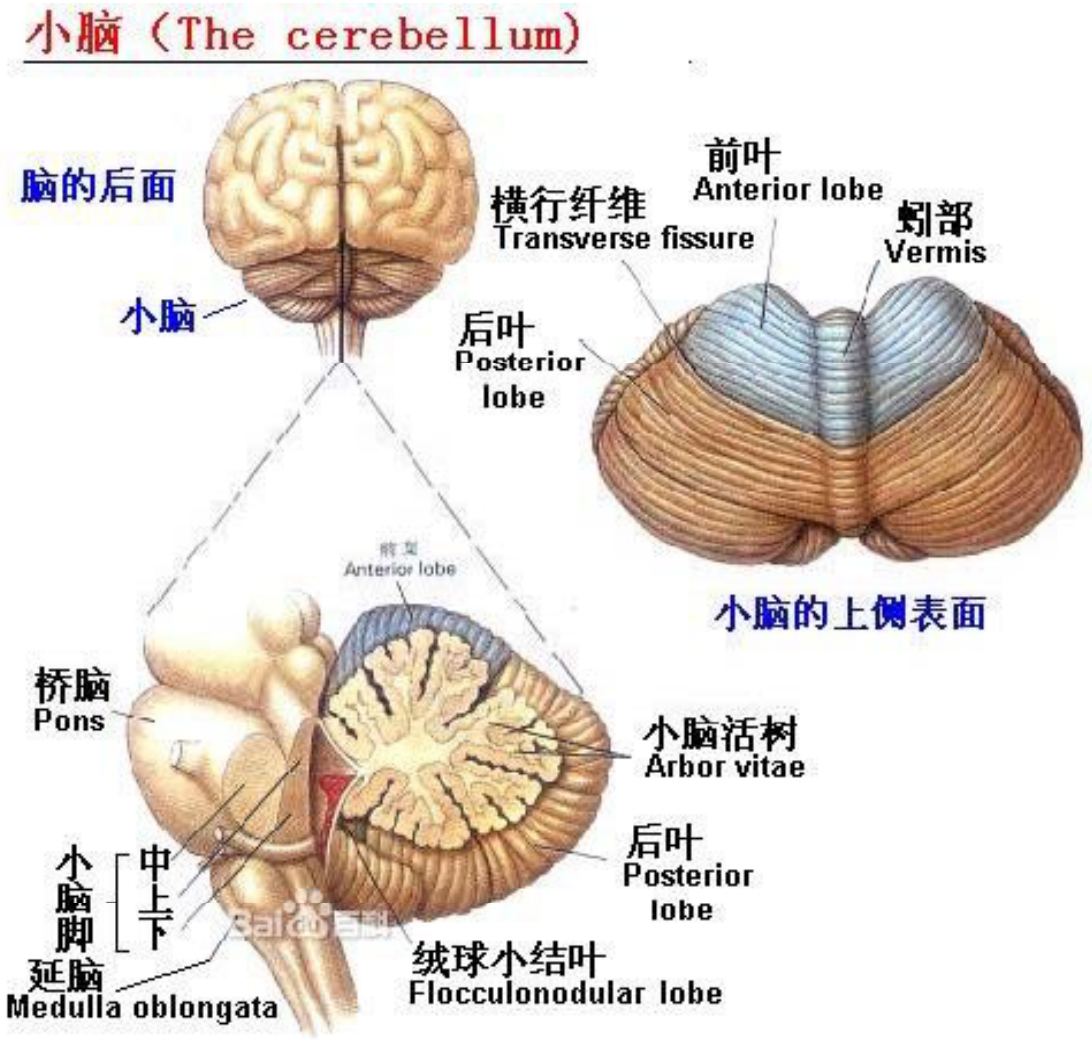
The Cerebellum小脑



External features 外部形态

Consists of two **cerebellar hemisphere** united in the midline by the **vermis.**

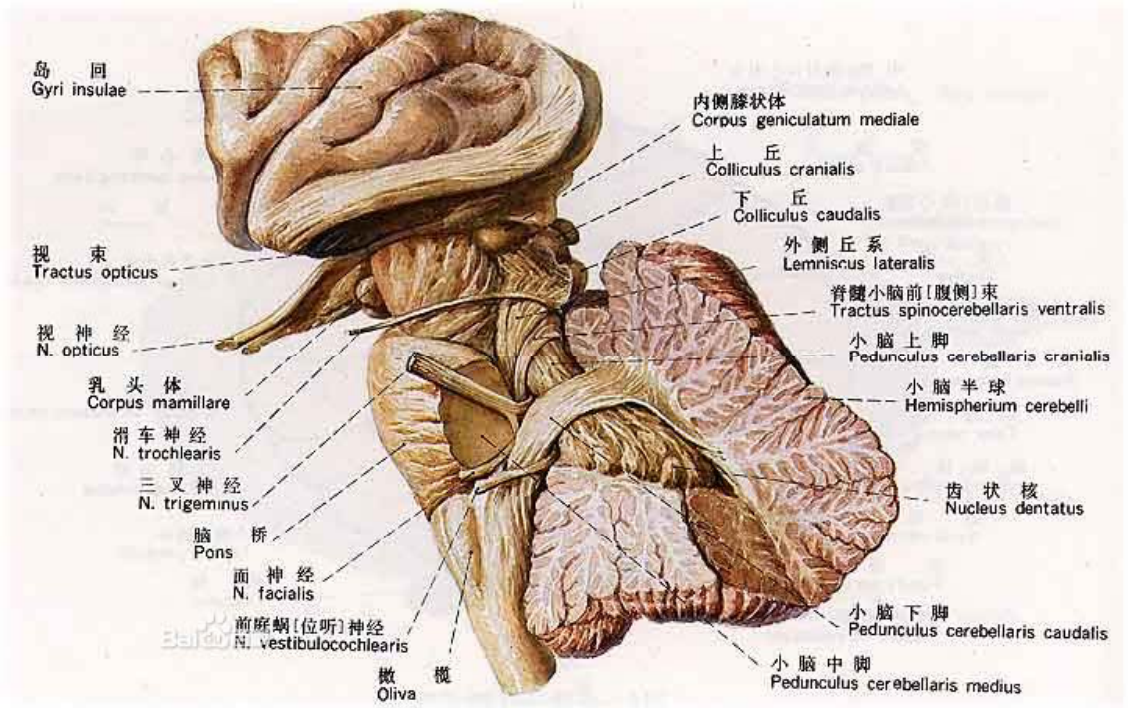
由2个小脑半球构成，经小脑蚓部在中线处连接



External features 外部形态

Three peduncles 小脑脚

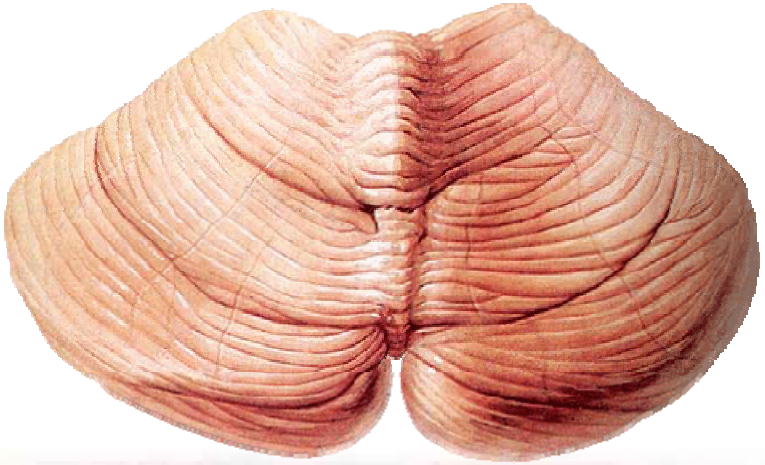
- **Inferior cerebellar peduncle**—connect with medulla and with spinal cord, contain both afferent and efferent fibers
  小脑下脚：与延髓和脊髓连接，包含传入和传出纤维
- **Middle cerebellar peduncle**—connect with pons, contain afferent fibers
  小脑中脚：与脑桥连接，包含传入纤维
- **Superior cerebellar peduncle** —connect with midbrain, contain mostly efferent fibers
  小脑上脚：与中脑连接，主要包含传出纤维



External features 外部形态

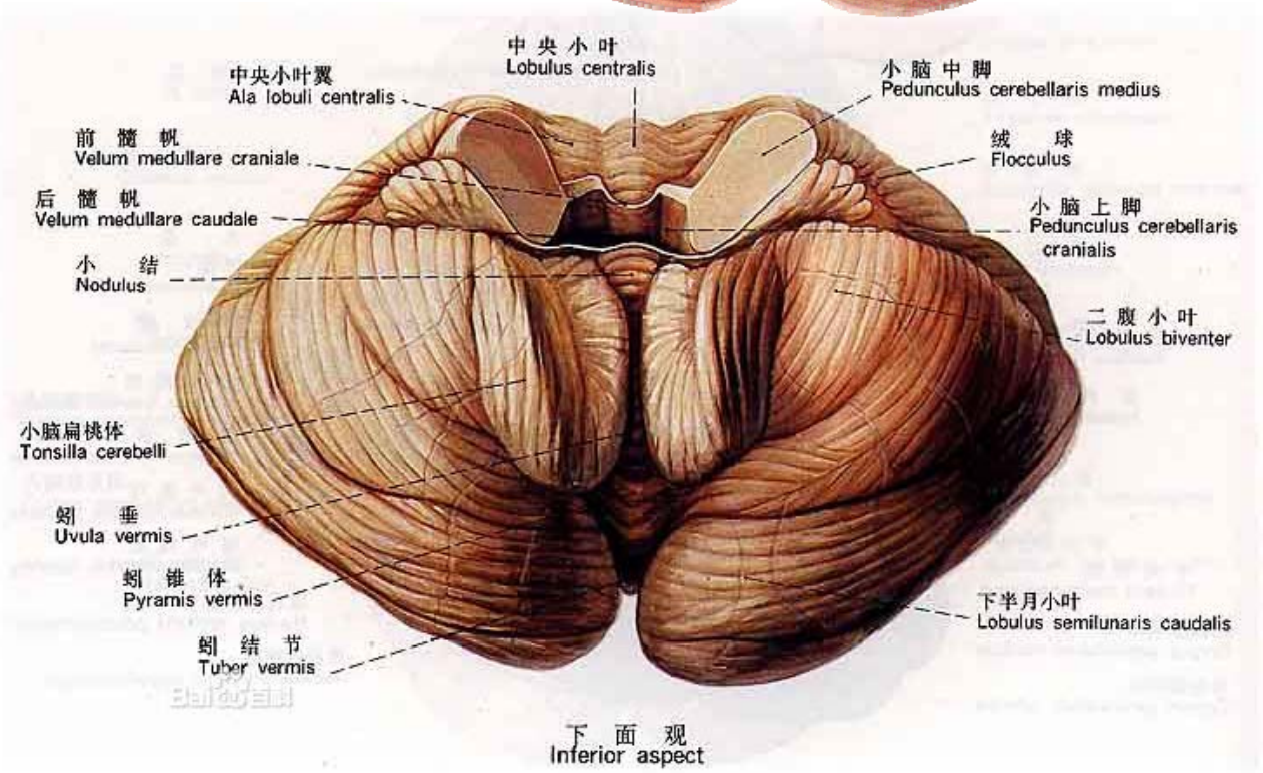
Tonsil of cerebellum

小脑扁桃体



two elevated masses on inferior surface of hemispheral portion just nearby **foramen magnum**

脑下表面靠近枕骨大孔的2个抬高的部分



Internal structures 内部结构

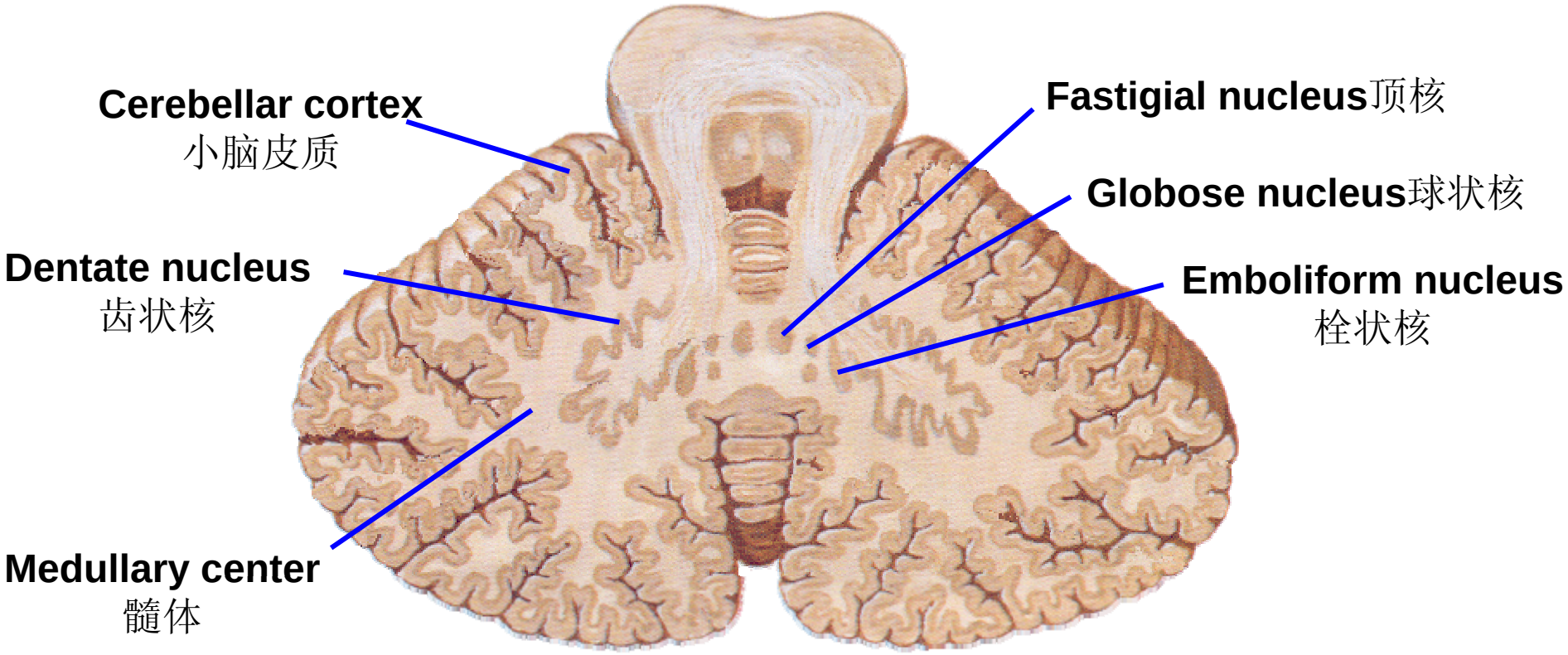
Gray matter灰质

- Cerebellar cortex 小脑皮质
- Cerebellar nuclei 小脑核
  - **Dentate nucleus** 齿状核
  - Fastigial nucleus 顶核
  - Interposed nucleus 中间核
    - Emboliform nucleus 栓状核
    - Globose nucleus球状核

White matter白质

—medullary center 髓体

Internal structures 内部结构



Three functional divisions 3个功能分区

- **Vestibulocerebellum**
- 前庭小脑
  - Archicerebellum 原小脑
  - Flocculonodular lobe 绒球小结叶
- **Spinocerebellum**
- 脊髓小脑
  - Paleocerebellum旧小脑
  - Vermis and intermediate zone蚓部和中间区域
- **Cerebrocerebellum**
- 大脑小脑
  - Neocerebellum 新小脑
  - Lateral zone外侧区