

# Anatomy of the Nervous System

## Part II

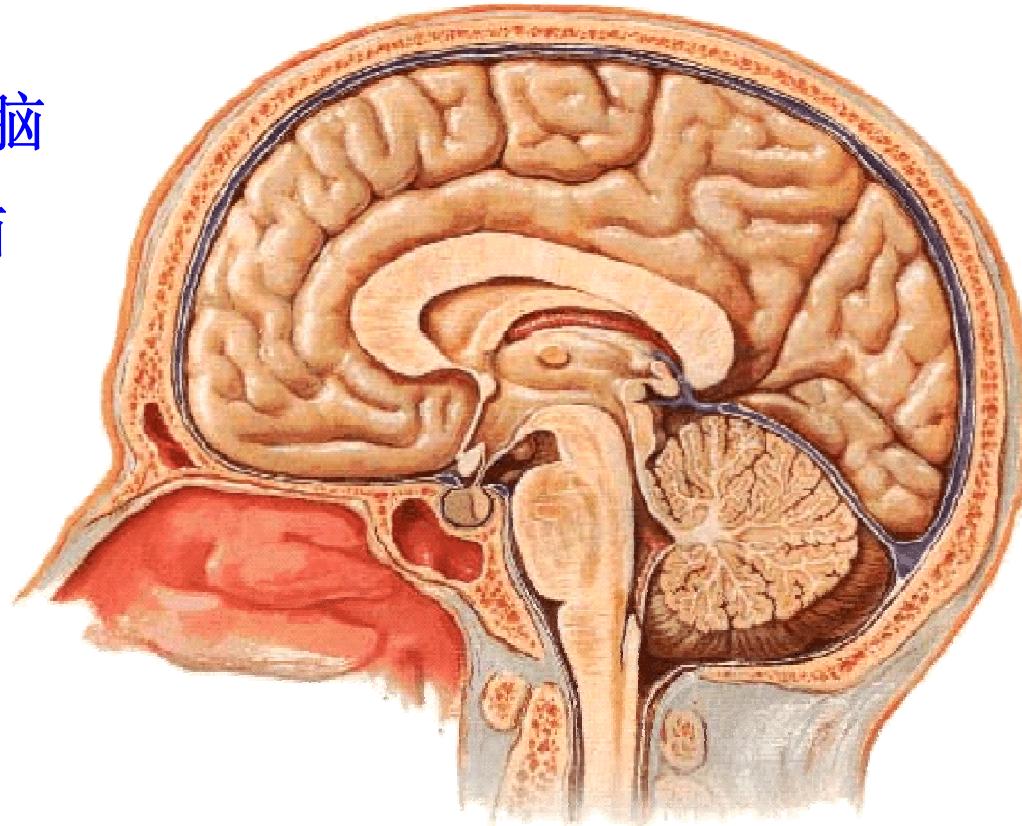
### 神经解剖（二）

Yan Zhang

张研

# The brain 脑

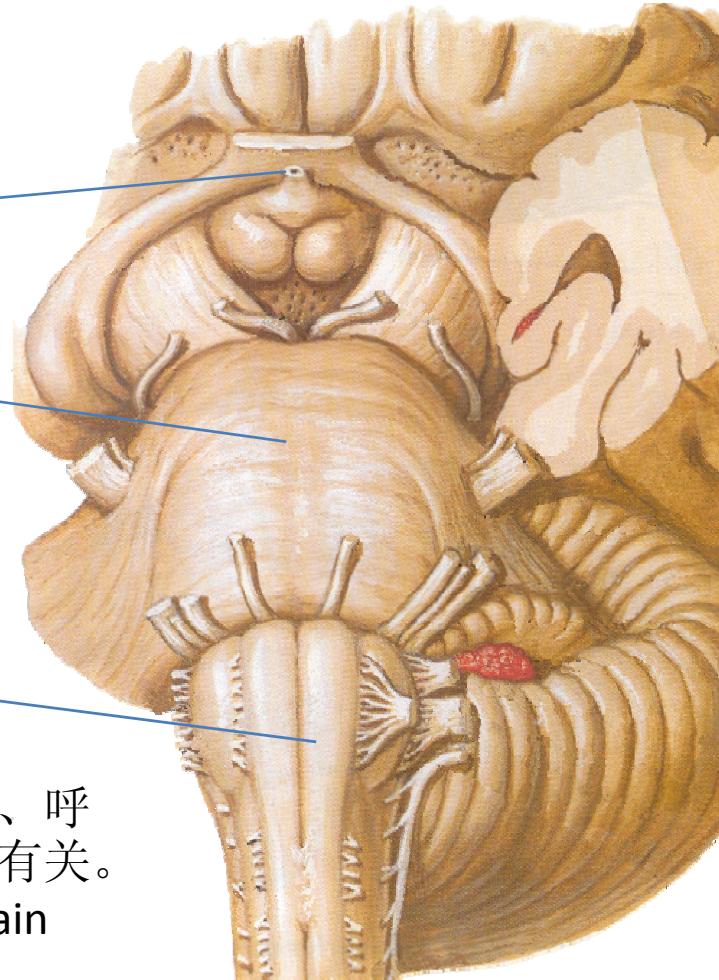
- Telencephalon 端脑
- Diencephalon 间脑
- Cerebellum 小脑
- Brain stem 脑干



# The brain stem 脑干

Consists of 组成部分:

- Midbrain 中脑
- Pons 脑桥
- Medulla oblongata 延髓



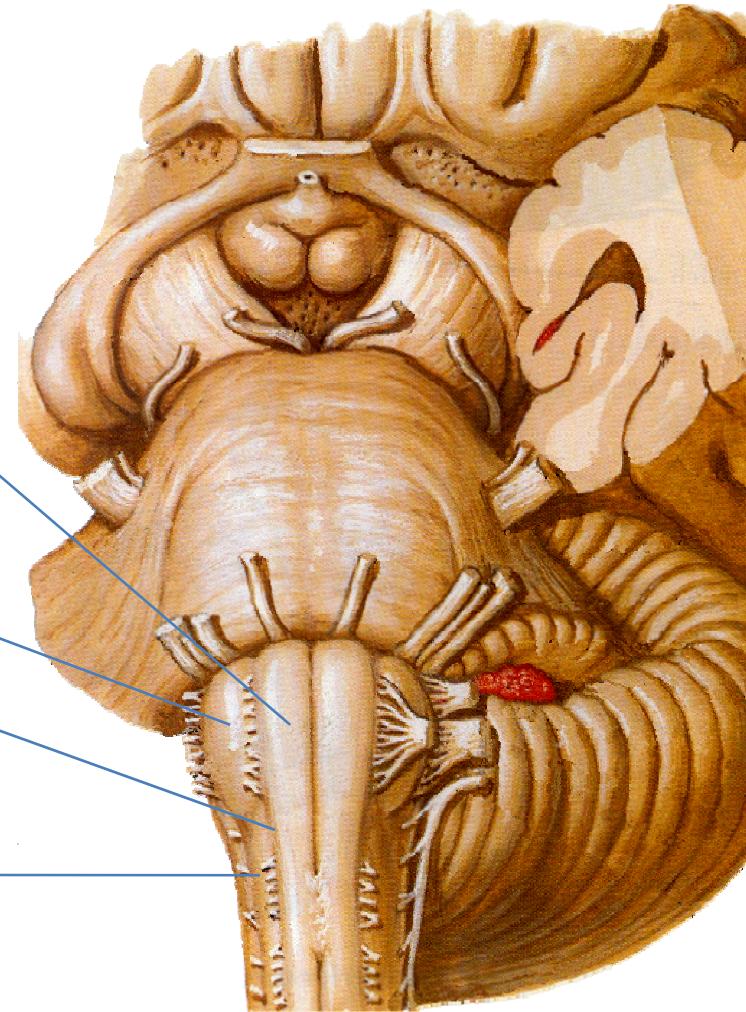
脑干的功能主要是维持个体生命，包括心跳、呼吸、消化等重要生理功能，均与脑干的功能有关。

The main function of the brainstem is to maintain life, including heartbeats, breath, digestion etc.

# Medulla oblongata 延髓

## Ventral surface 腹侧面

- **Pyramid** 锥体: contain **pyramidal tract** (corticospinal tract) 包含锥体束，又称皮层脊髓束
- **Decussation of pyramid** 锥体交叉: formed by crossing fibers of **corticospinal tract** 由皮层脊髓束纤维交叉形成
- **Olive** 橄榄: produced by underlying **inferior olivary nucleus** 由下橄榄核产生
- **Anterolateral sulcus** 前外侧沟: rootlets of **hypoglossal nerve** emerge from it 由此显露在外的舌下神经的细根
- **Retroolivary sulcus** 橄榄后沟: rootlets of **glossopharyngeal, vagus and accessory nerves** emerge from it 舌咽神经、迷走神经和副神经的细根



# Function of medulla oblongata 延髓的功能

The **medulla oblongata** is the lower half of the brainstem, which is continuous with the spinal cord, the upper half being the pons. It is often referred to simply as the **medulla**. The medulla contains the cardiac, respiratory, vomiting and vasomotor centers and therefore deals with the autonomic (involuntary) functions of breathing, heart rate and blood pressure.

延髓在脑干下部，续以脊髓，其上为脑桥，简称medulla。包括心脏、呼吸、呕吐、血管舒缩中心，因此与呼吸、心率、血压等自律功能有关。

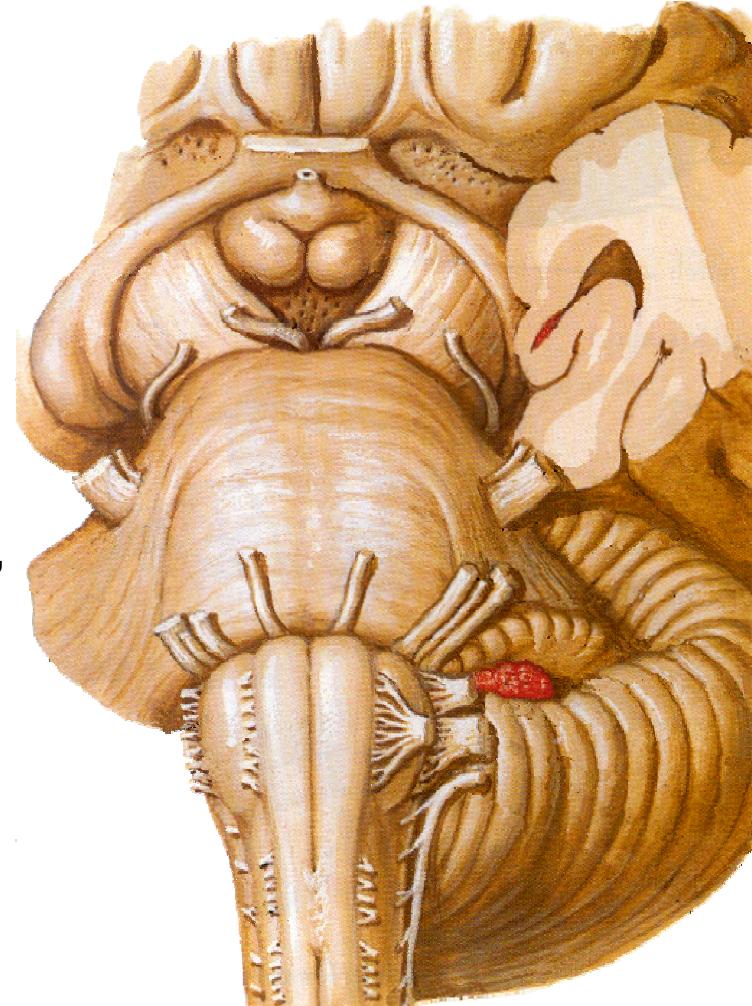
Amyotrophic lateral sclerosis (ALS) 脊髓侧索硬化症



# Pons 脑桥

The pons is part of the brainstem, and is cranial to the medulla oblongata, caudal to the midbrain, and ventral to the cerebellum. In humans and other bipeds, this means it is above the medulla, below the midbrain, and anterior to the cerebellum. The **pons** is also called the **pons Varolii** ("bridge of Varoli"), after the Italian anatomist and surgeon Costanzo Varolio (1543–75). This white matter includes tracts that conduct signals from the cerebrum down to the cerebellum and medulla, and tracts that carry the sensory signals up into the thalamus.

脑桥是脑干的一部分，在延髓上方、中脑下方、小脑腹侧。在人类和其他两足动物中，这意味着它在延髓上方、中脑下方、小脑前方。脑桥又叫做pons Varolii，以意大利解剖学家和外科医生Costanzo Varolio（1543-75）命名。这部分白质包括由大脑下发至小脑和延髓的神经束和携带上传至丘脑的感觉信号的神经束。



# Nuclei in the pons 脑桥核团

A number of [cranial nerve nuclei](#) are present in the pons:

脑桥中有许多颅神经

mid-pons: the 'chief' or 'pontine' nucleus of the [trigeminal nerve](#) sensory nucleus (V)

中脑桥：三叉神经感觉核团的主要脑桥核团

mid-pons: the [motor nucleus for the trigeminal nerve](#) (V)

中脑桥：三叉神经运动核团

lower down in the pons: [abducens nucleus](#) (VI)

脑桥下部：外展神经核

lower down in the pons: [facial nerve nucleus](#) (VII)

脑桥下部：面神经核

lower down in the pons: [vestibulocochlear nuclei](#) ([vestibular nuclei](#) and [cochlear nuclei](#)) (VIII)

脑桥下部：前庭蜗神经核（前庭神经核和蜗神经核）

# Nuclei in the pons 脑桥核团

The medulla oblongata connects the higher levels of the [brain](#) to the [spinal cord](#), and is responsible for several functions of the [autonomous nervous system](#), which include:

延髓连接脑的较高层次和脊髓，负责自主神经系统的如下功能：

[Respiration – chemoreceptors](#). These chemoreceptors detect changes in acidity of the blood, thus if the blood is considered too acidic by the medulla oblongata electrical signals are sent to the muscle tissue in the lungs increasing their contraction rate in order to reoxygenate the blood.

呼吸：化学感受器。这些化学感受器感受血液的酸度变化，因此如果延髓判断血液酸度太高，电信号会被传导至肺部肌肉组织，提高其收缩率以氧化血液。

[Cardiac center – sympathetic, parasympathetic nervous system](#)

心搏中枢：交感神经系统、副交感神经系统

[Vasomotor center – baroreceptors](#)

血管舒缩中枢：压力感受器

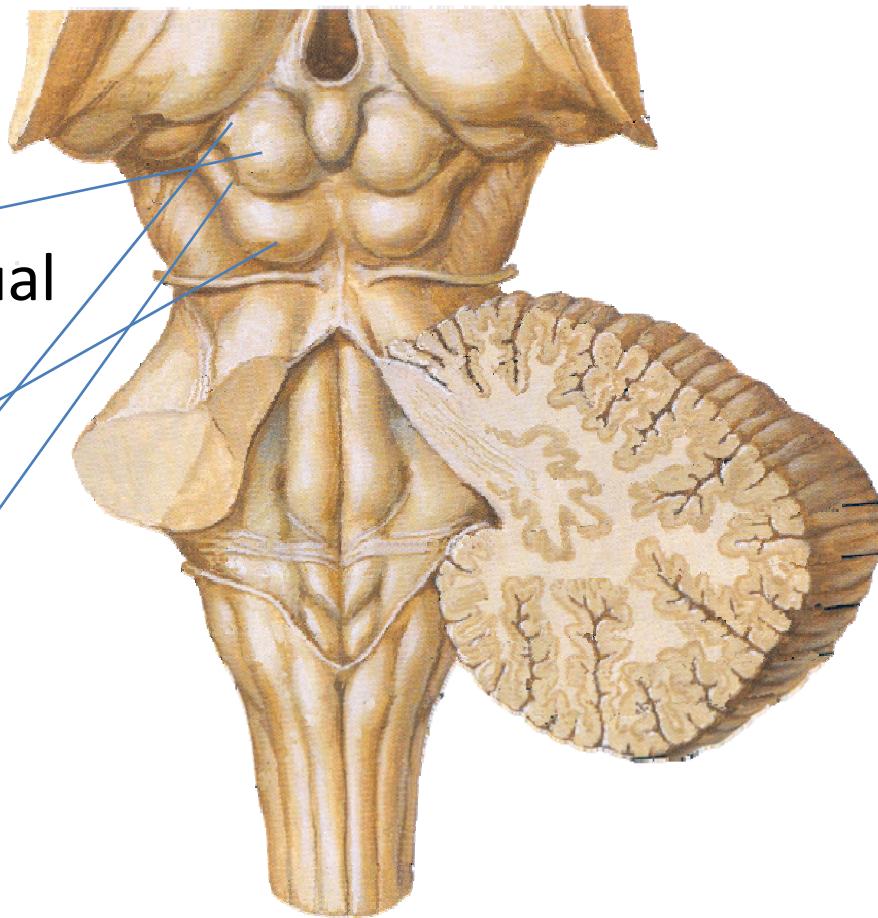
[Reflex](#) centers of vomiting, coughing, sneezing, and swallowing. These reflexes which include the [pharyngeal reflex](#), the [swallowing](#) reflex (also known as the palatal reflex), and the [masseter reflex](#) can be termed, *bulbar reflexes*.

呕吐、咳嗽、喷嚏、吞咽反射中枢。条件反射包括咽反射、吞咽反射（上颌反射）、嚼肌反射（延髓反射）。

# Midbrain 中脑

## Dorsal surface 背侧面

- **Superior colliculus 上丘**  
constitute centers for visual reflexes 组成视觉反射
- **Inferior colliculus 下丘**  
associated with auditory pathway 和听觉通路有关
- **Brachium of superior colliculi 上丘臂**
- **Brachium of inferior colliculi 下丘臂**

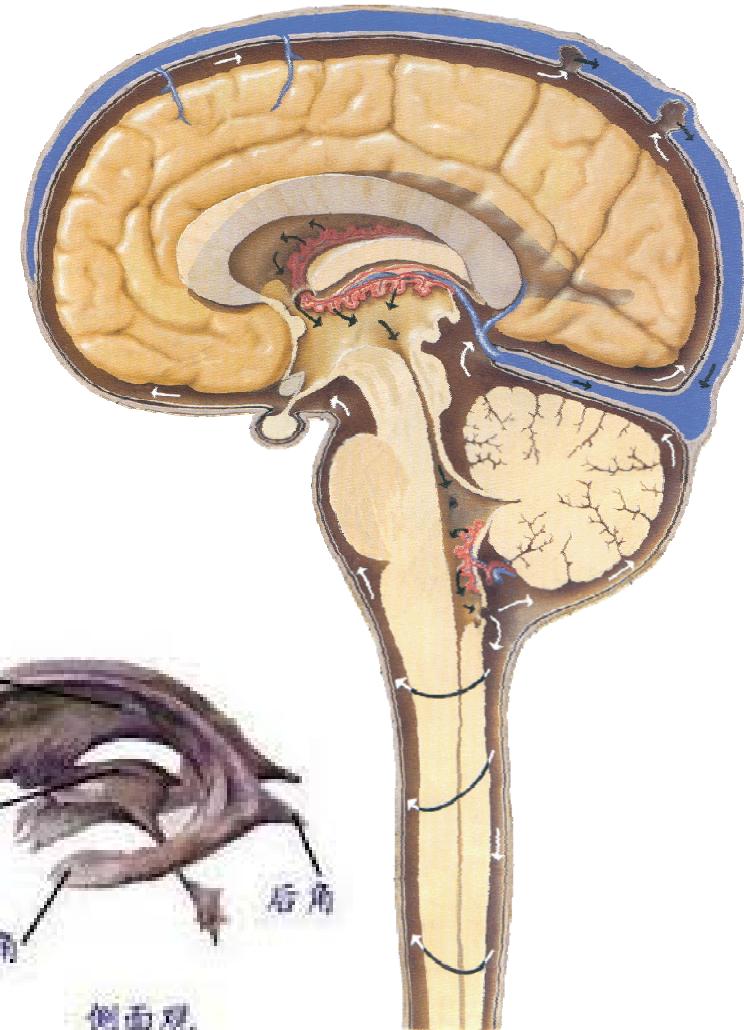
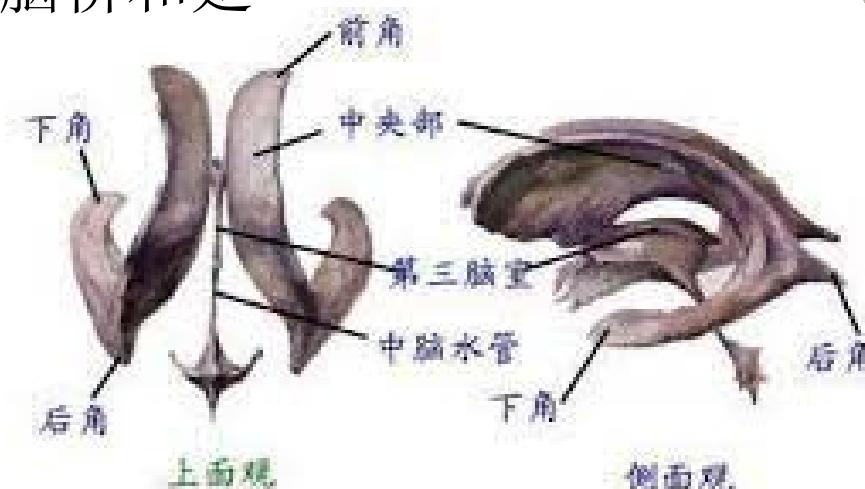


# Fourth ventricle 第四脑室

Central canal → fourth ventricle → mesencephalic aqueduct → third ventricle  
中央管→第四脑室→中脑水管→第三脑室

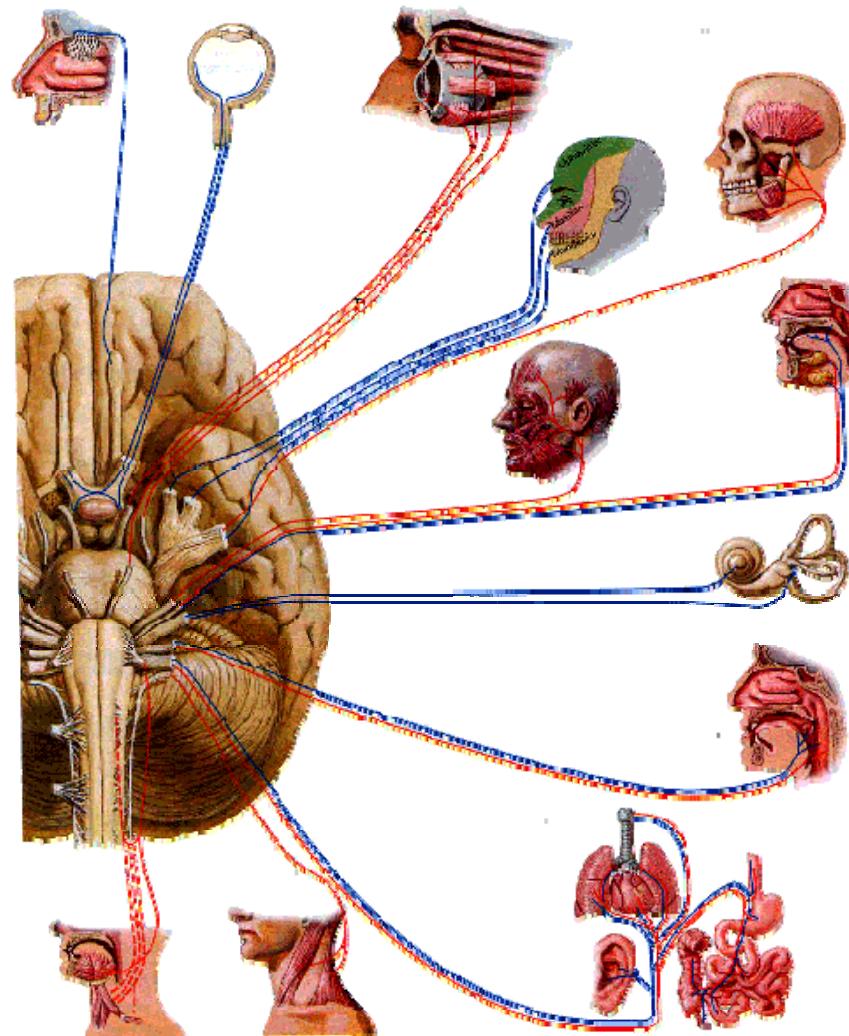
## Position 位置

- Situated ventral to cerebellum, and dorsal to pons and cranial half of medulla
- 位于小脑腹侧，脑桥和延髓颅内部分背侧



# Names of cranial nerves 脑神经

- I Olfactory nerve 嗅神经
- II Optic nerve 视神经
- III Oculomotor nerve 动眼神经
- IV Trochlear nerve 滑车神经
- V Trigeminal nerve 三叉神经
- VI Abducent nerve 展神经
- VII Facial nerve 面神经
- VIII Vestibulocochlear nerve 前庭蜗神经
- IX Glossopharyngeal nerve 舌咽神经
- X Vagus nerve 迷走神经
- XI Accessory nerve 副神经
- XII Hypoglossal nerve 舌下神经



# Classification of cranial nerves 脑神经分类

- **Sensory cranial nerves:** contain only afferent (sensory) fibers
- 感觉脑神经：只含有传入纤维
  - I **Olfactory nerve** 嗅神经
  - II **Optic nerve** 视神经
  - VIII **Vestibulocochlear nerve** 听神经
- **Motor cranial nerves:** contain only efferent (motor) fibers
- 运动脑神经：只含有传出纤维
  - III **Oculomotor nerve** 动眼神经
  - IV **Trochlear nerve** 滑车神经
  - VI **Abducent nerve** 外展神经
  - XI **Accessory nerve** 副神经
  - XII **Hypoglossal nerve** 舌下神经
- **Mixed nerves:** contain both sensory and motor fibers
- 混合神经：包括感觉和运动纤维
  - V **Trigeminal nerve**, 三叉神经
  - VII **Facial nerve**, 面神经
  - IX **Glossopharyngeal nerve** 舌咽神经
  - X **Vagus nerve** 迷走神经

端脑:	嗅神经
中脑:	视神经、动眼神经、滑车神经
脑桥:	三叉神经、展神经、面神经、前庭蜗神经
延髓:	舌咽神经、迷走神经、副神经、舌下神经

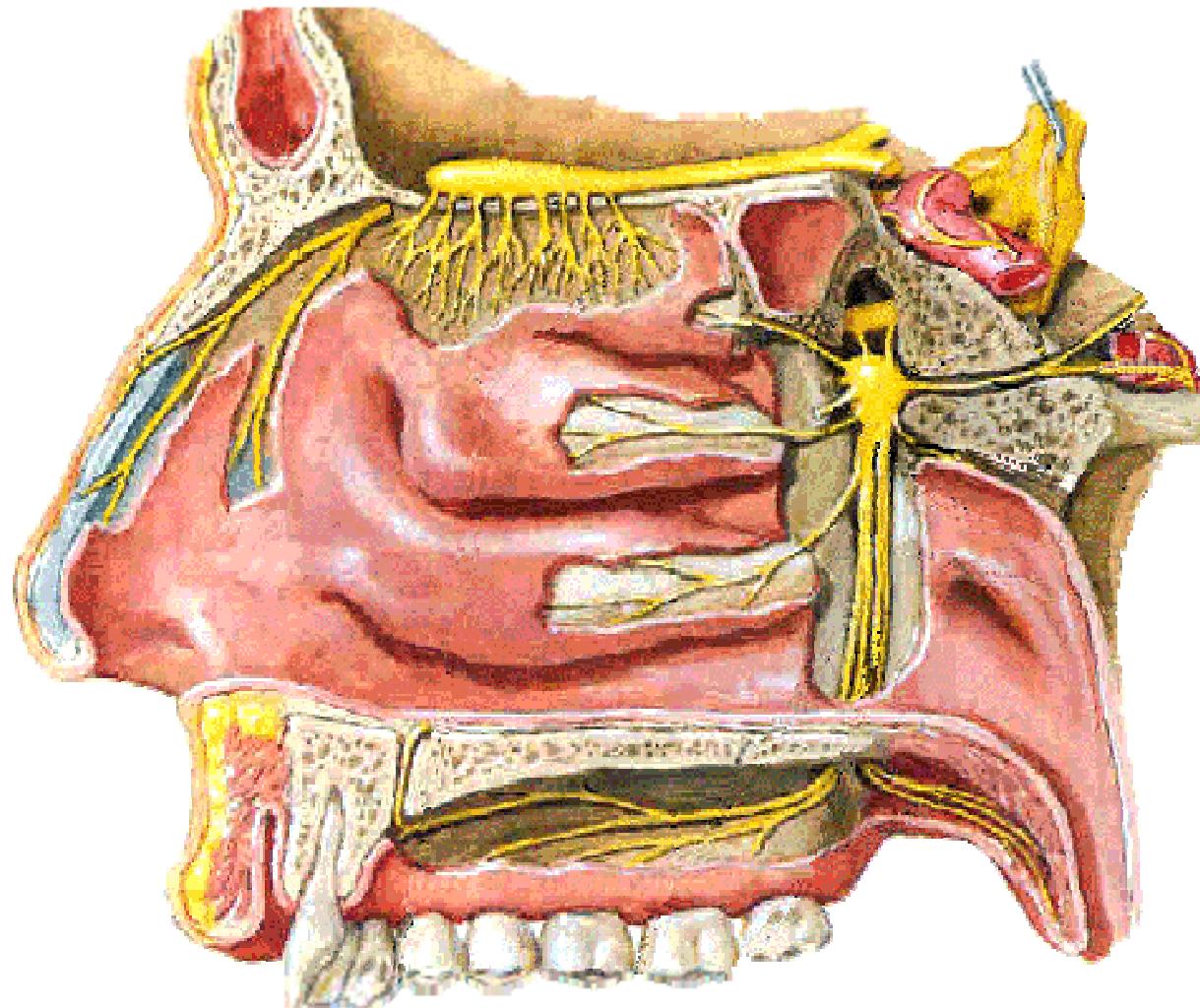
# Sensory cranial nerves 感觉脑神经

N.	Location of cell body and axon categories 细胞体位置和轴突分类	Cranial exit 颅出口	Terminal nuclei 末端核团	Main action 主要活动
I	Olfactory cells (SVA) 嗅细胞	Cribriform Foramina 筛孔	Olfactory bulb 嗅球	Smell 嗅觉
II	Ganglion cells (SSA) 神经节细胞	Optic canal 视神经管	Lateral geniculate body 外侧膝状体	Vision 视觉
VIII	Vestibular ganglion(SSA) 前庭神经节	Internal acoustic meatus 内耳道	Vestibular nuclei 前庭神经核	Equilibrium 平衡
	Cochlear ganglion 耳蜗神经节 (SSA)		Cochlear nuclei 蜗神经核	Hearing 听力

SSA: special somatic afferent 特殊躯体传入; SVA: special visceral afferent 特殊内脏传入

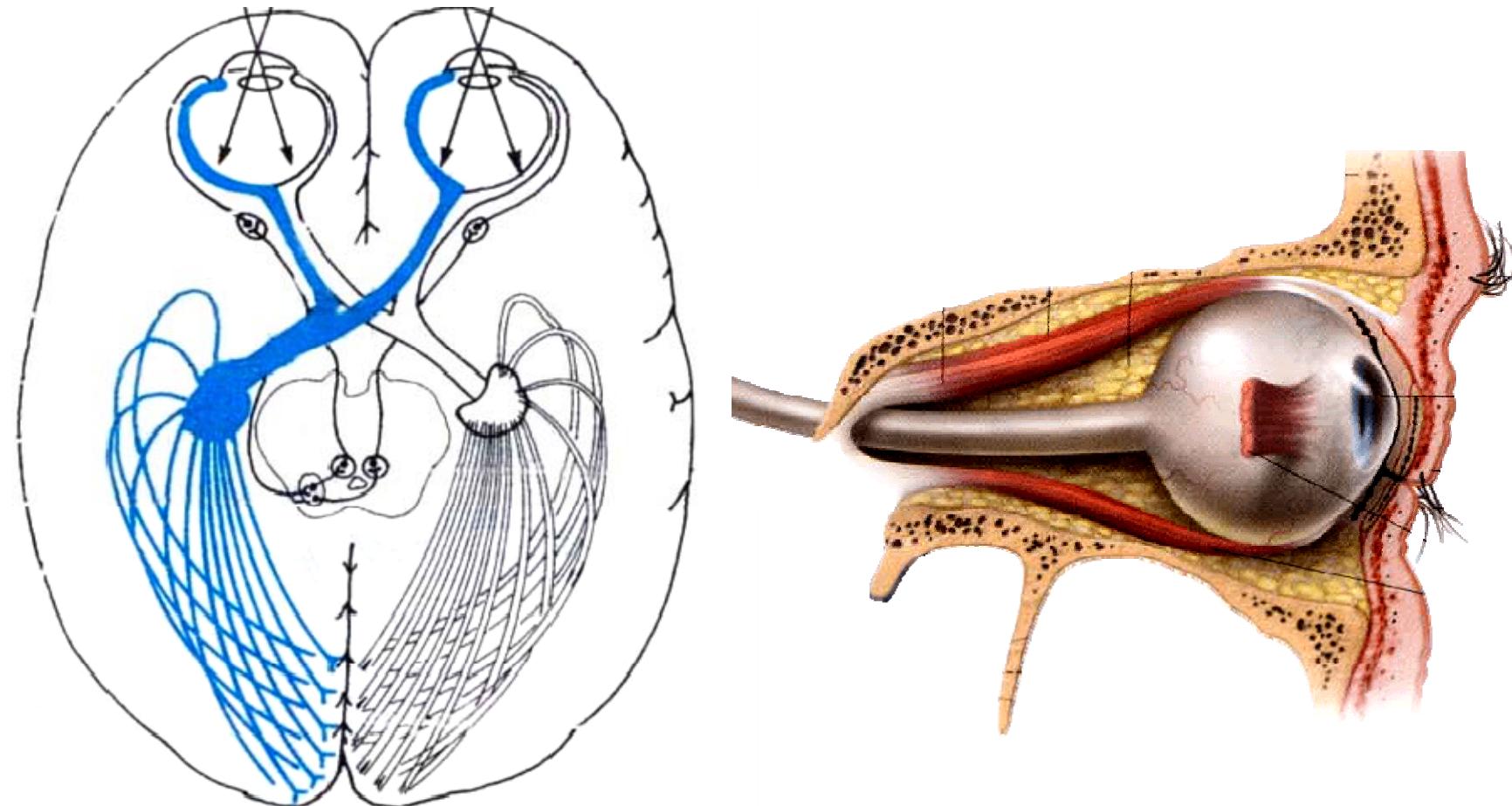
# Olfactory nerve 嗅神经

Olfactory mucosa 嗅粘膜(SVA) → Cribiform foramina 篩孔 → Olfactory bulb 嗅球



# Optic nerve 视神经

Ganglion cell 神经节细胞 (SSA) → Optic canal 视神经管 → Lateral geniculate body 外侧膝状体



# Vestibulocochlear nerve 前庭蜗神经

**Vestibular ganglion(SSA)** ↓

前庭神经节

**Cochlear ganglion (SSA)** ↗

耳蜗神经节

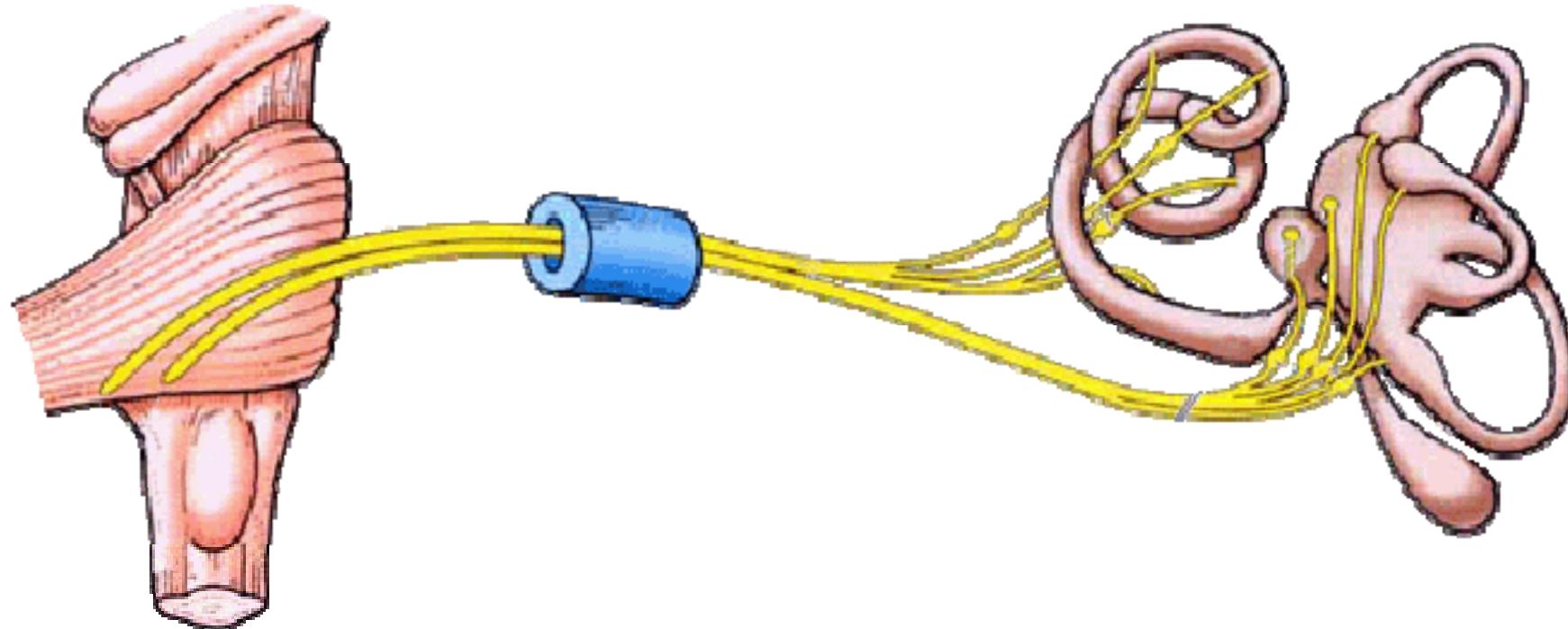
Internal acoustic meatus 内耳道

↗ **Vestibular nuclei**

前庭神经核

↘ **Cochlear nuclei**

蜗神经核



# Motor cranial nerves 运动颅神经

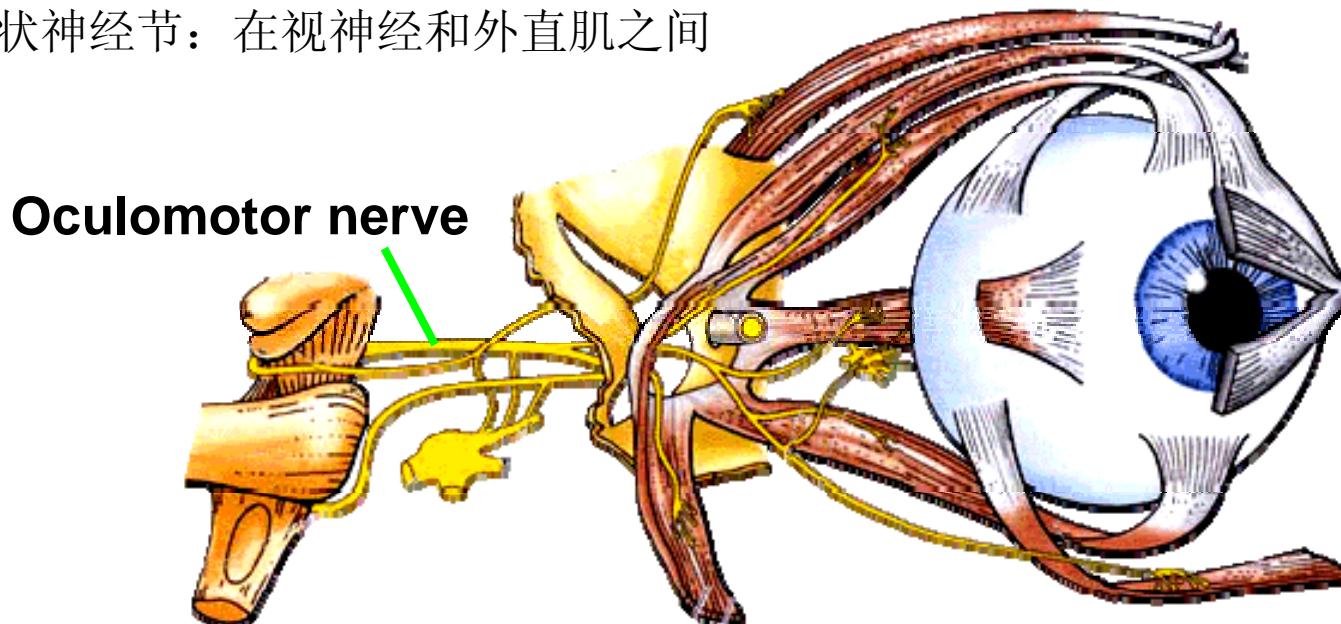
N.	Nucleus of origin and axon categories 起源神经核和轴突分类	Cranial exit 颅出口	Main action 主要功能
III	<b>Nucleus of oculomotor</b> 动眼神经核 (GSE)	<b>Superior orbital fissure</b> 眶上裂	<b>Motor to superior, inferior and medial recti; inferior obliquus; levator palpebrae superioris</b> 上、下、内直肌；下斜肌上睑提肌运动
	<b>Accessory nucleus of oculomotor (GVE)</b> 动眼神经副核		<b>Parasympathetic to sphincter pupilla and ciliary muscle</b> 瞳孔括约肌、睫状肌副交感
IV	<b>Nucleus of trochlear nerve (GSE)</b> 滑车神经核	<b>Superior orbital fissure</b> 眶上裂	<b>Motor to superior obliquus</b> 上斜肌运动
VI	<b>Nucleus of abducent nerve (GSE)</b> 外展神经核	<b>Superior orbital fissure</b> 眶上裂	<b>Motor to lateral rectus</b> 外直肌运动
XI	<b>Nucleus of accessory nerve (SVE)</b> 副神经核	<b>Jugular foramen</b> 颈静脉孔	<b>Motor to sternocleidomastoid and trapezius</b> 胸锁乳突肌和斜方肌运动
XII	<b>Nucleus of hypoglossal nerve( GSE)</b> 舌下神经核	<b>Hypoglossal canal</b> 舌下神经管	<b>Motot to muscles of tongue</b> 舌肌肉运动

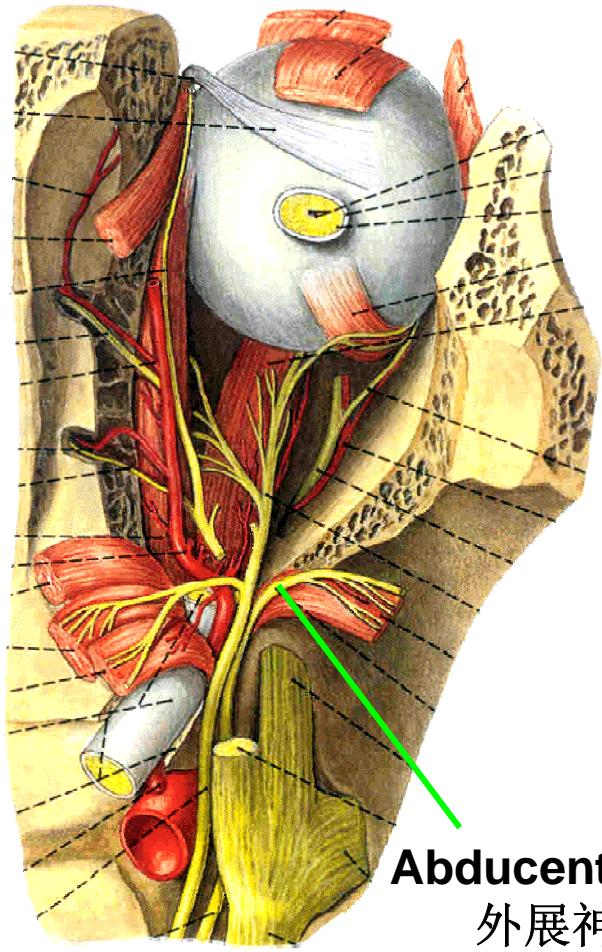
GSE: general somatic efferent一般躯体传出； GVE: general visceral afferent一般内脏传入；

SVE: special visceral efferent特殊内脏传出

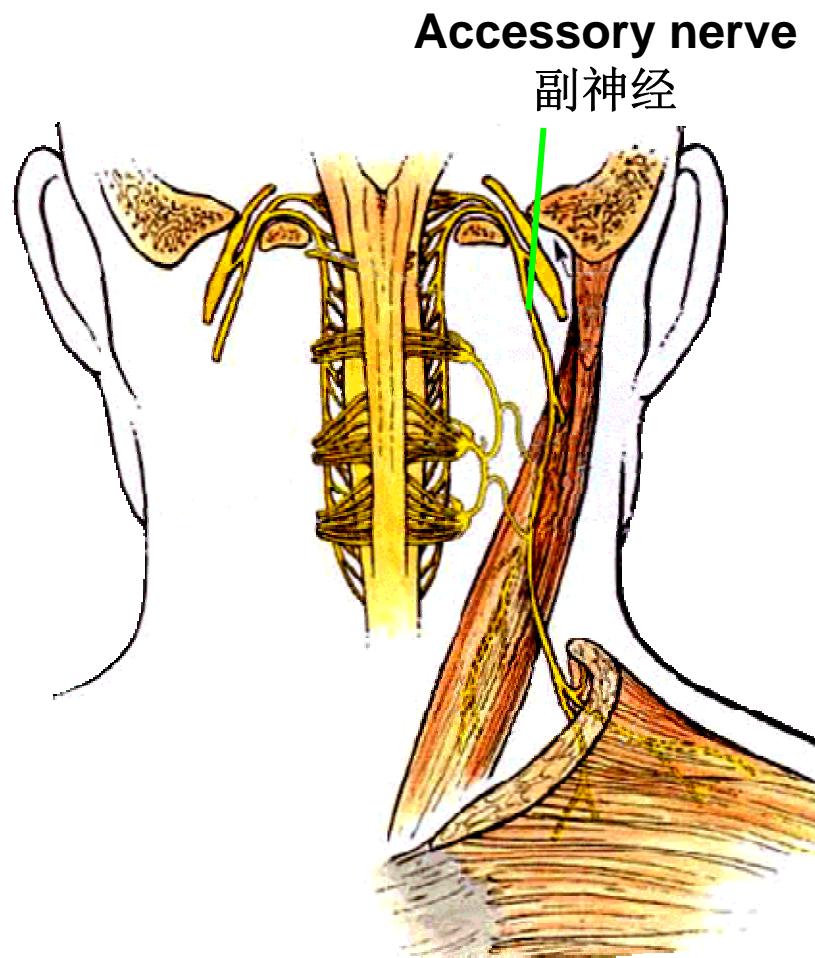
# Oculomotor nerve 动眼神经

- **Components** 组成
  - General somatic efferent fibers (GSE) 一般躯体传出纤维
  - General visceral efferent fibers (GVE) 一般内脏传出纤维
- **Main action—supplies** 主要活动：供给
  - Superior, inferior and medial recti; inferior obliquus; levator palpebrae superioris
  - 上、下、内直肌；下斜肌；上睑提肌
  - Sphincter pupilla and ciliary muscle
  - 瞳孔括约肌、睫状肌
- **Ciliary ganglion:** lies between optic nerve and lateral rectus
- 睫状神经节：在视神经和外直肌之间



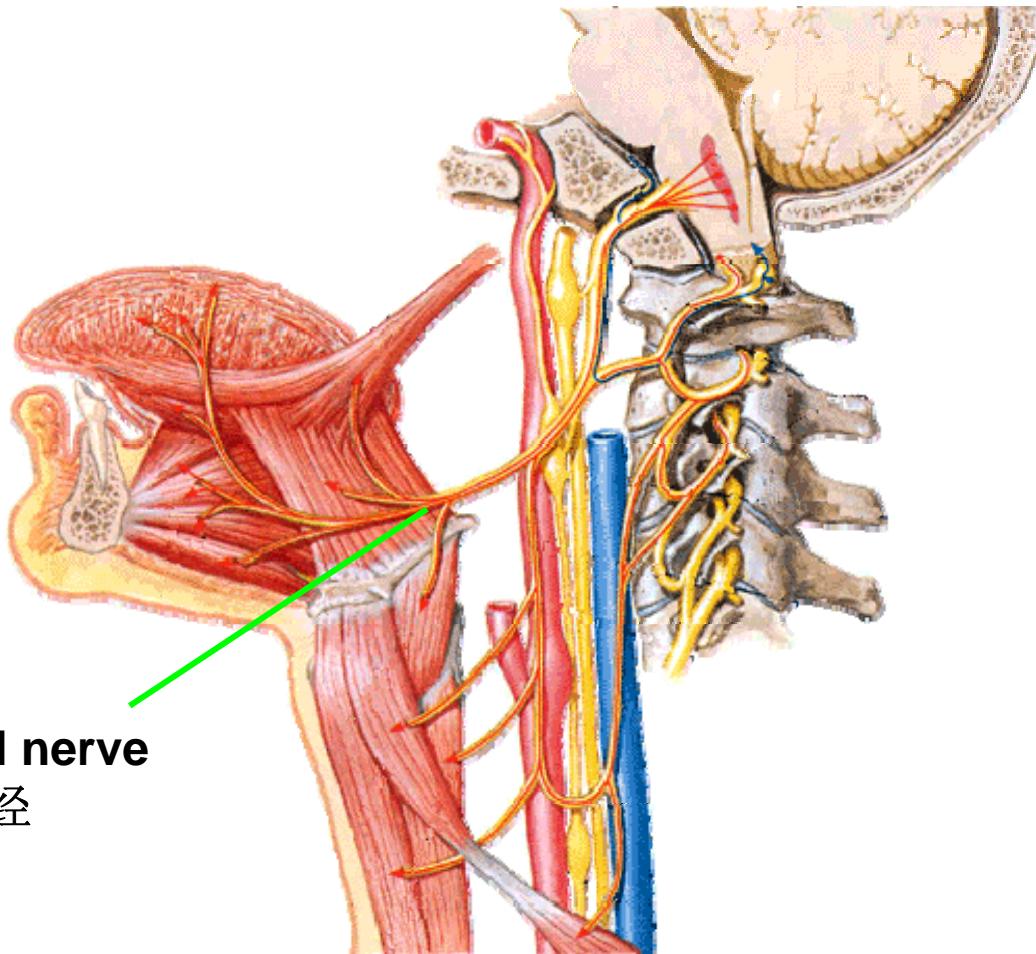


**Abducent nerve**  
外展神经



**Accessory nerve**  
副神經

# Hypoglossal nerve 舌下神经



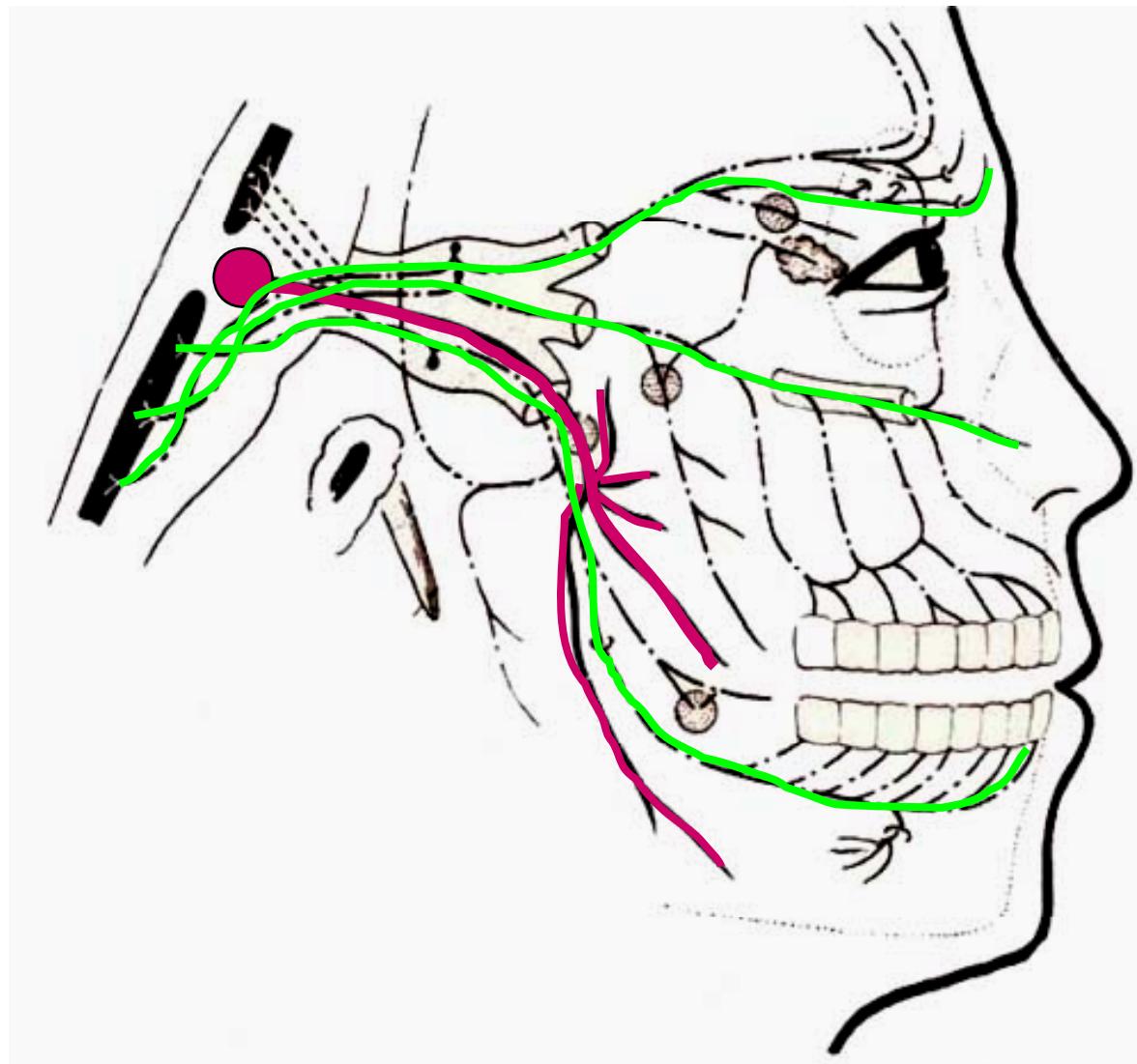
Hypoglossal nerve  
舌下神经

# Mixed cranial nerves 混合脑神经

## Trigeminal nerve 三叉神经

### Components of fibers 纤维组成

- **SVE fibers**: originate from motor nucleus of trigeminal nerve, and supply masticatory muscles
- SVE纤维：由三叉神经运动核发出，支持咀嚼肌
- **GSA fibers**: transmit facial sensation to sensory nuclei of trigeminal nerve, the GSA fibers have their cell bodies in trigeminal ganglion, which lies on the apex of petrous part of temporal bone
- GSA纤维：将面部感觉传输至三叉神经感觉核，GSA纤维的细胞体在三叉神经节，三叉神经节在颞骨岩部顶点



## Distribution 分布:

- Sensation from cerebral dura mater
- 硬脑膜感觉
- Visual organ
- 视觉器官
- Mucosa of nose
- 鼻粘膜
- Skin above the eye and back of nose
- 眼睛上方和鼻子后部皮肤



## Distribution 分布:

- Sensation from cerebral dura mater
- 硬脑膜感觉
- Maxillary teeth
- 上颌骨神经
- Mucosa of nose and mouth
- 口鼻粘膜
- Skin between eye and mouth
- 眼睛和嘴唇之间的皮肤



## Distribution 分布:

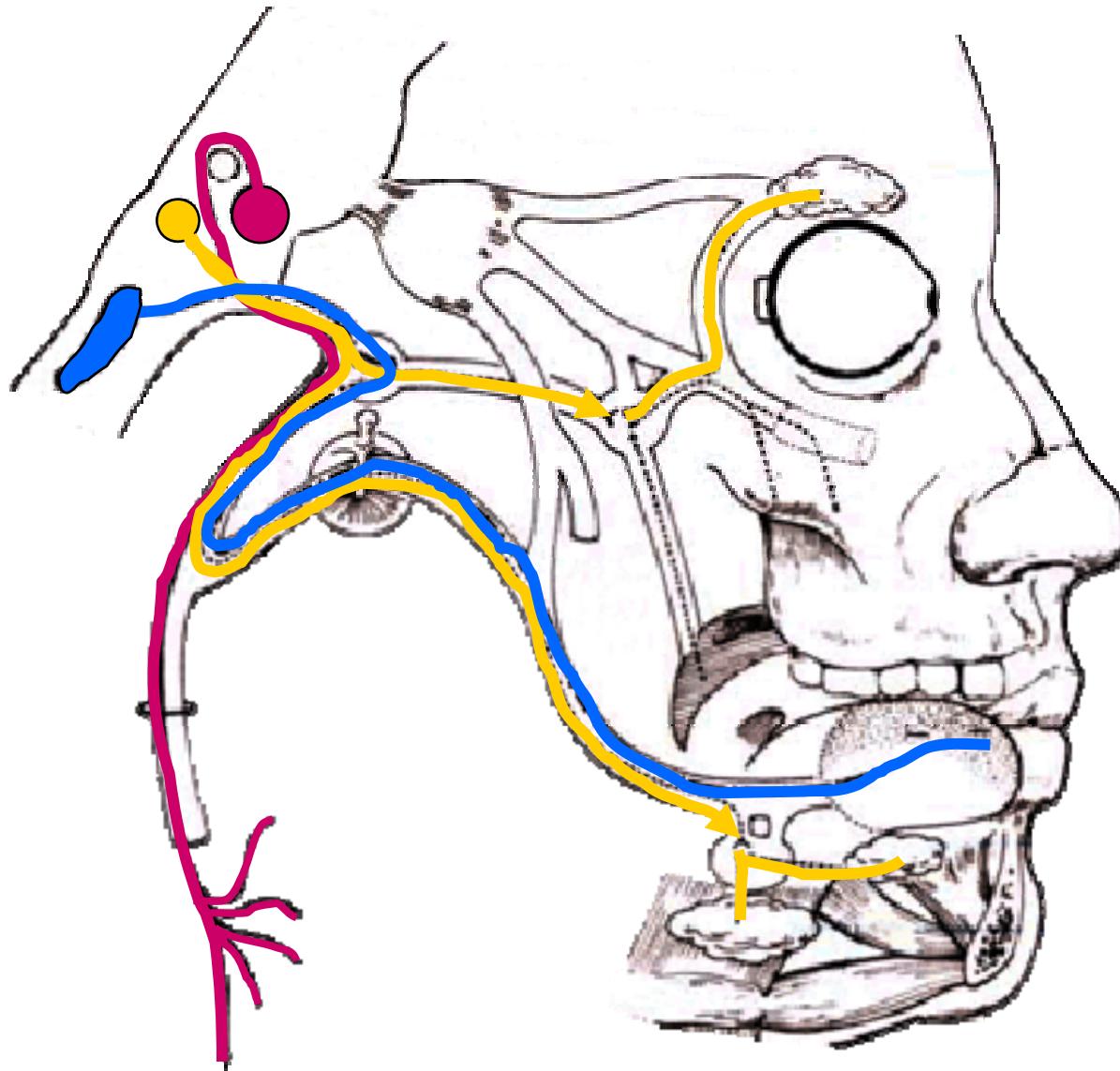
- Sensation from cerebral dura mater
- 硬脊膜感觉
- Teeth and gum of lower jaw
- 下颌牙齿和牙龈
- Mucosa of floor of mouth
- 口底粘膜
- Anterior 2/3 of tongue
- 舌前2/3
- Skin of auricular and temporal regions and below the mouth
- 耳、颞、口下皮肤
- Motor to masticatory muscles, mylohyoid, and anterior belly of digastric
- 咀嚼肌、下颌舌骨肌、二腹肌前腹运动



# Facial nerve (VII) 面神经

Components of fibers 纤维组成

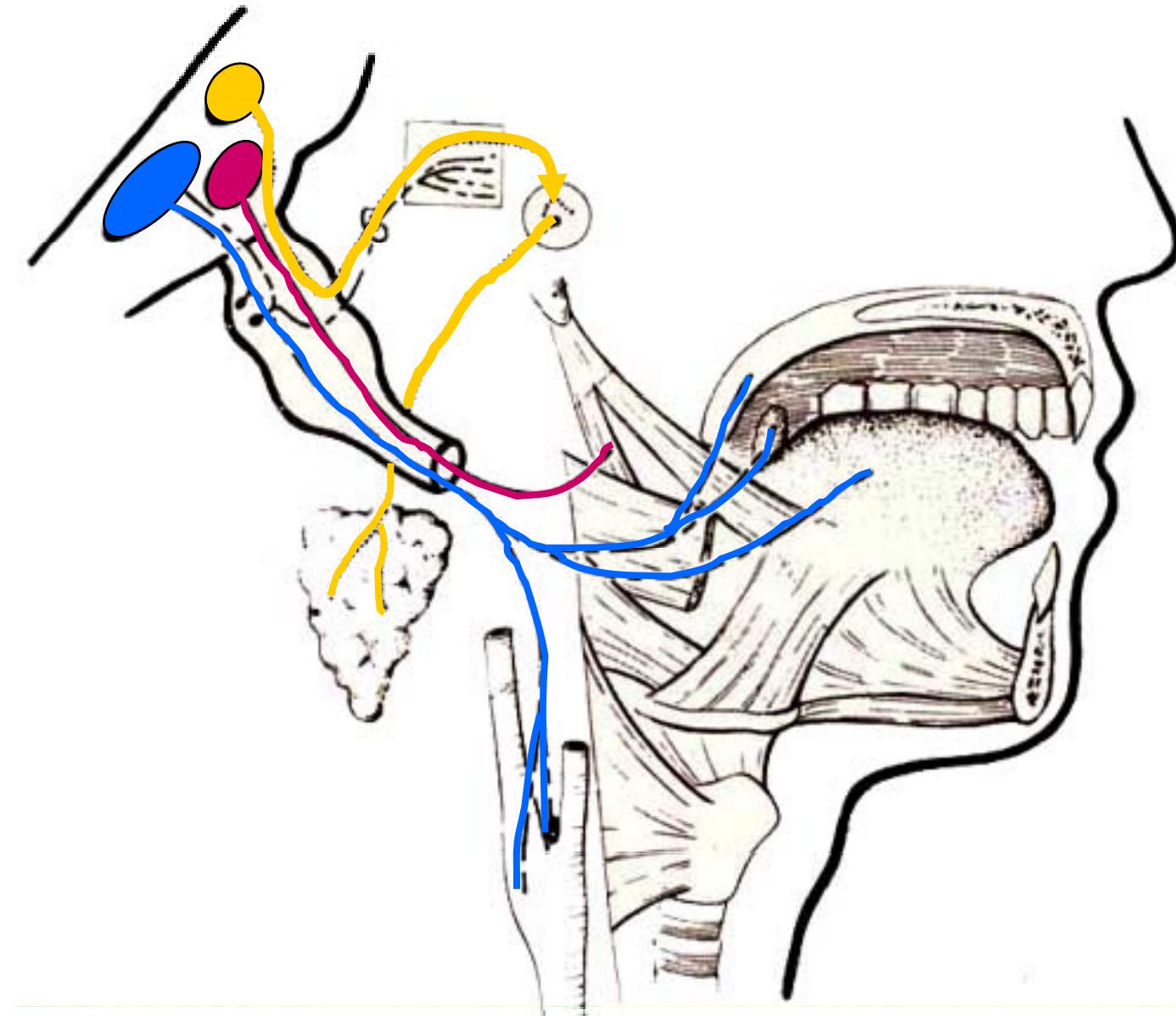
- SVE fibers originate from nucleus of facial nerve, and supply facial muscles
- SVE纤维：面神经核发出，支持面部肌肉
- GVE fibers derived from superior salivatory nucleus and relayed in pterygopalatine ganglion and submandibular ganglion. The postganglionic fibers supply lacrimal, submandibular and sublingual glands
- 上泌涎核发出的GVE纤维，在翼腭神经节和下颌下神经节换元。神经节后纤维支持泪腺、下颌下腺和舌下腺
- SVA fiber from taste buds of anterior two-thirds of tongue which cell bodies are in the geniculate ganglion of the facial nerve and end by synapsing with cells of nucleus of solitary tract
- 舌前2/3味蕾发出的SVA纤维，细胞体在面神经膝状神经节，止于同孤束核的突出连接
- GSA fibers from skin of external ear
- 从皮肤和外耳发出的GSA纤维



# Glossopharyngeal nerve (IX) 舌咽神经

## Components of fibers 纤维组成

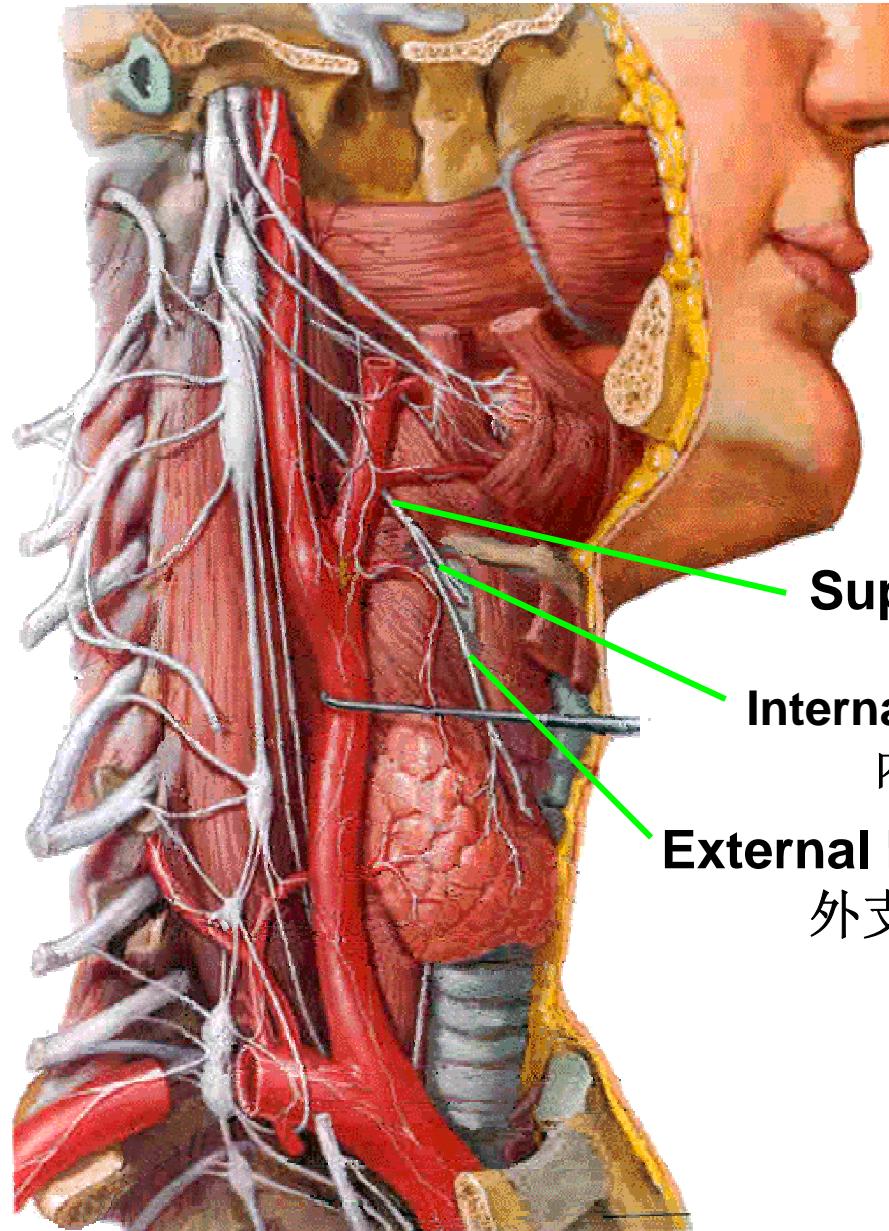
- **SVE** fibers: originate from nucleus ambiguus, and supply stylopharyngeus
- SVE神经纤维：从疑核发出，支持茎突咽肌
- **GVE** fibers: arise from inferior salivatory nucleus and ralyed in otic ganglion, the postganglionic fibers supply parotid gland
- GVE纤维：从下泌涎核发出，在耳神经节换元，节后纤维支持腮腺
- **SVA** fibers: arise from the cells of inferior ganglion, the central processes of these cells terminate in nucleus of solitary tract, the peripheral processes supply the taste buds on posterior third of tongue
- SVA纤维：下神经节细胞发出，这些细胞的中枢突止于孤束核，周围突支持舌后1/3味蕾
- **GVA** fibers: visceral sensation from mucosa of posterior third of tongue, pharynx, auditory tube and tympanic cavity, carotid sinus and glomus, and end by synapsing with cells of nucleus of solitary tract
- GVA纤维：舌前1/3粘膜、咽部、咽鼓管、鼓室颈动脉窦和血管球的内脏感觉，止于孤束核。
- **GSA** fibers: sensation from skin of posterior surface of auricle
- GSA纤维：耳廓表面后部皮肤感觉



# Vagus nerve (X) 迷走神经

## components of fibers 纤维组成

- **GVE** fibers: originate from dorsal nucleus of vagus nerve, synapse in parasympathetic ganglion, short postganglionic fibers innervate cardiac muscles, smooth muscles and glands of viscera
- GVE纤维：迷走神经背核发出，在副交感神经节发生突触，短节后纤维支配心肌、平滑肌和内脏腺体
- **SVE** fibers: originate from ambiguus, to muscles of pharynx and larynx
- SVE纤维：发自疑核，至咽喉
- **GVA** fibers: carry impulse from viscera in neck, thoracic and abdominal cavity to nucleus of solitary tract
- GVA纤维：携带来自颈部、胸腹腔的内脏冲动，至孤束核
- **GSA** fiber: sensation from auricle, external acoustic meatus and cerebral dura mater
- GSA纤维：耳廓、外耳道、硬脑膜感觉



**Superior laryngeal nerve**

喉上神经

**Internal branch**

内支

**External branch**

外支

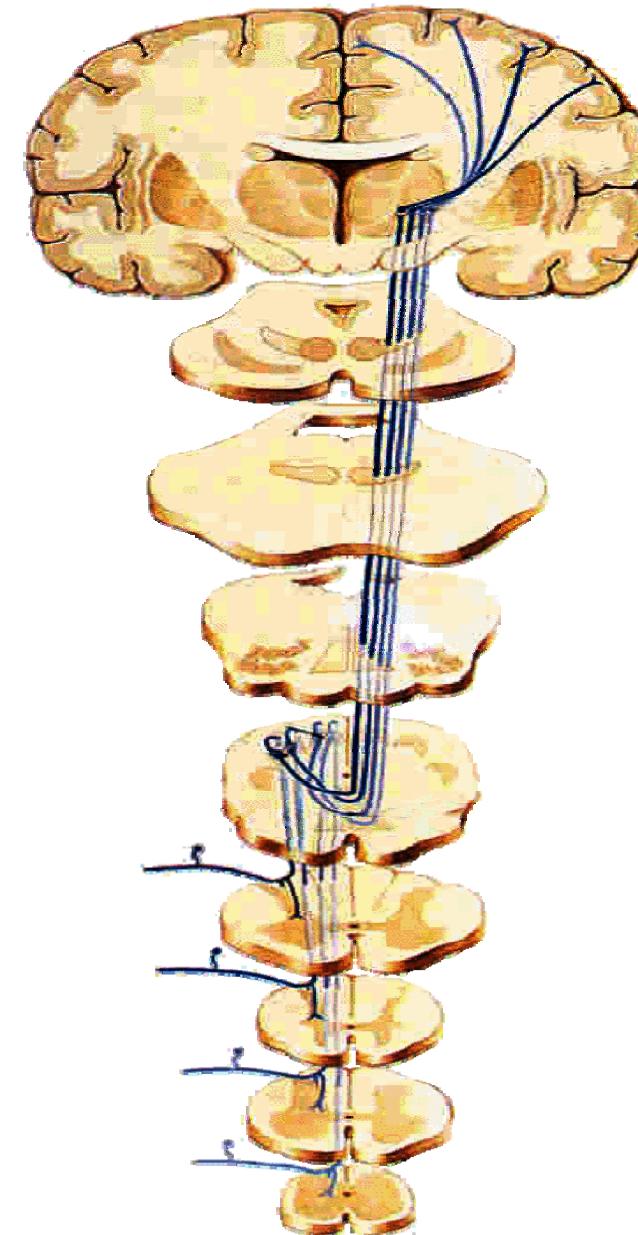
# White matter 白质

## Ascending tracts 上行束

- Medial lemniscus 内侧丘系
- Spinal lemniscus 脊髓丘系
- Trigeminal lemniscus 三叉丘系
- Lateral lemniscus 外侧丘系

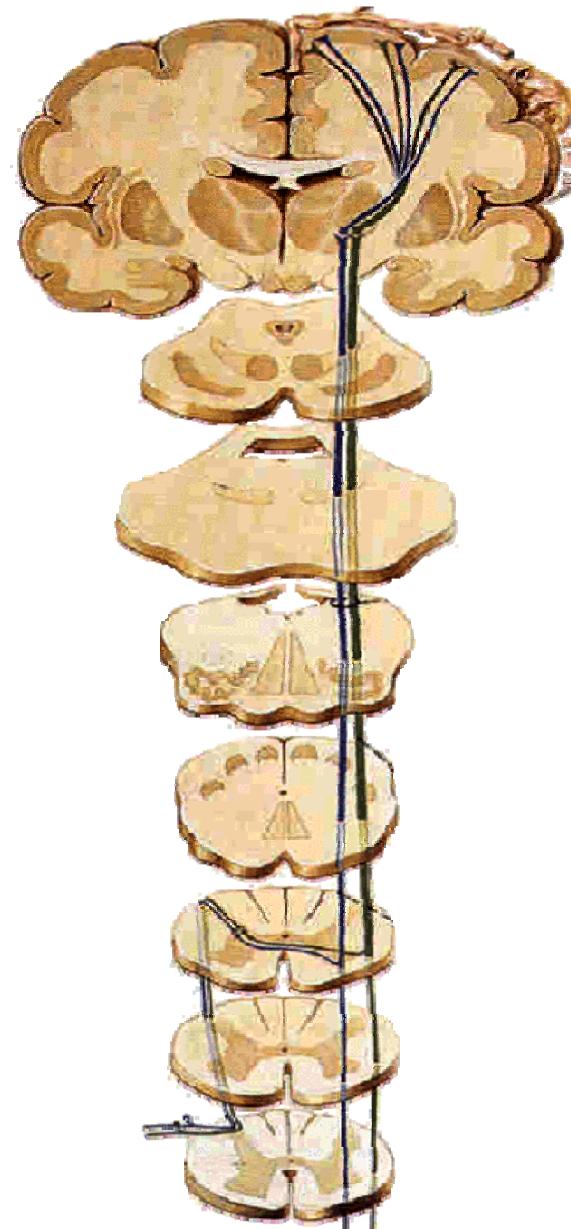
# Medial lemniscus

内侧丘系



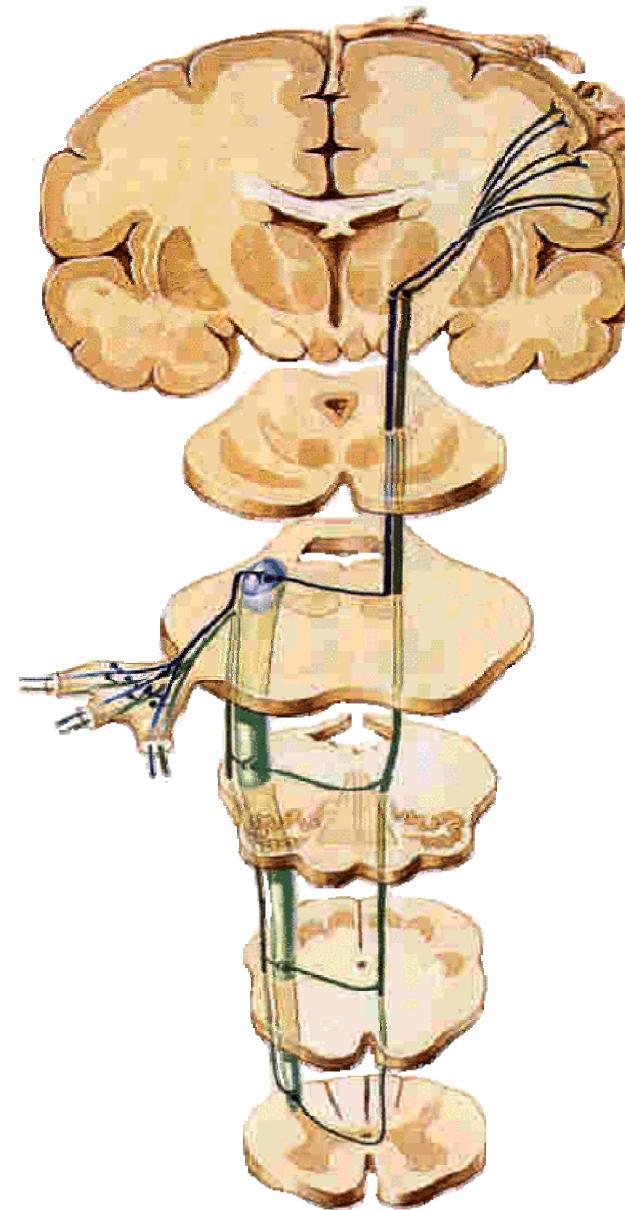
# **Spinal lemniscus**

## 脊髓丘系



# Trigeminal lemniscus

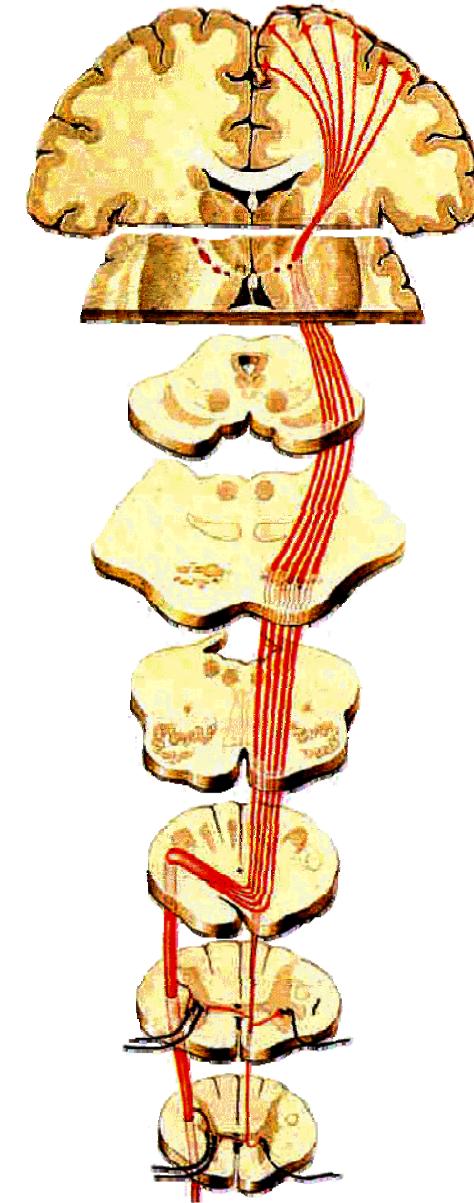
三叉丘系



# Descending tracts

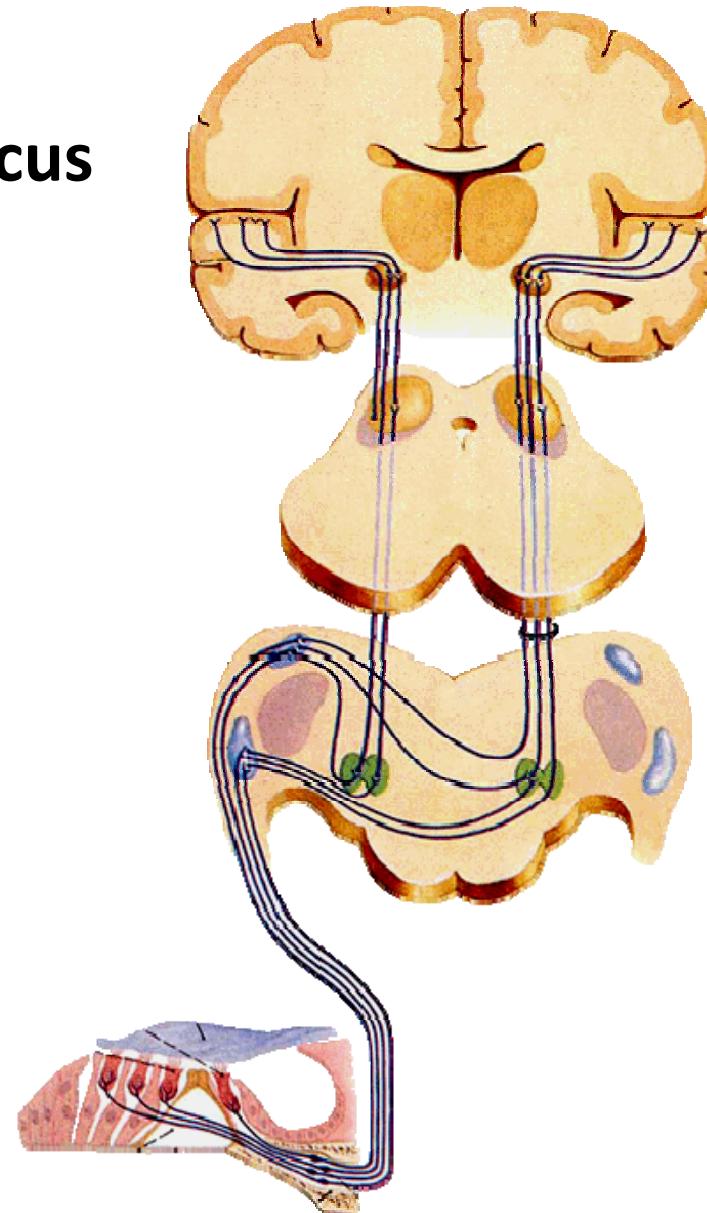
## 下行束

- **Corticospinal tract** 皮质脊髓束
- Rubrospinal tract 红核脊髓束
- Tectospinal tract 顶盖脊髓束
- Vestibulospinal tract 前庭脊髓束
- Reticulospinal tract 网状脊髓束



# Lateral lemniscus

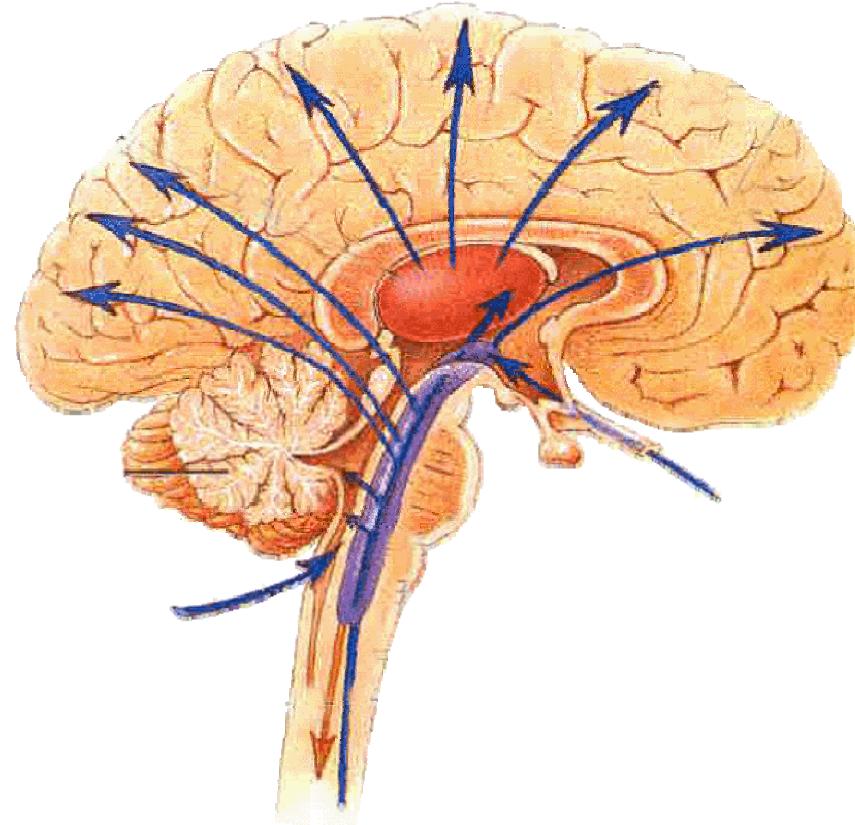
外侧丘系



# Reticular formation of brain stem

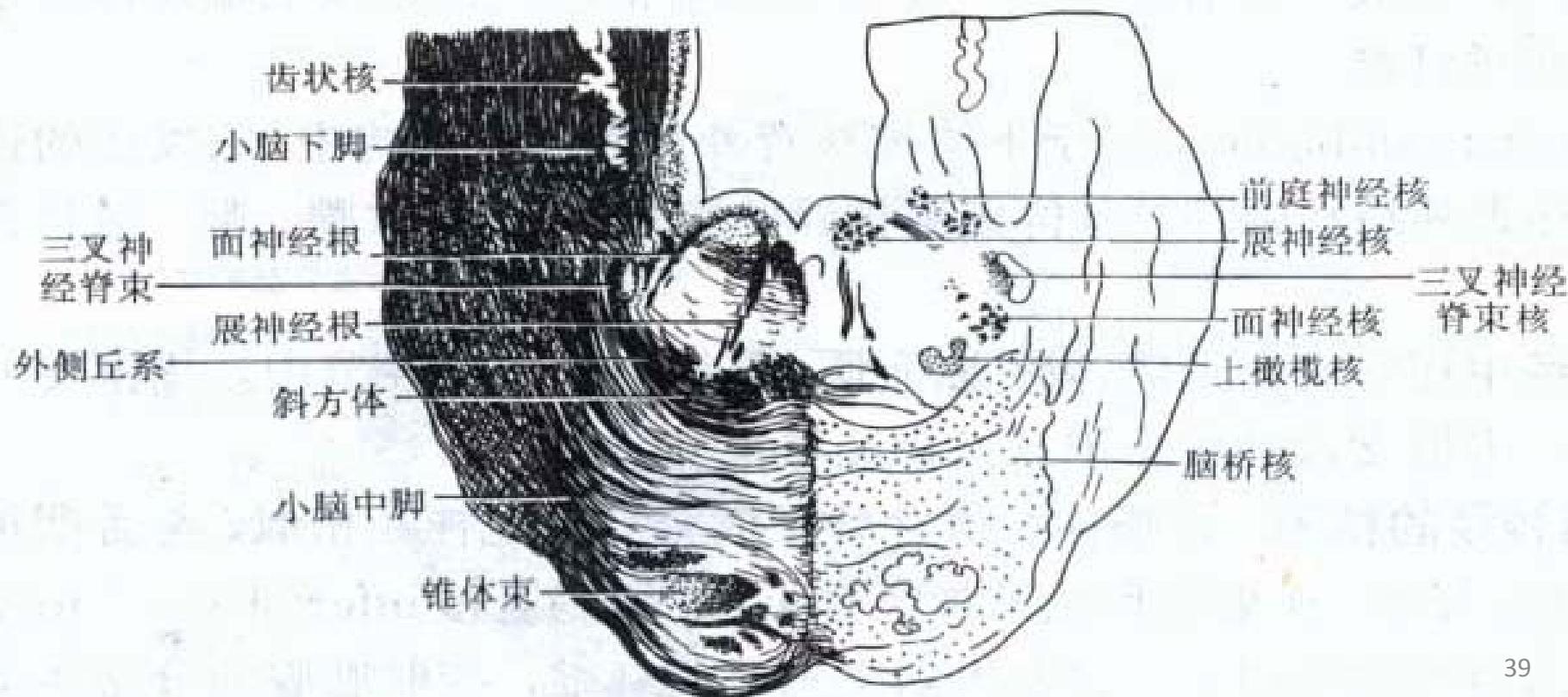
## 脑干的网状结构

- Ascending reticular activating system (ARAS)
- 上行网状激动系统
- Motor central and vital centres 运动重要中心
  - Reticulospinal tract
  - 网状脊髓束
  - Cardiovascular center and respiratory center
  - 心血管中枢和呼吸中枢
- Serotonergic rapheal nuclei
- 血清素能的中缝核



# Pons 脑桥

- **Tegmentum of pons** 脑桥被盖 directed upward continuation of medulla oblongata 延髓向上延伸处
- **Basilar part** 基底部  
contain both longitudinal and transverse fibers intermixed with pontine nuclei  
包括与脑桥核混合的纵向和横向纤维



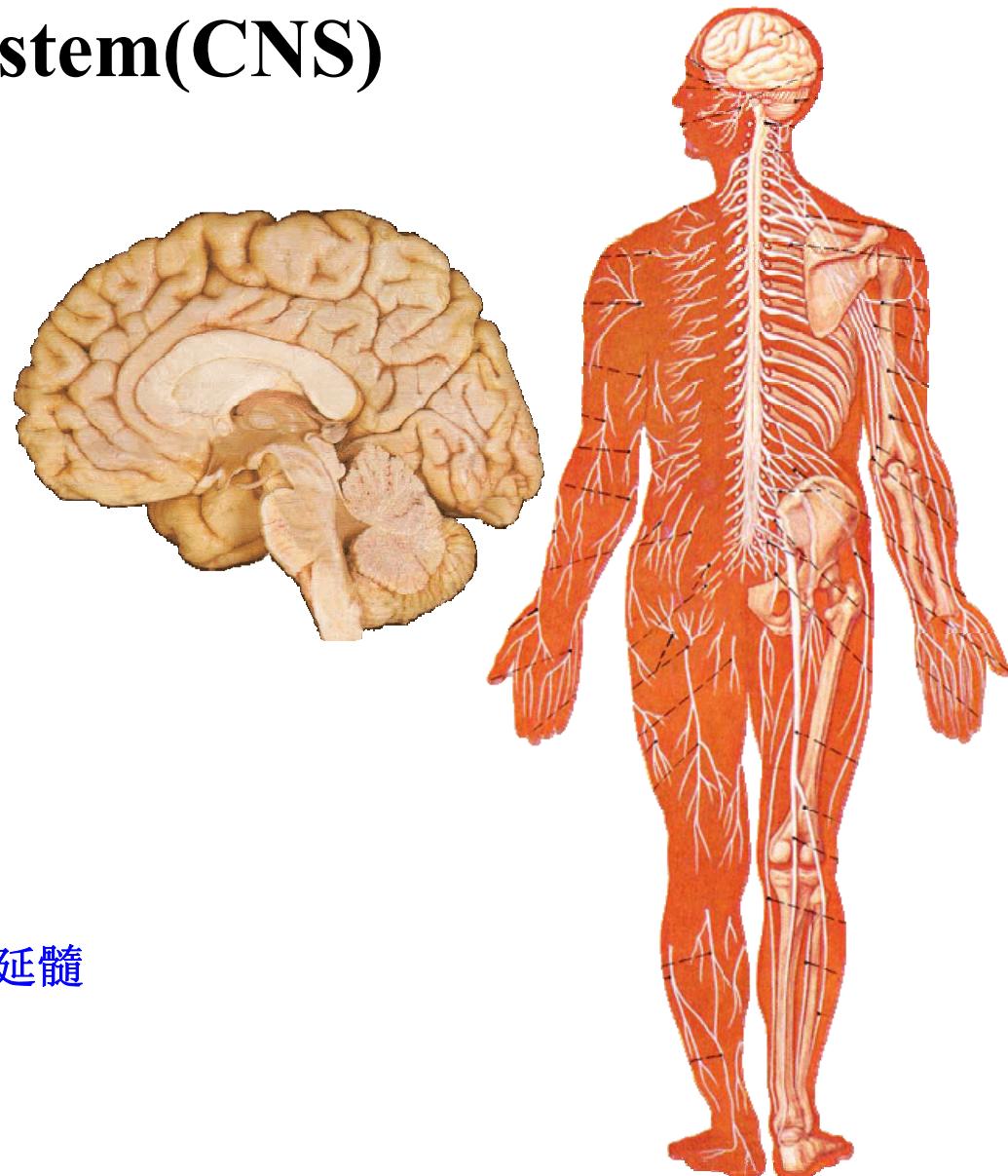
# Divisions 分类

- Central nervous system (CNS)
- 中枢神经系统
- Peripheral nervous system (PNS)
- 周围神经系统

# Central nervous system(CNS)

## 中枢神经系统

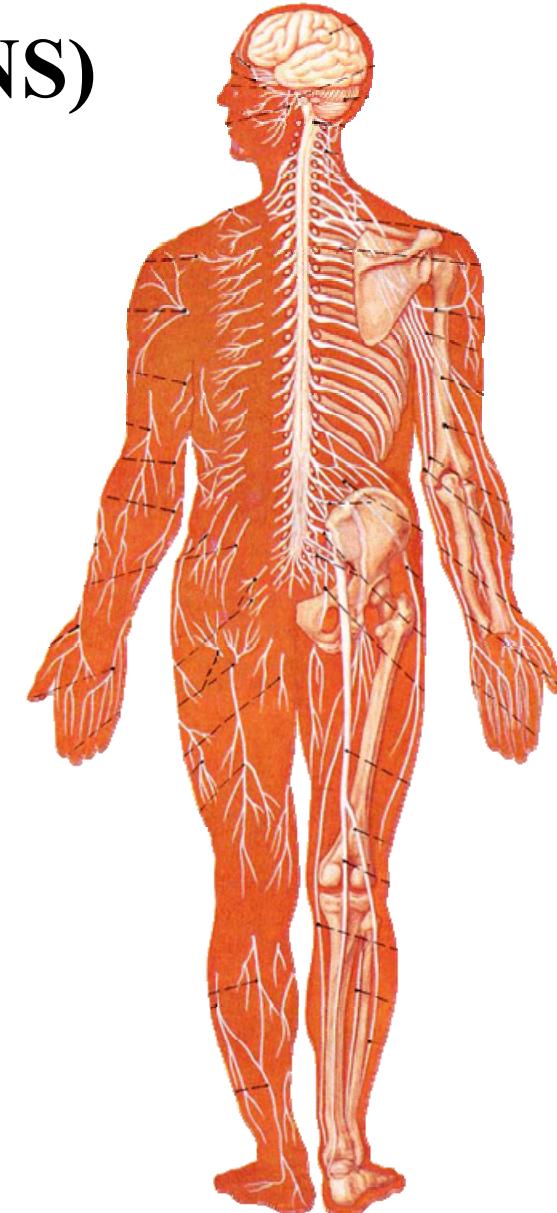
- **Brain 脑**
  - Telencephalon 端脑
  - Diencephalon 间脑
  - Cerebellum 小脑
  - Brain stem 脑干
    - Midbrain 中脑
    - Pons 脑桥
    - Medulla oblongata 延髓
- **Spinal cord 脊髓**



# Peripheral nervous system (PNS)

## 周围神经系统

- **Cranial n. (12 pairs)** 脑神经
- **Spinal n. (31 pairs)** 脊神经
- **Visceral n.** 内脏神经
  - **Visceral sensory n.** 内脏感觉神经
  - **Visceral motor n.** 内脏运动神经
    - **Sympathetic part** 交感神经
    - **Parasympathetic part** 副交感神经



# Reflex and reflex arc 反射和反射弧

- **Reflex**: a reaction of the organism by the nervous system in response to a stimulus
- 反射: 机体通过神经系统对刺激的反应
- **Reflex arc**: has 5 basic components
- 反射弧: 5个基本组成

Receptor 感受器



Sensory neurons 感觉神经元



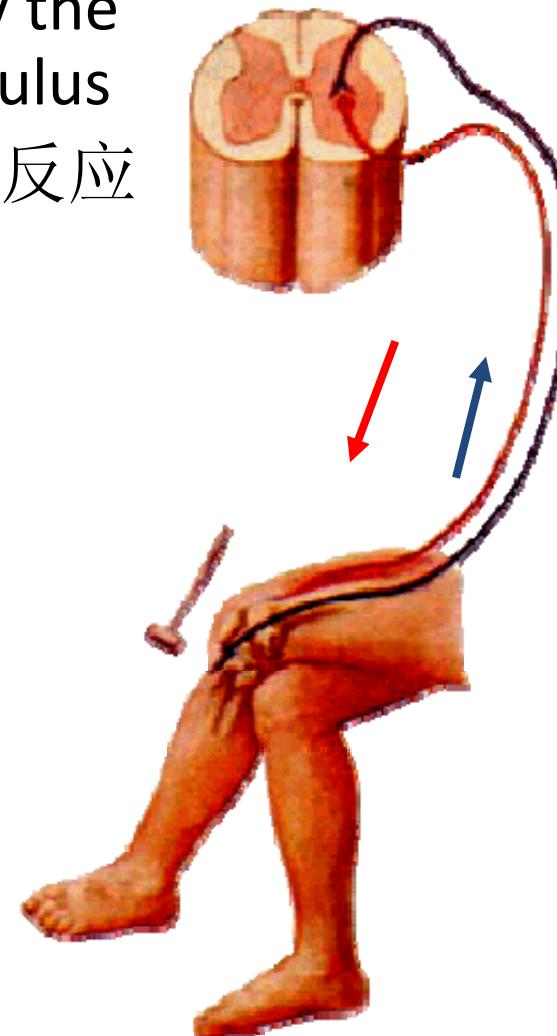
CNS 中枢神经系统



Moter neurons 运动神经元



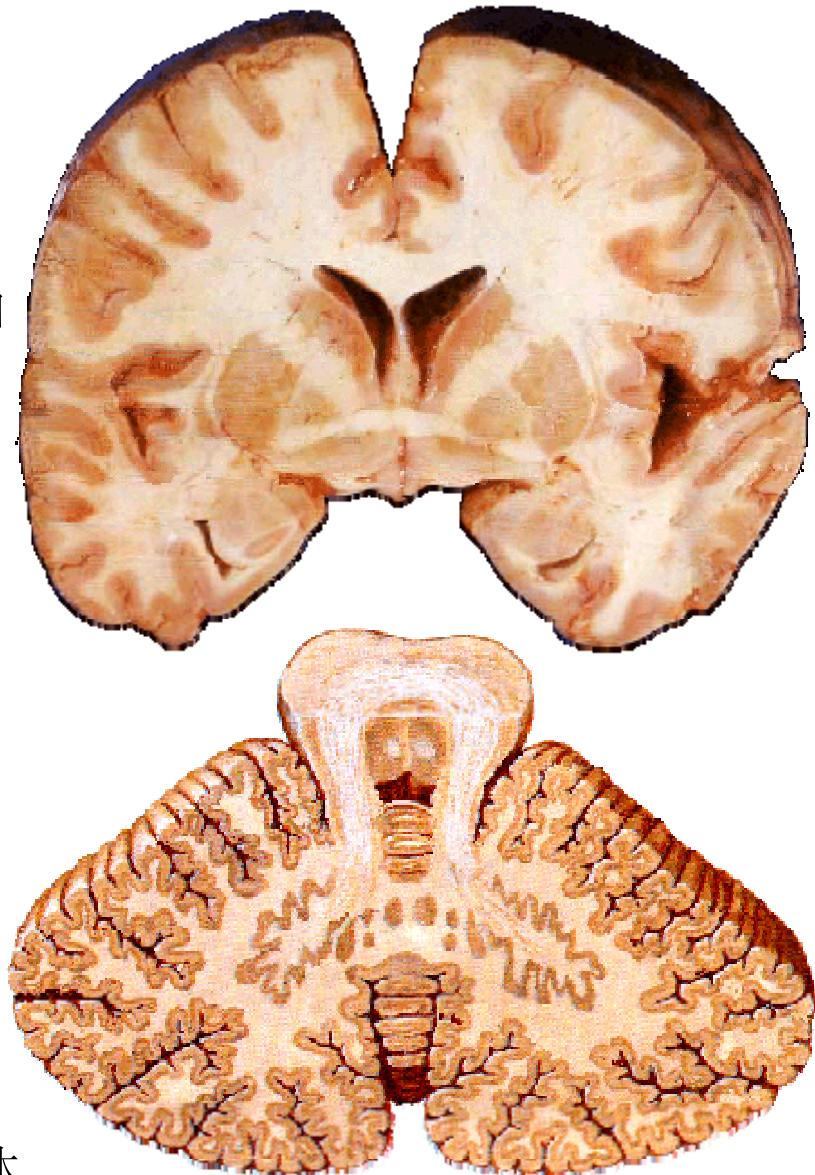
Effector 效应器



# In the CNS :

## 中枢神经系统中

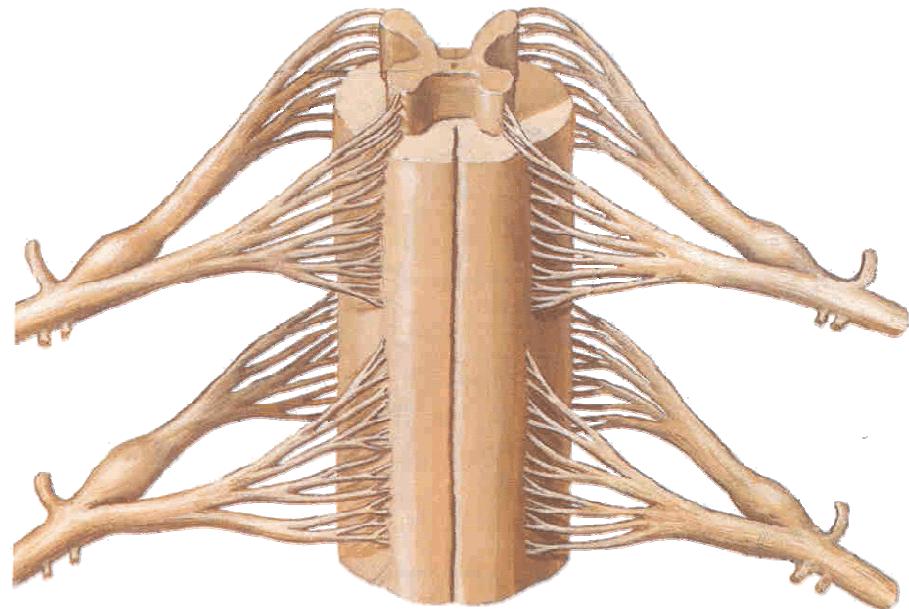
- **Gray matter** 灰质: collection of nerve cell bodies and their dendrites, gray color during fresh condition 神经细胞细胞体和树突的集合，新鲜时为灰色
- **Cortex** 皮质: the outermost layer of gray matter in cerebrum and cerebellum 大脑和小脑灰质的最外层
- **White matter** 白质: collection of nerve fibers, white color during fresh condition 神经纤维的集合，新鲜时为白色
- **Medulla** 髓质: a central core of white matter beneath cortex of cerebrum and cerebellum 在大脑和小脑下的白质中央核心
- **Nucleus** 神经核: a collection ( group ) of cell bodies which have the same shape and function 有相同形状和功能的细胞体集合



# In the PNS

## 周围神经系统中

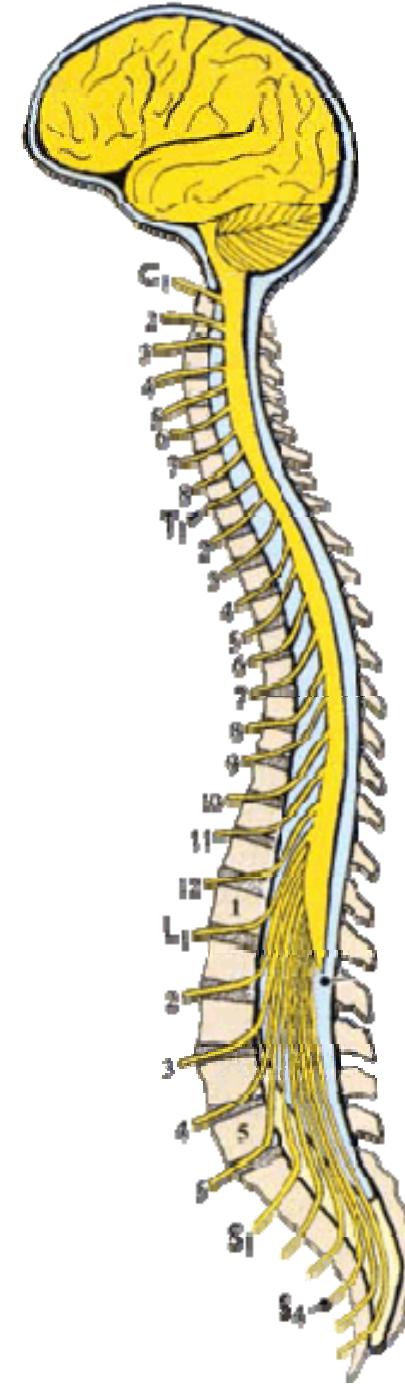
- **Ganglion 神经节:** a collection of neuronal cell bodies outside the CNS CNS外细胞体的集合
- **Nerve 神经:** a bundle of nerve fibers held together by connective tissue sheath 连合的组织鞘围住的神经纤维束



# The Spinal Cord 脊髓

## Position 位置

- Lies in vertebral canal
- 在脊椎管中
- Continuous above with medulla oblongata at level of foramen magnum
- 在枕骨大孔处与延髓相连
- Ends below at lower border of L1 in adult; at birth at level of L3
- 在成年人中止于L1下缘；出生时止于L3



# External features

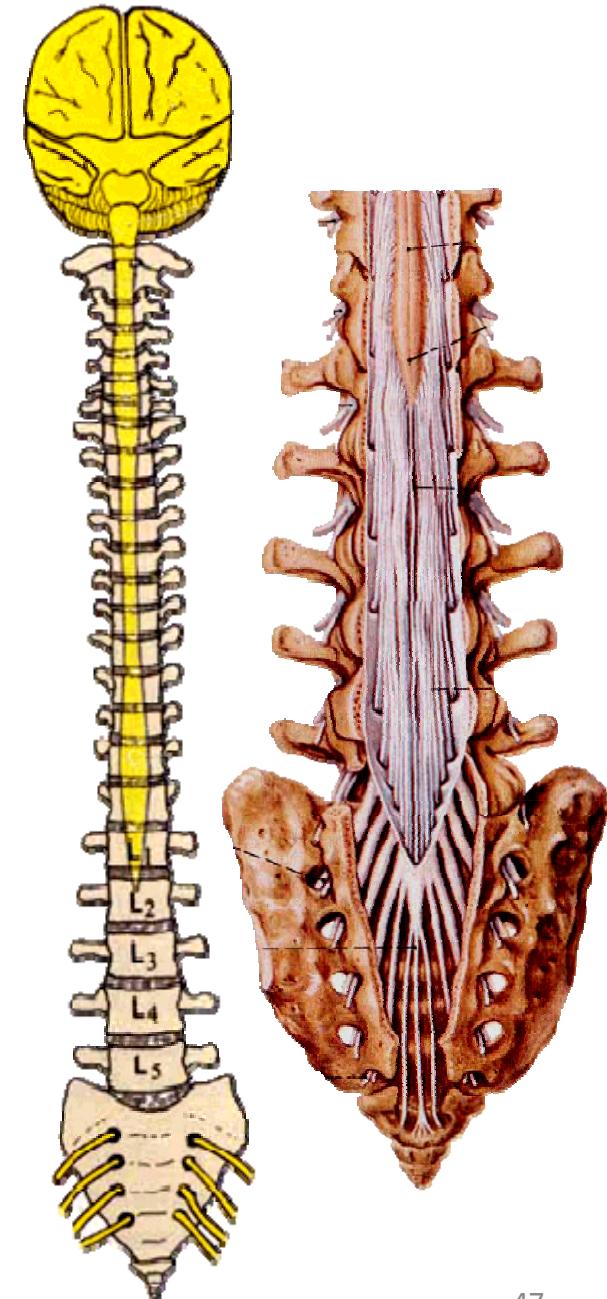
## 外部形态

- A long cylindrical structure and slightly flattened anteroposteriorly
- 长圆柱形结构，前后稍扁
- **Conus medullaris** (脊髓圆锥)
- **Filum terminale** (终丝)
- **Cauda equina** (马尾)
- Two enlargements 两个膨大

**Cervical enlargement** (颈膨大) :

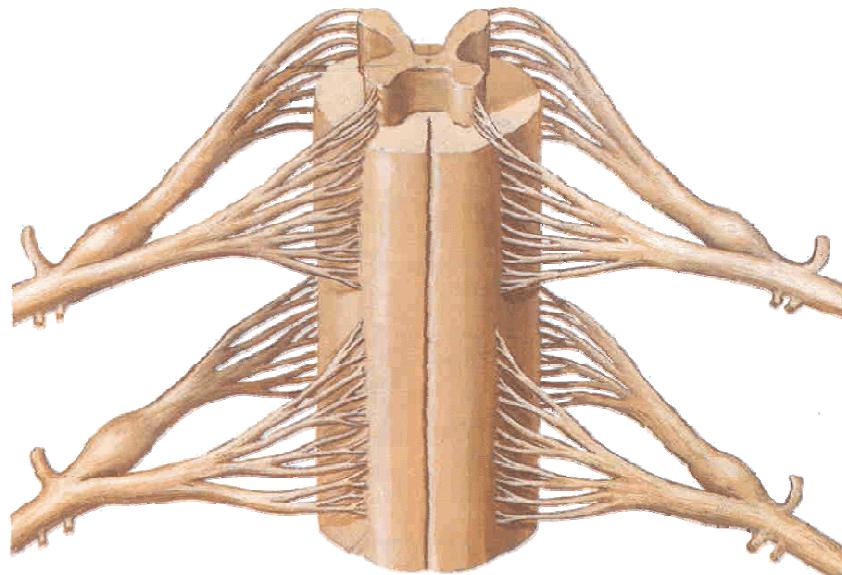
corresponds to the C4 to the T1 segments 对应C4到T1段

**Lumbosacral enlargement** (腰骶膨大) : corresponds to the L2 to the S3 segments 对应L2到S3段



## Fissure and sulci 沟槽

- **Anterior median fissure** 前正中裂
- **Posterior median sulcus** 后正中沟
- **Anterolateral sulcus** 前外侧沟—anterior (motor) roots emerge serially  
前（运动）根连续出现
- **Posterolateral sulcus** 后外侧沟—posterior (sensory) roots enter spinal cord  
后（感觉）根入脊髓, each bear a spinal ganglion which constitutes the first cell-station of the sensory nerves  
每一个上有一个脊神经节，构成感觉神经的第一细胞站



# Relationship of segments of spinal cord to vertebrae

## 椎骨和脊髓的对应关系

- A portion of the cord that gives rise to a pair of spinal nerve constitutes a segment.

- 一部分脊髓和它发出的一对脊神经组成一个节段

- There are 31 segments

- 31个节段

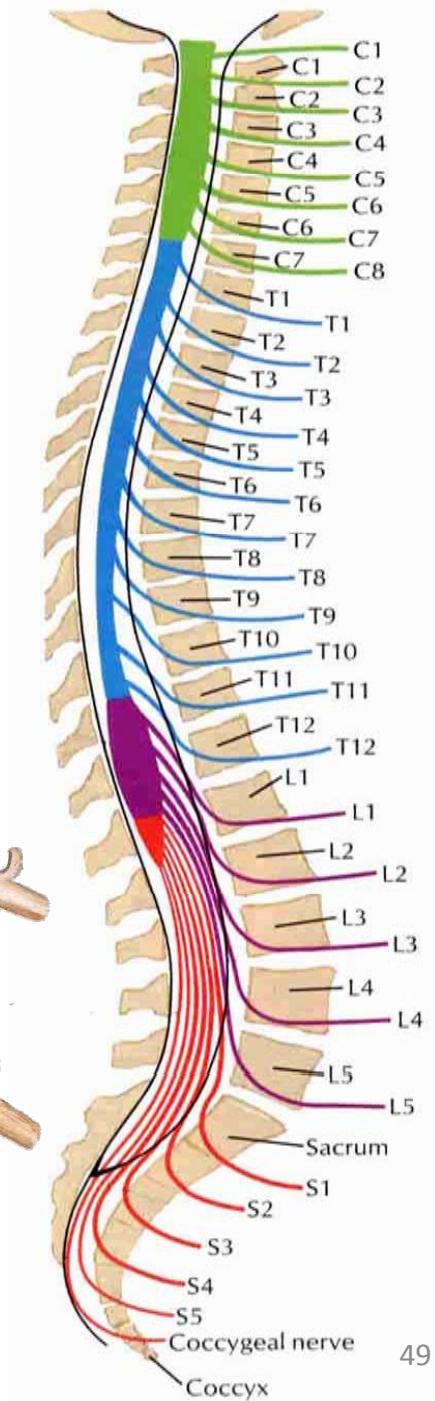
8 cervical 8个颈髓节段

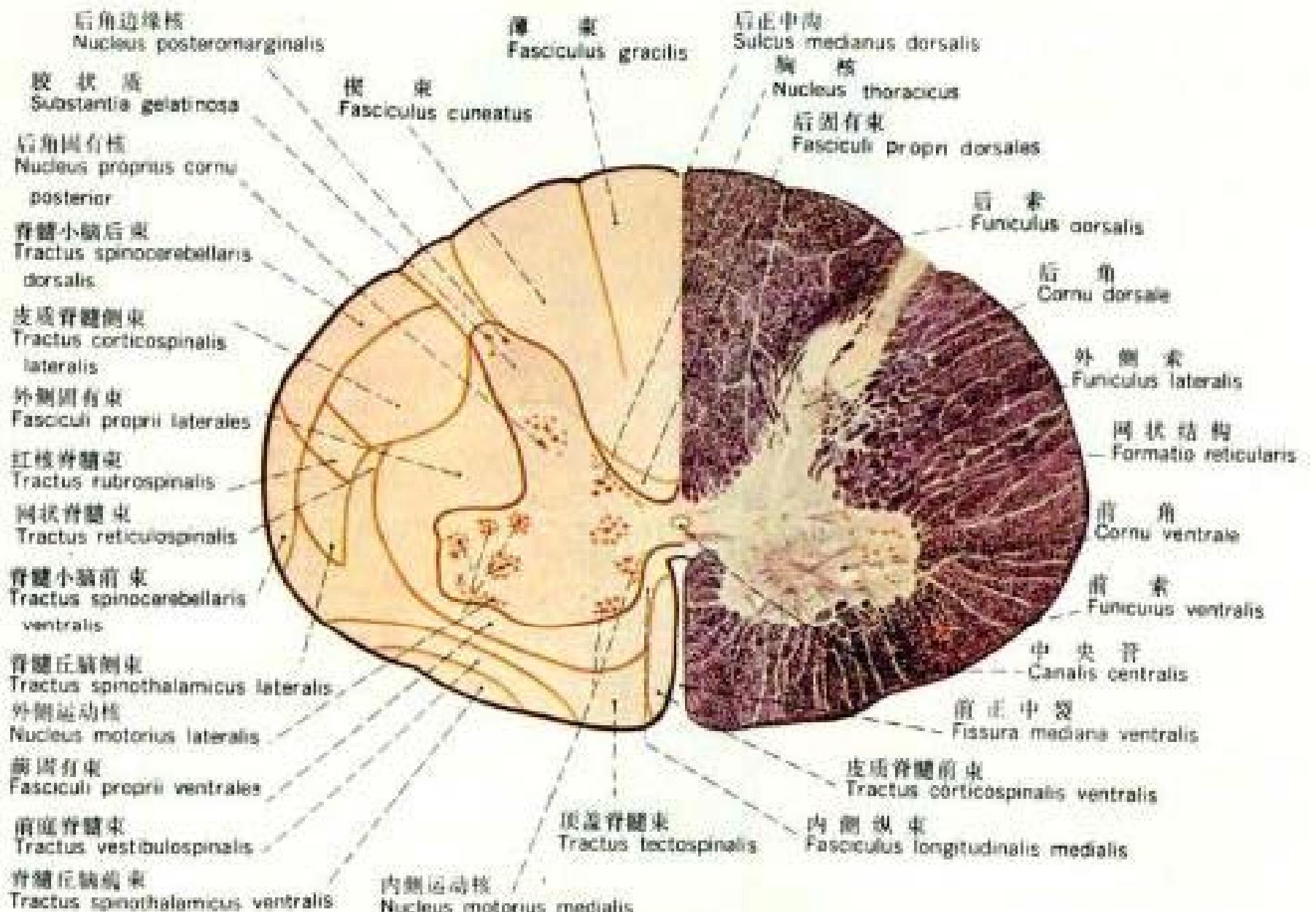
12 thoracic 12个胸髓节段

5 lumbar 5个腰髓节段

5 sacral 5个骶髓节段

1 coccygeal 1个尾椎节段

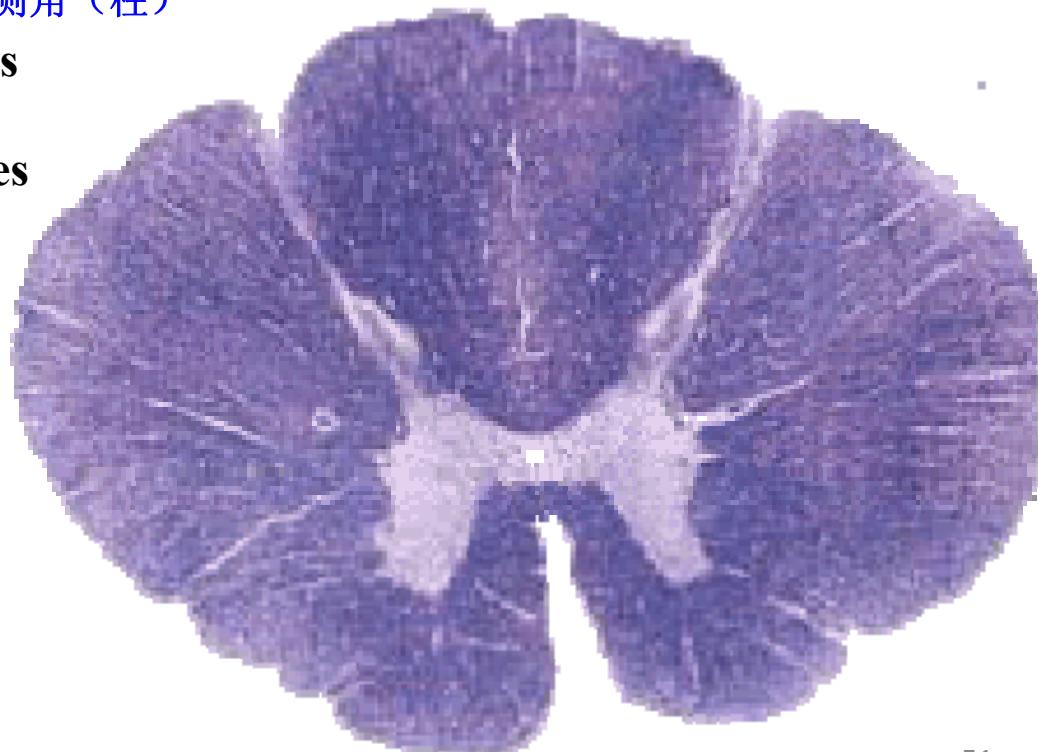




221. 脊髓颈段横切面  
Transverse section through cervical segment of spinal cord

# Internal structures 内部结构

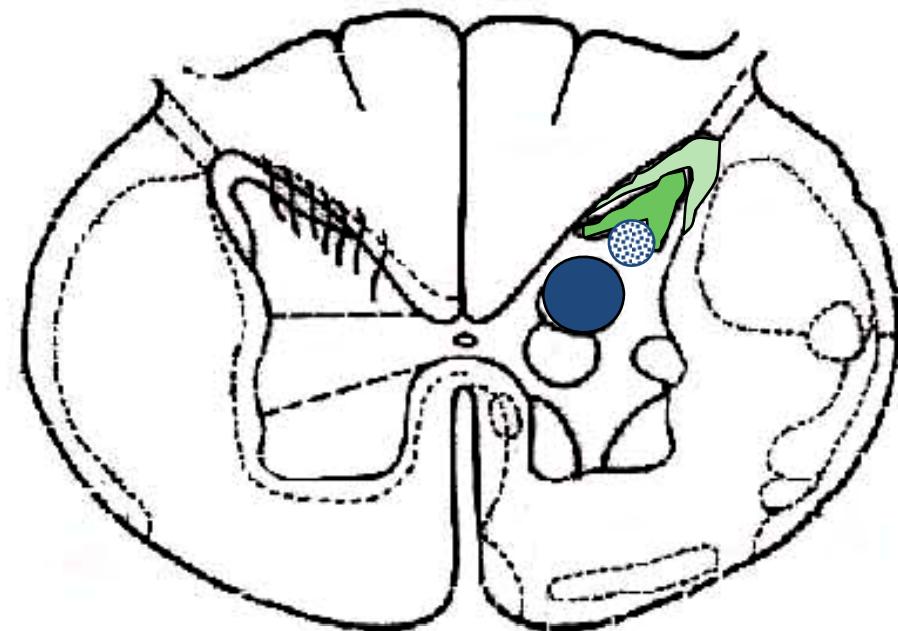
- Central canal 中央管
- Gray matter
  - Anterior horn (column) 前角 (柱)
  - Posterior horn (column) 后角 (柱)
  - Intermediate zone 中间带
    - Lateral horn (column) 侧角 (柱)
  - Anterior gray commissures 灰质前连合
  - Posterior gray commissures 灰质后连合
- White matter
  - Anterior funiculus 前索
  - lateral funiculus 外侧索
  - Posterior funiculus 后索
  - Anterior white commissure 白质前连合



## Posterior horn(column):

后角（柱）

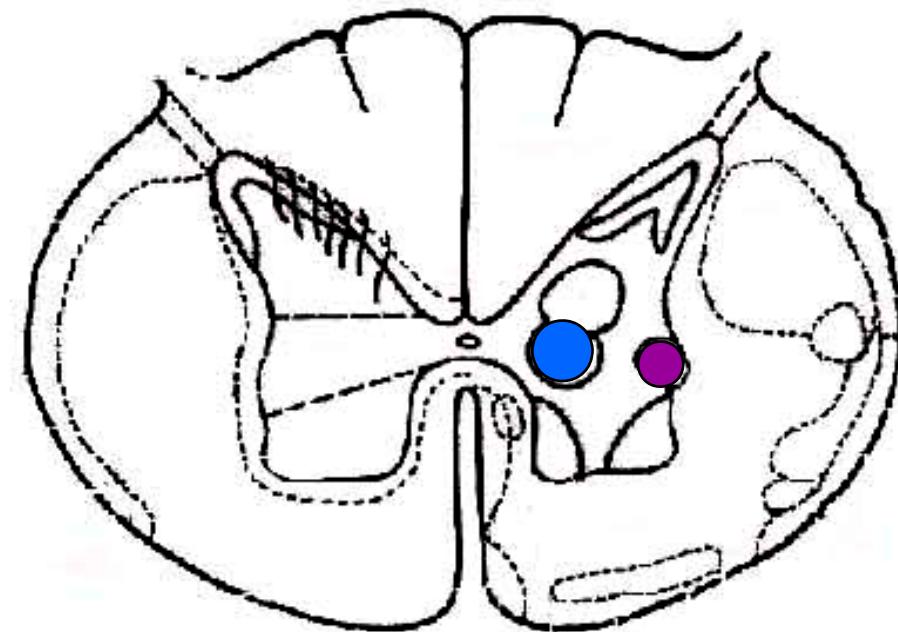
- **Marginal layer** （缘层）
- **Substantia gelatinosa**  
(胶状质)
- **Nucleus proprius**  
(后角固有核)
- **Nucleus thoracicus**  
(胸核)  
in segments C8~L3  
在C8到L3段



# Intermediate zone

## 中间区

- **Intermediaolateral nucleus** (中间外侧核) (**lateral horn or column**) (侧角或侧柱) : lies in segments T1~L3, containing sympathetic preganglionic neurons 在T1~L3节段，包含交感神经节前神经元
- **Sacral parasympathetic nucleus** (骶副交感核) : lies in segments S2~S4, containing parasympathetic preganglionic neurons 在S2到S4节段，包含副交感神经节前神经元
- **Intermediomedial nucleus** (中间内侧核) : for sensation of viscera 内脏感觉



## Anterior horn (column):

contain motor neurons

前角（前柱）：含运动神经元

- Three kinds of neuron

三种神经元

- **$\alpha$ -motor neuron**: larger multipolar neuron, innervates extrafusal fibers of skeletal m., producing contraction of m.
- **$\alpha$ -运动神经元**: 较大的多极神经元，支配肌梭外骨骼肌纤维，产生肌肉收缩
- **$\gamma$ -motor neuron**: smaller neuron, innervates intrafusal fibers regulating muscular tonus
- $\gamma$ -运动神经元: 较小的神经元，支配调节调节肌紧张的梭内纤维
- **Renshaw's cell**: negative feedback mechanism
- 闰绍细胞: 负反馈机制

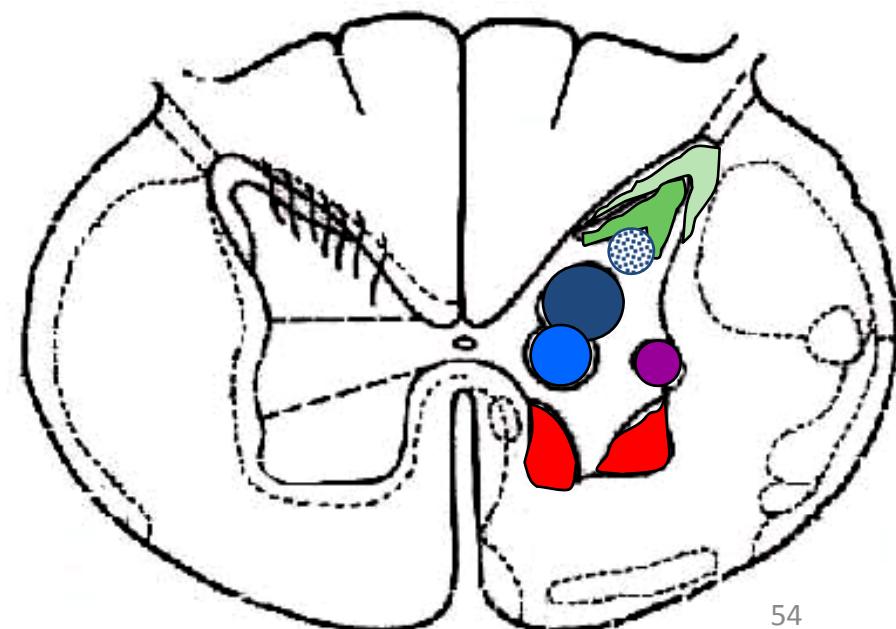
- Two groups of nuclei  
两类核团

**Medial nuclear group**: present in most segments of spinal cord, innervating axial muscles

内侧核群: 存在于脊髓绝大多数节段中，支配中轴肌

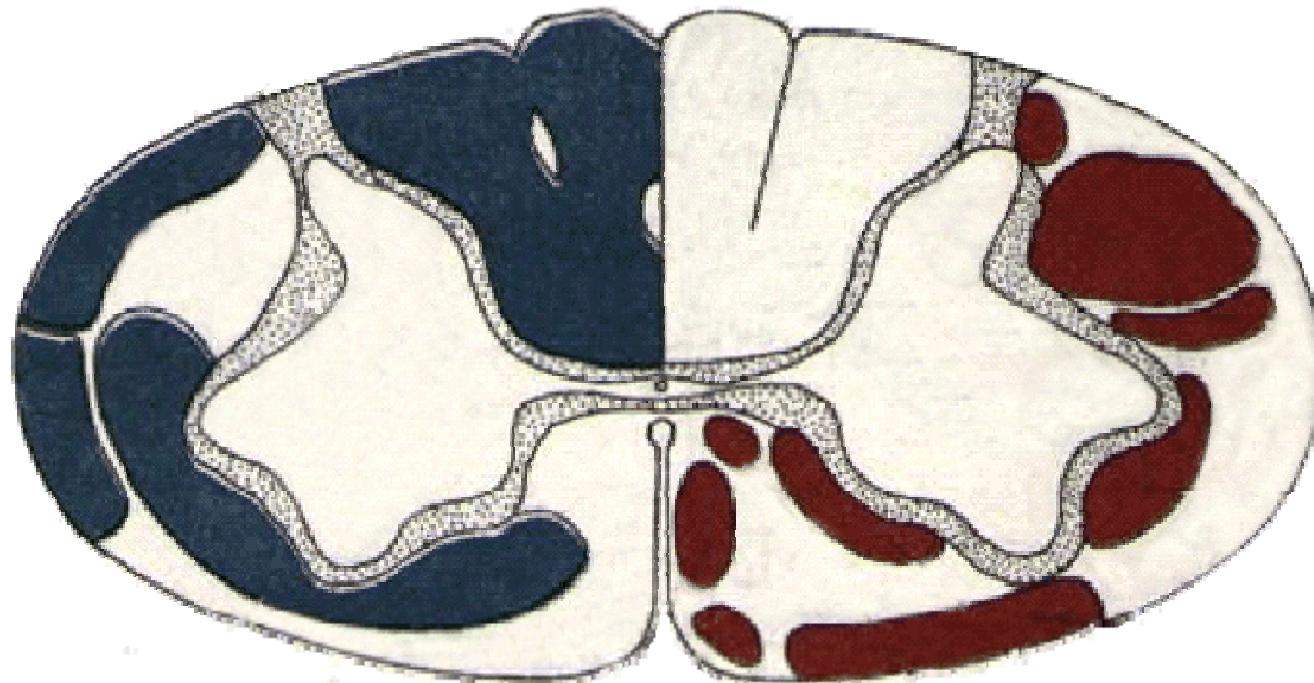
**Lateral nuclear group**: present only in cervical and lumbosacral enlargements, innervating limb muscles

外侧核群: 仅存在于颈膨大和腰骶膨大，支配肢体肌肉

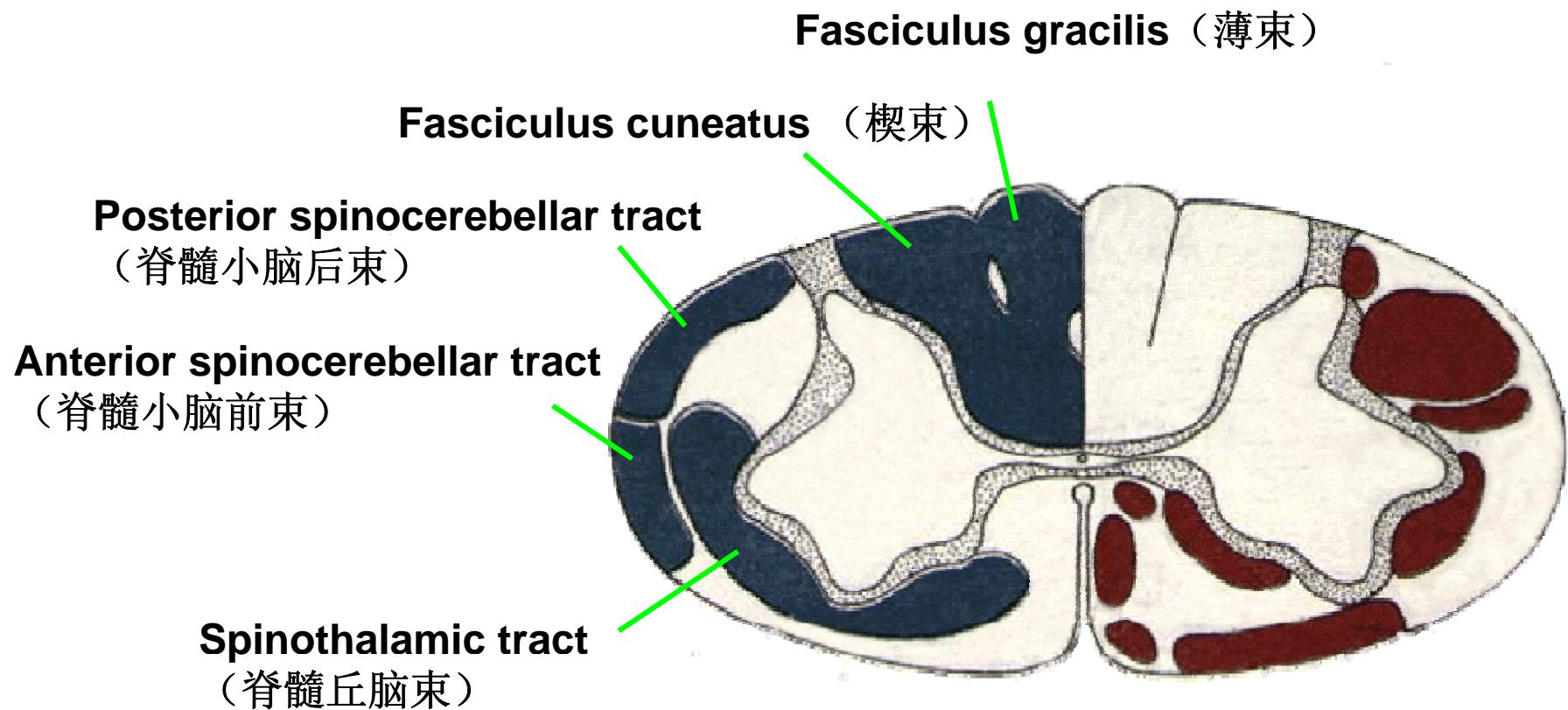


# White matter 白质

White matter contains three kinds of fibers: ascending,  
descending, and fasciculus proprius 固有束  
白质包括三种纤维：上行、下行和固有束

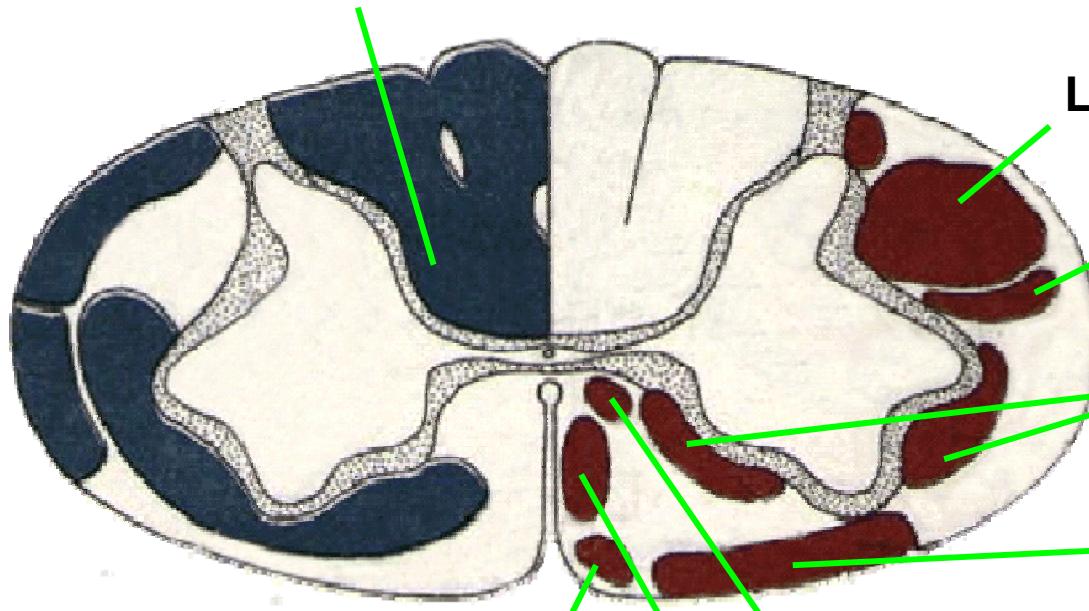


# Ascending tracts 上行束



# Descending tracts 下行束

Fasciculus proprius (固有束)



Lateral corticospinal tract  
(皮质脊髓侧束)

Rubrospinal tract  
(红核脊髓束)

Reticulospinal tract  
(网状脊髓束)

Vestibulospinal tract  
(前庭脊髓束)

Tectospinal tract  
(顶盖脊髓束)

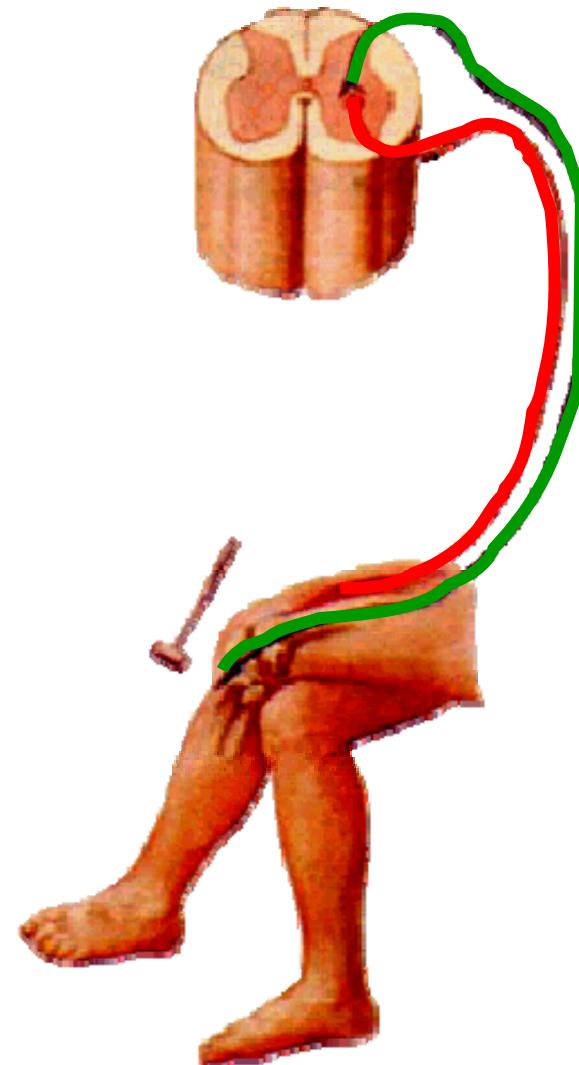
Medial longitudinal fasciculus (内侧纵束)  
Anterior corticospinal tract (皮质脊髓前束)



# Main functions of spinal cord

脊髓的主要功能

- Conduction of excitations  
兴奋传导
- Reflex activity  
反射活动



# General description 一般说明

- **31 pairs spinal nerves:**

31对脊神经

8 cervical, 12 thoracic, 5 lumbar, 5 sacral, and 1 coccygeal nerve.

8个颈髓节段、2个胸髓节段、5个腰髓节段、5个骶髓节段、1个尾椎节段

- **Formation:** each spinal nerve is formed by union of anterior and posterior roots at intervertebral foramen

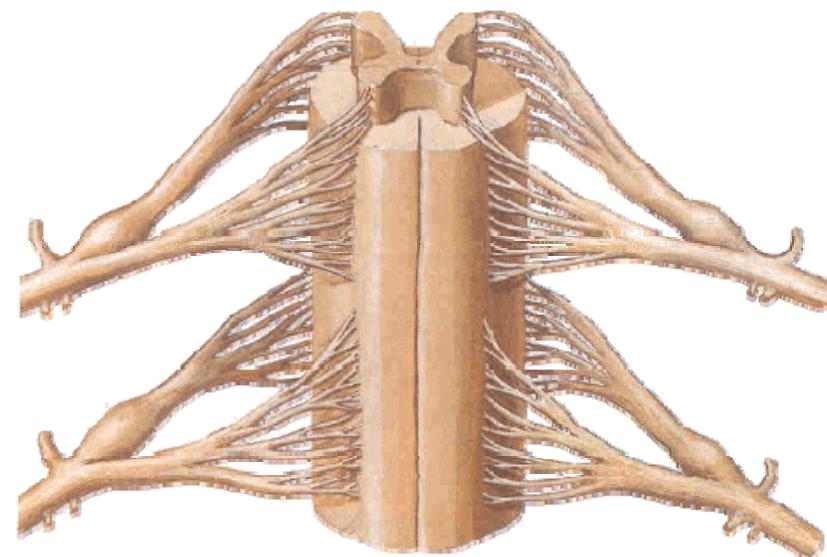
组成：每条脊神经由前后根在椎间孔的联合构成

**The anterior root**—contains motor fibers for skeletal muscles. Those from T1 to L2 contain sympathetic fibers; S2 to S4 also contain **parasympathetic fibers**.

前根：包含骨骼肌运动纤维。从T1到L2包含交感神经，由S2到S4也包含副交感神经

**The posterior root**—contains sensory fibers whose cell bodies are in the spinal ganglion.

后根：包含感觉纤维，其细胞体在脊神经节

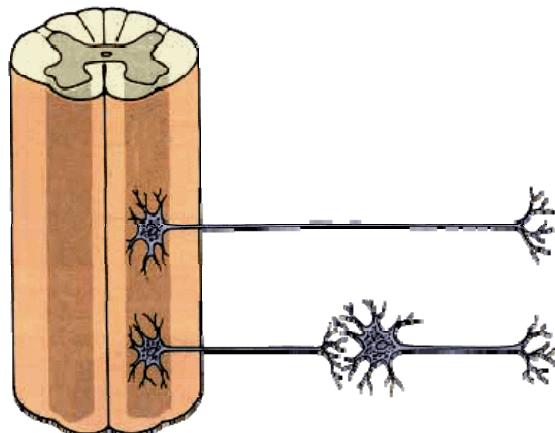
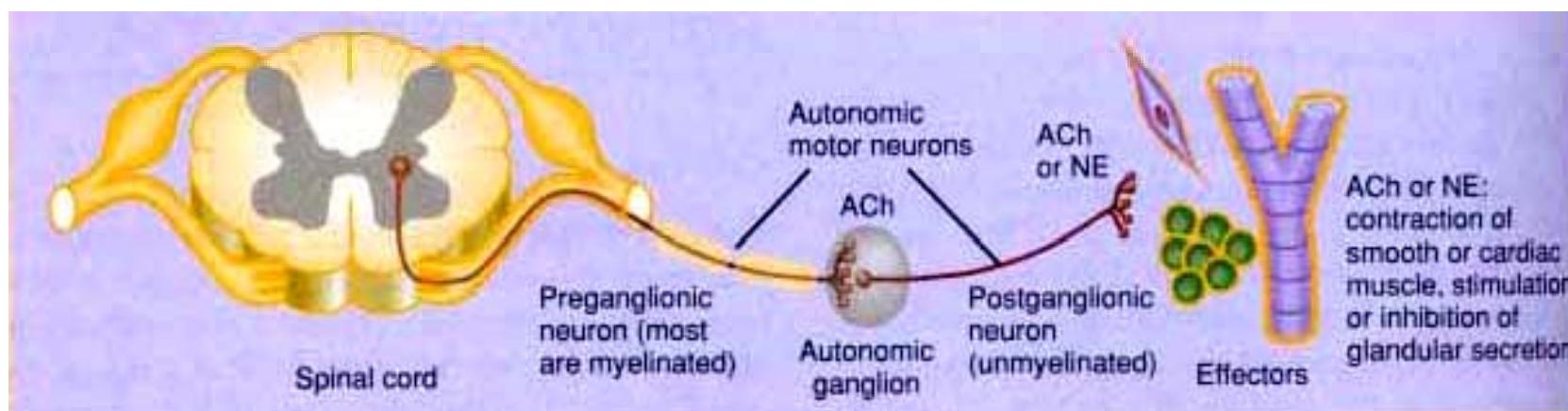
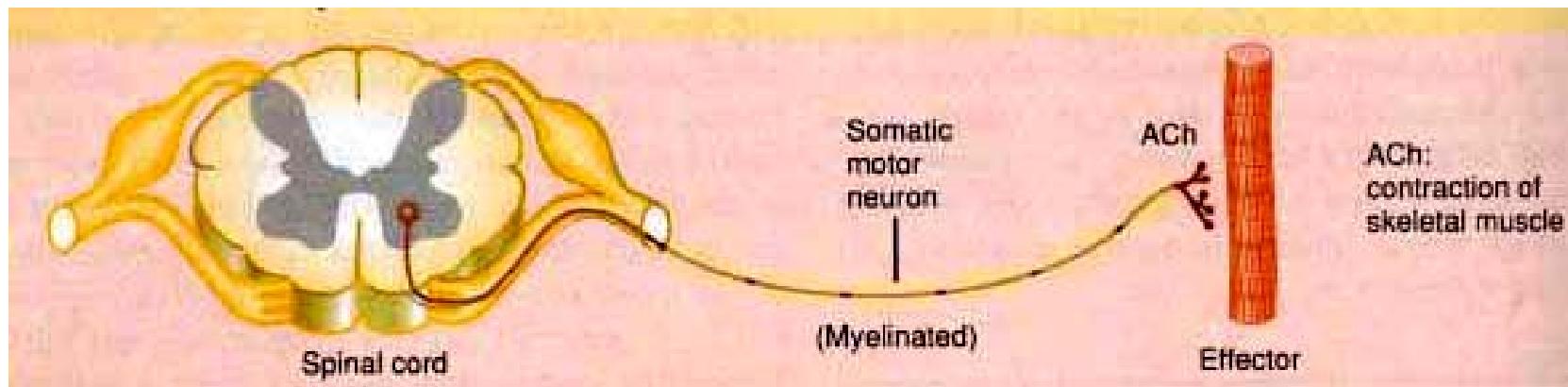


# The Visceral Nervous System

## 内脏神经系统

### **Composition** 组成

- Visceral motor nerves (autonomic nervous system)
  - Sympathetic part 交感部
  - Parasympathetic part 副交感部
- Visceral sensory nerves  
内脏感觉神经



# Main differences between somatic motor and visceral motor n.

躯体运动神经和内脏运动神经的主要区别

	Somatic 躯体	Visceral 内脏
<b>Effectors</b> 效应器	<b>Skeletal muscles</b> 骨骼肌	<b>Cardiac, smooth muscles and glands</b> 心肌、平滑肌和腺体
<b>Kind of fibers</b> 纤维种类	<b>One</b> 一种	<b>Two: sympathetic and parasympathetic</b> 两种：交感神经和副交感神经
<b>From lower center to effect require</b> 从低级中枢到效应器需要	<b>Single neuron</b> 单个神经元	<b>Two neurons: preganglionic neuron (fiber) and postganglionic neuron (fiber)</b> 两个神经元：交感神经元和副交感神经元
<b>Fibers</b> 纤维	<b>Thick myelinated</b> 厚髓鞘化	<b>Preganglionic: thin myelinated</b> <b>postganglionic: unmyelinated</b> 神经节前：薄髓鞘化 神经节后：无髓鞘
<b>Distributive form</b>	<b>Nerve trunk</b> 神经干	<b>Nerve plexuses</b> 神经丛
<b>Control</b>	<b>Voluntary</b> 自愿 (consciousness) (意识)	<b>Involuntary (unconsciousness )</b> 不自愿 (无意识)

# Sympathetic part 交感部

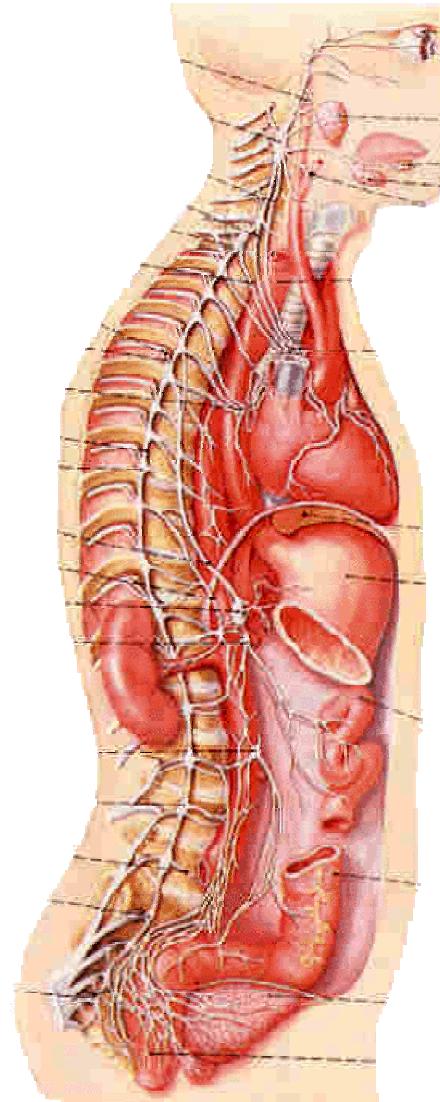
- **Lower center:** located in lateral gray horn of spinal cord segments T1~L3
- 低级中枢：在脊髓T1~L3节段侧向灰质角
- **Sympathetic ganglia**
- 交感神经节
  - Paravertebral ganglia 椎旁节
  - Prevertebral ganglia 椎前节



自主神经系统概观

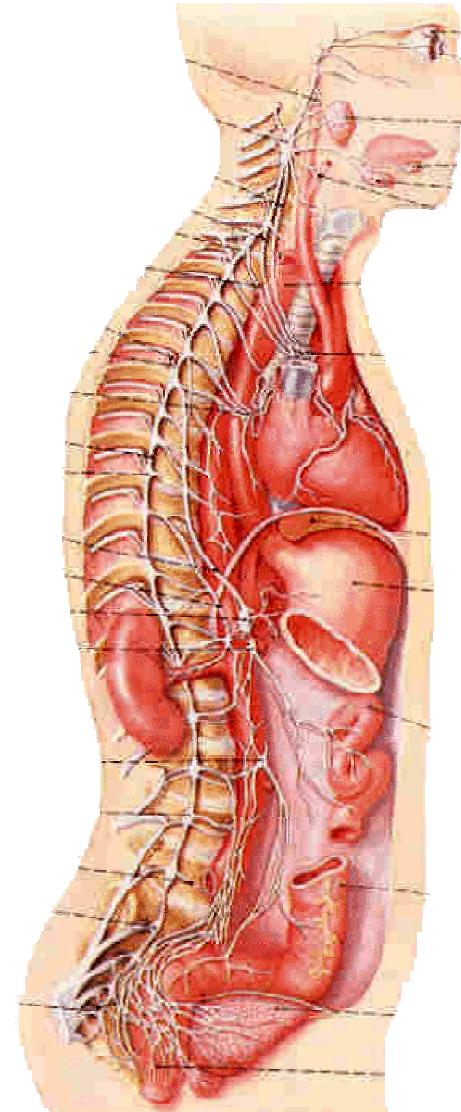
# Paravertebral ganglia 椎旁节

- Arranged on either side of vertebral column
- 在脊柱两侧
- Consist of 19~22 of oval-shaped ganglia
- 包括19~22个椭圆形神经节
  - Three cervical
  - 3个颈神经节
  - 10~12 thoracic
  - 10~12个胸神经节
  - 4 lumbar
  - 4个腰神经节
  - 2~3 sacral
  - 2~3个骶神经节
  - Ganglion impar 奇神经节:  
unpaired on the anterior face of coccyx 在尾椎前面，不成对



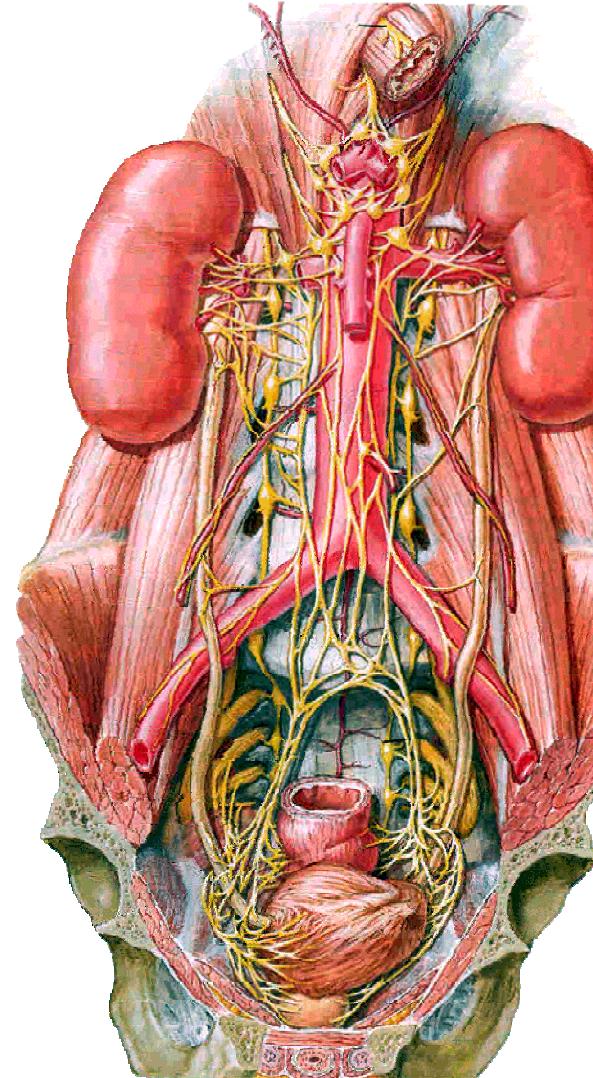
# Sympathetic trunk 交感干

- Formed by paravertebral ganglia and interganglionic branches 由副交感神经节和神经节间分支形成
- Lie on either side of vertebral column from base of skull to coccyx 在脊柱两侧，从颅底到尾骨
- The trunks of two side unite in front of the coccyx at a small swelling, the ganglion impar 两尾骨侧神经干在尾骨前一处膨大——奇神经节汇合



# Prevertebral ganglia 椎前节

- Lie anterior to vertebral column and near the arteries for which they are named  
**Celiac ganglion** 在脊柱前面，靠近动脉，所以命名为**腹腔神经节**
- **Aorticorenal ganglion** 主动脉肾节
- **Superior mesenteric ganglion** 肠系膜上神经节
- **Inferior mesenteric ganglion** 肠系膜下神经节



# Distribution of sympathetic nerve

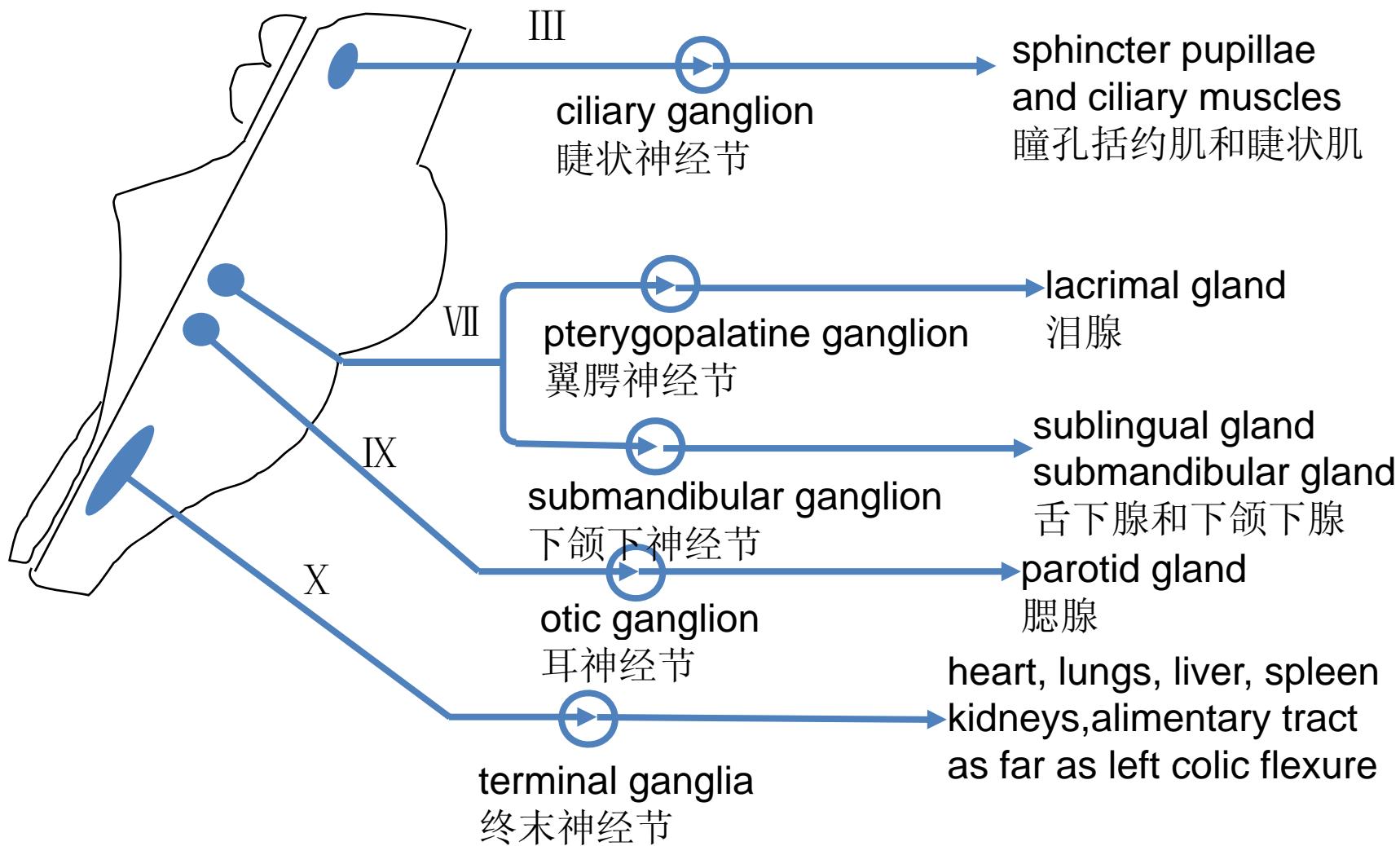
## 交感神经分布

Preganglionic fibers 节前纤维	Postganglionic fibers 节后纤维
T1~T5	<b>Head, neck, upper limb and thoracic viscera</b> 头，颈，上肢和胸部脏器
T5~T12	<b>Abdominal viscera</b> 腹部脏器
L1~L3	<b>Pelvic viscera and lower limb</b> 盆腔脏器和下肢

# Parasympathetic part 副交感部

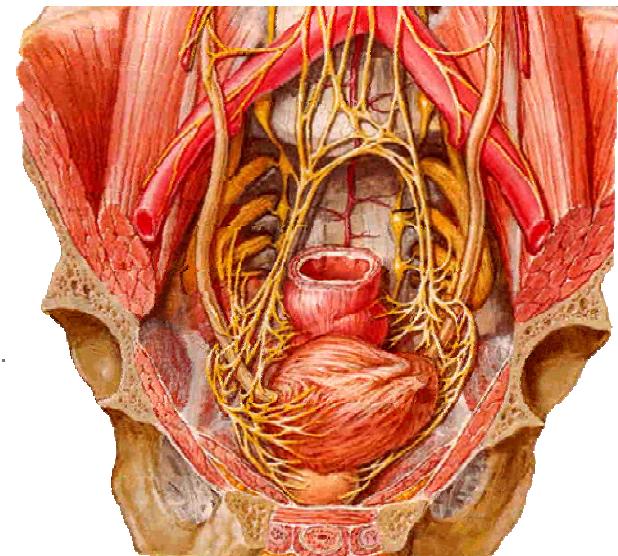
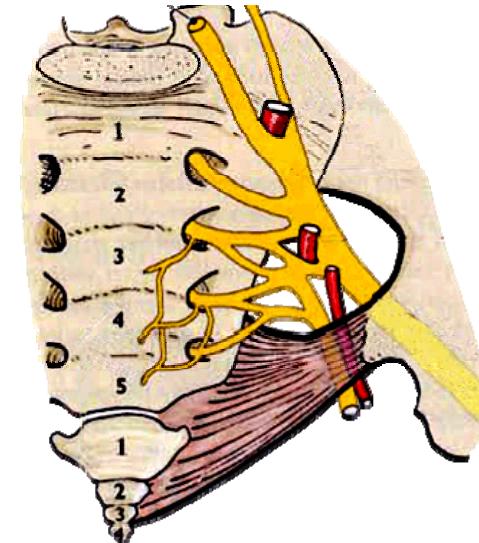
- **Lower center:** located in four pairs parasympathetic nuclei in brain stem and in sacral parasympathetic nucleus of spinal cord segments S2~S4
- 低级中枢：在四对脑干副交感神经核和脊髓骶骨S2~S4副交感神经核
- **Parasympathetic ganglia:** terminal ganglia are near or within the wall of a visceral organ
- 副交感神经节：
  - Para-organ ganglia 器官旁节
    - Ciliary ganglion 睫状神经节
    - Pterygopalatine ganglion 翼腭神经节
    - Submandibular ganglion 下颌下神经节
    - Otic ganglion 耳神经节
  - Intramural ganglia 壁内节

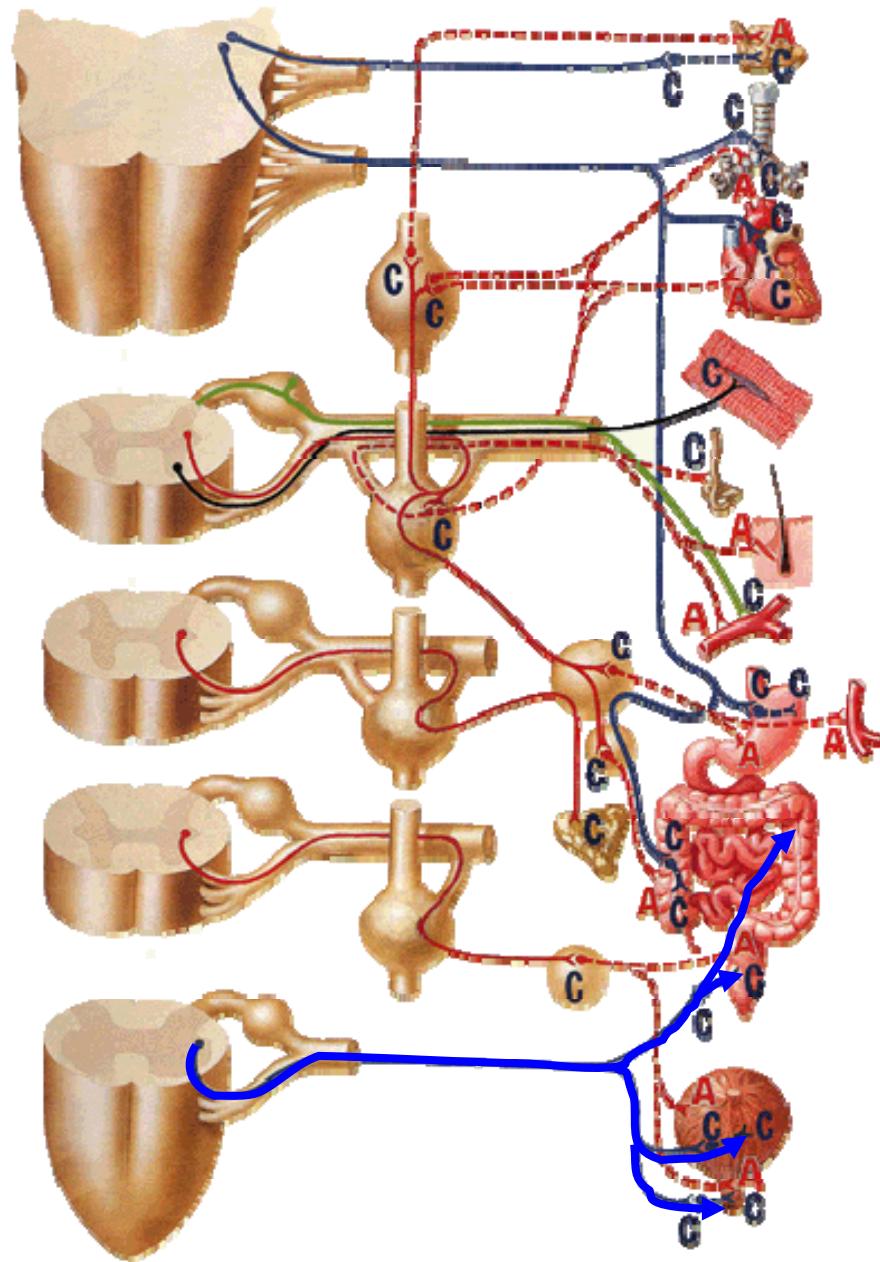
# Cranial portion 颅部



# Sacral portion 骶部

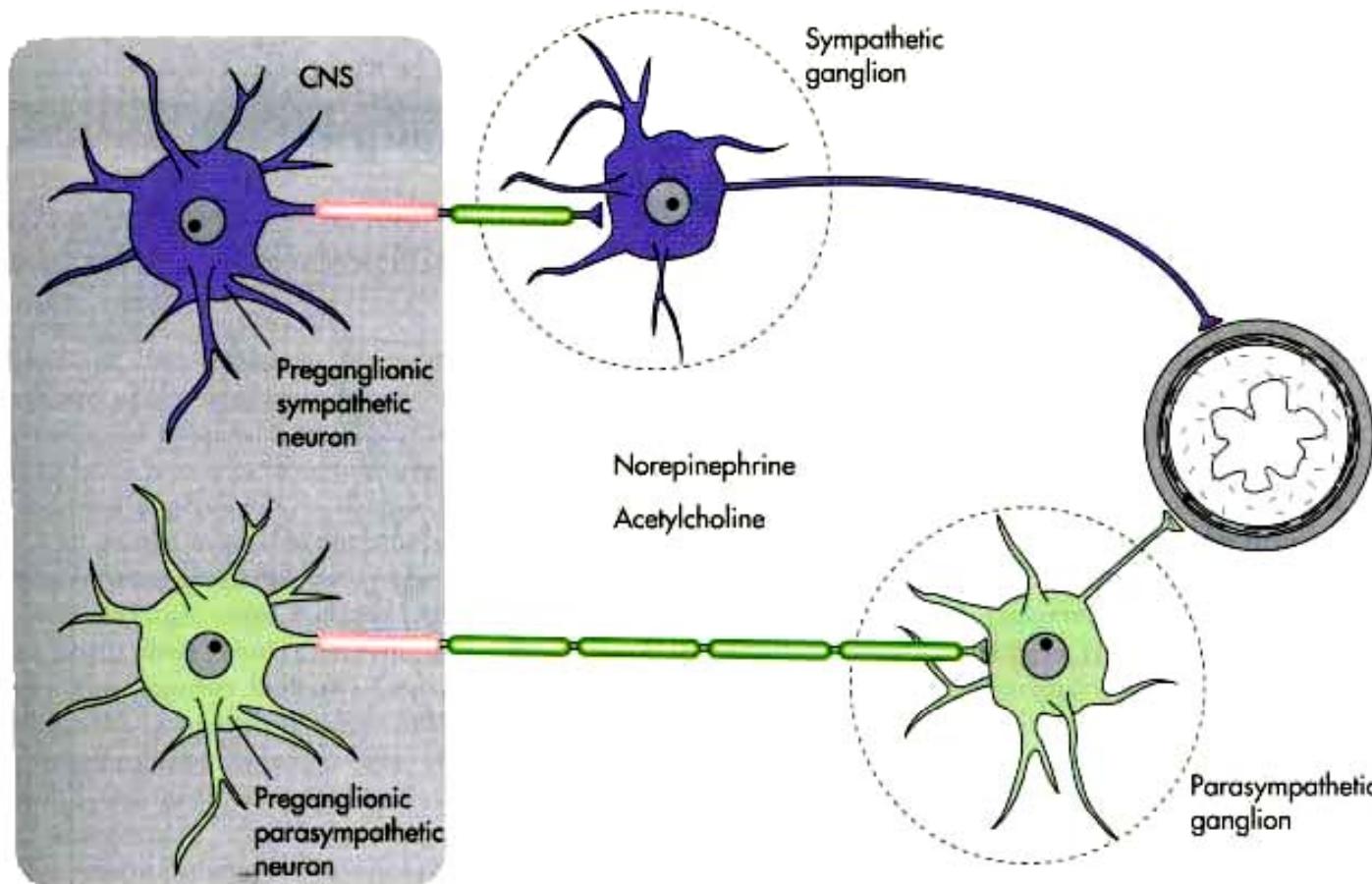
- Preganglionic fibers from sacral parasympathetic nucleus leave spinal cord with anterior roots of the spinal nerves S2~S4
- 由骶副交感神经核发出的节前神经纤维，由S2-S4前根离开脊髓神经
- Then leave sacral nerves and form pelvic splanchnic nerve and travel by way of pelvic plexus to terminal ganglia in pelvic cavity
- 离开骶神经形成盆内脏神经、经由盆从到位于盆腔的终末神经节
- Postganglionic fibers terminate in descending and sigmoid colon, rectum and pelvic viscera
- 节后神经纤维止于下行和乙状结肠、直肠和盆腔内脏





# Main differences between sympathetic and parasympathetic

交感神经和副交感神经的主要区别



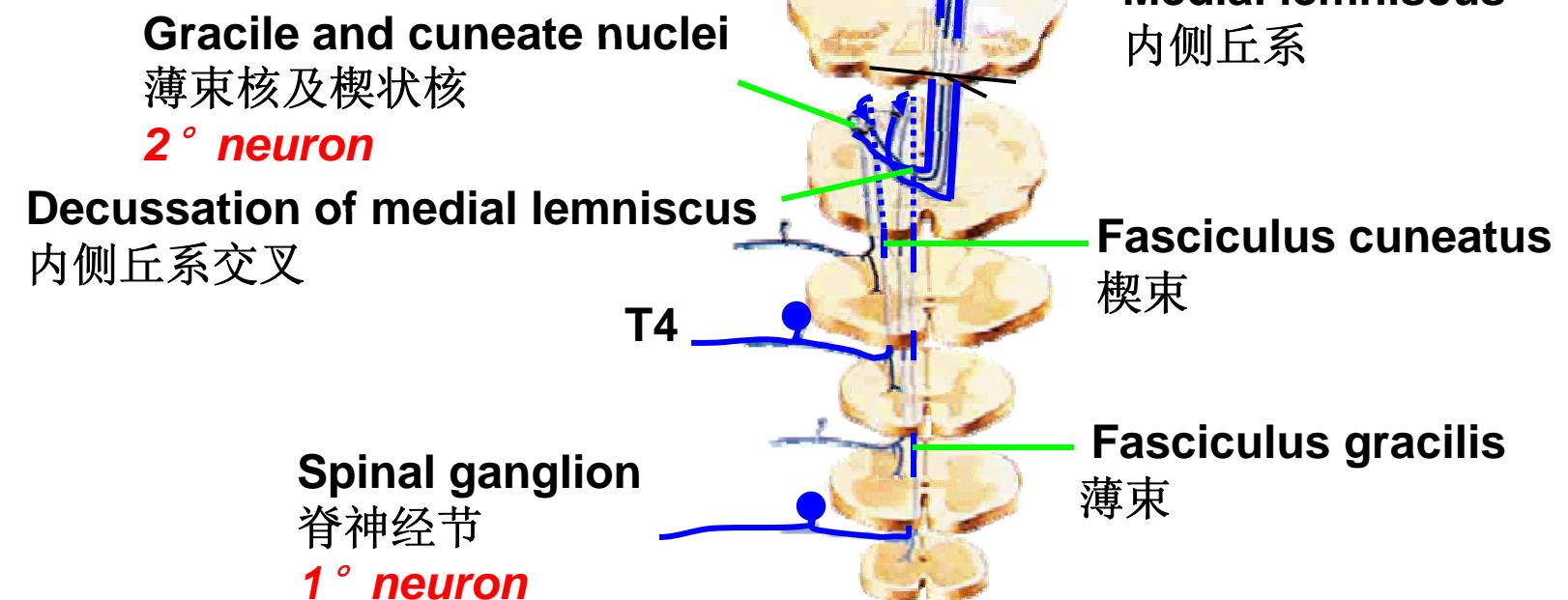
# Main differences between sympathetic and parasympathetic

## 交感神经和副交感神经的主要区别

	Sympathetic 交感神经	Parasympathetic 副交感神经
<b>Lower center</b> 低级中枢	Lateral gray horn of spinal cord segments T1~L3 脊髓T1~L3侧灰质角	Four pairs parasympathetic nuclei and sacral parasympathetic nucleus 4对副交感神经核和骶骨副交感神经核
<b>Ganglia</b> 神经节	Paravertebral, prevertebral 椎旁、椎骨前	Terminal 终末
<b>Preganglionic f.</b> 节前纤维	Shorter 较短	Longer 较长
<b>Postganglionic f.</b> 节后纤维	Longer 较长	Shorter 较短
<b>Pre: Postganglionic</b> 节前/后	1: many more 1: 多	1: a few 1: 少
<b>Distributions</b> 分布	Throughout the body 遍布全身	Limited primarily to head and viscera of thorax, abdomen, and pelvis 主要限制头和胸、腹、盆腔内脏
<b>Different action</b> 不同活动	Prepares for emergency situation (fight or flight) 为紧急情况作准备（战或逃）	Conserve and restore body energy (rest and relaxation) 保存体力（休息和放松）

# Conscious proprioceptive and fine touch pathway of trunk and limbs

躯干和肢体有意识本体感  
受和精细触觉通路



# Unconscious proprioceptive pathway

无意识本体感受通路

Superior cerebellar peduncle

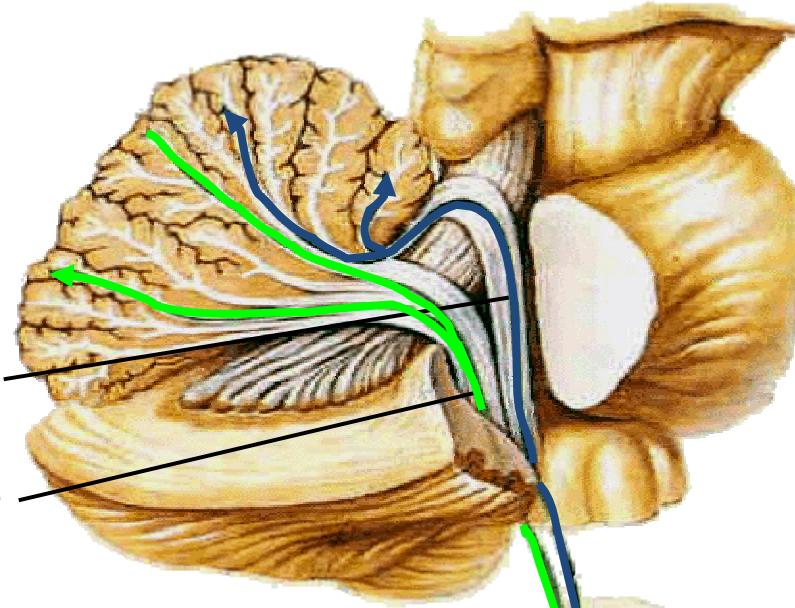
小脑上脚

Inferior cerebellar peduncle

小脑下脚

Posterior spinocerebellar tract  
后脊髓小脑束

Spinal ganglion  
脊神经节

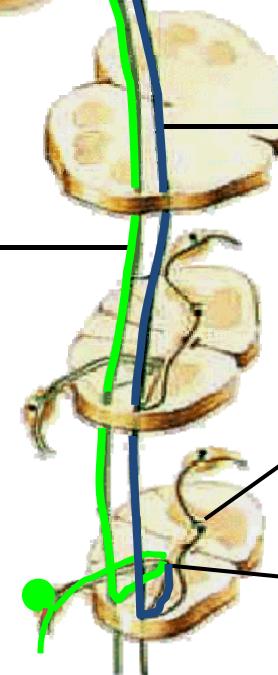


Anterior  
Spinocerebellar  
tract

前脊髓小脑束

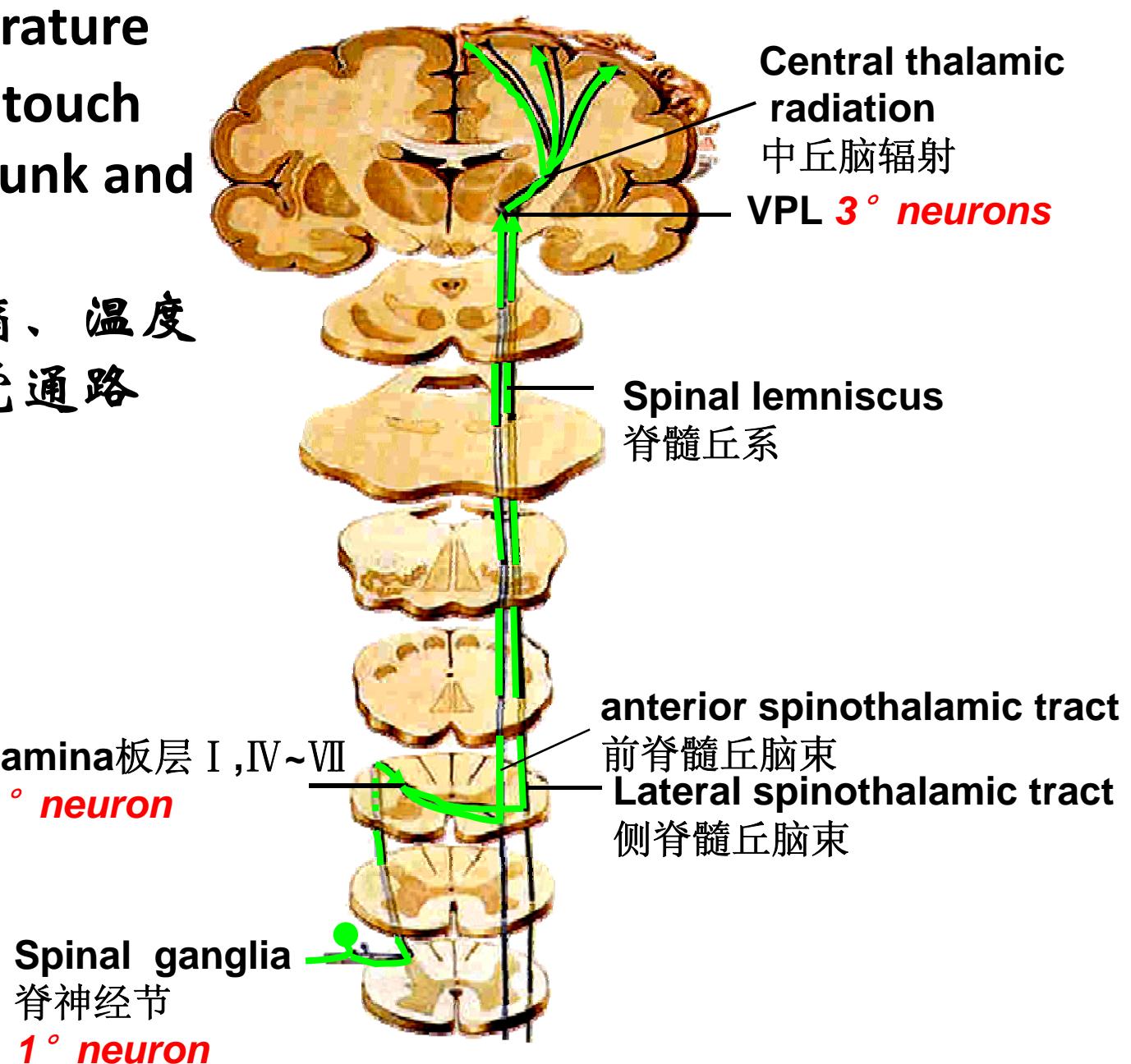
Lamina V-VII  
板层

Nucleus  
thoracicus  
胸核



# Pain, temperature and simple touch pathway of trunk and limbs

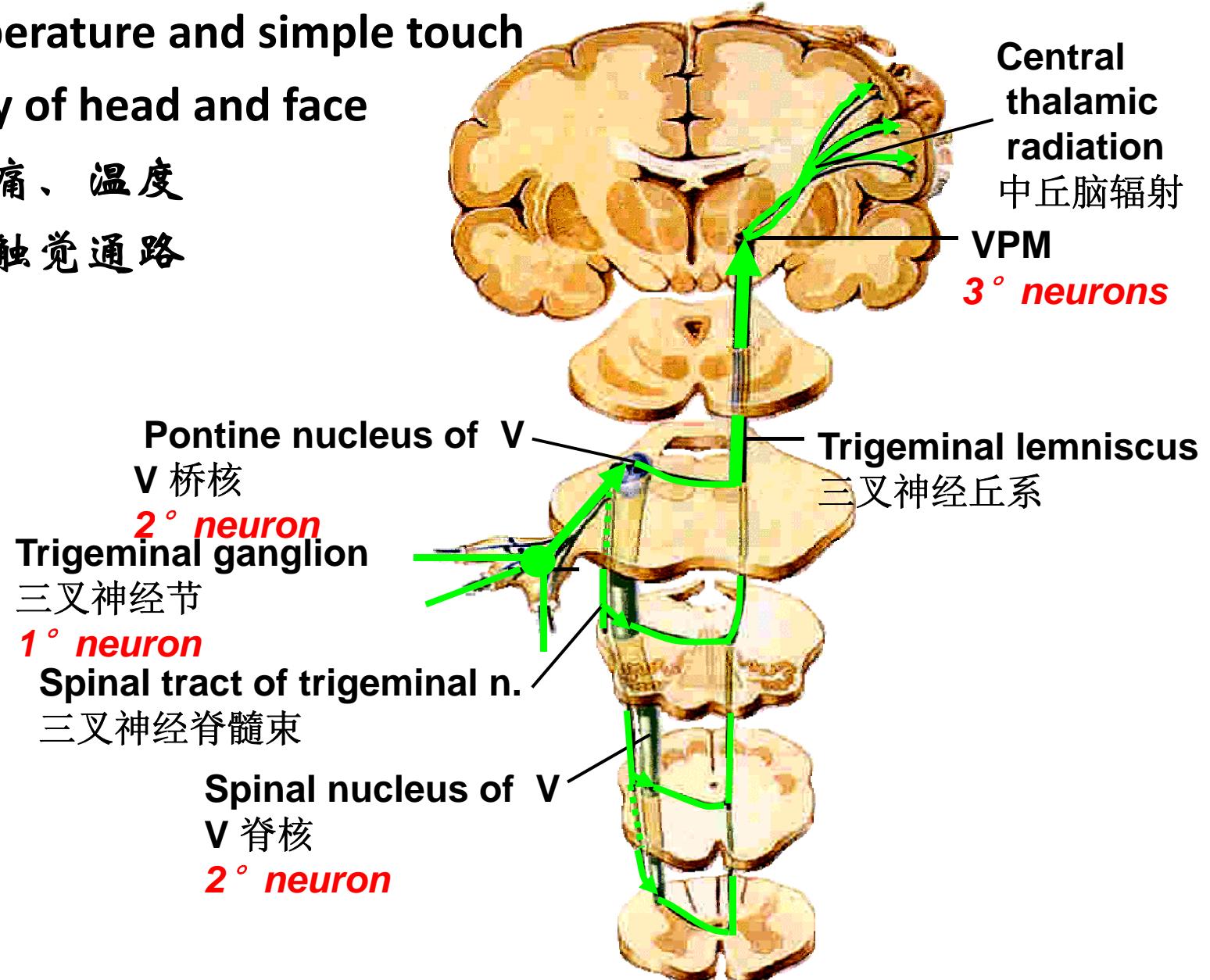
躯干和四肢痛、温度  
和简单触觉通路



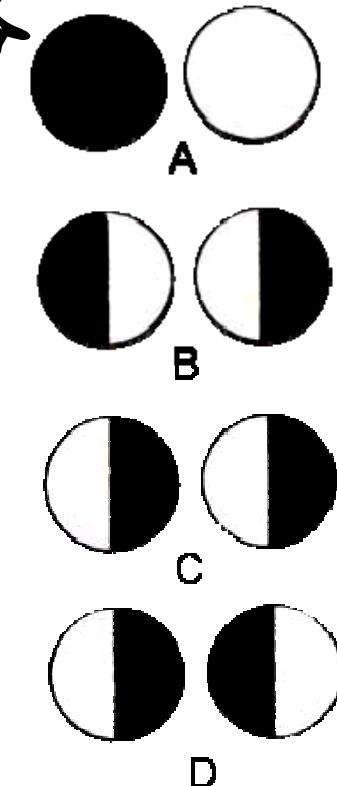
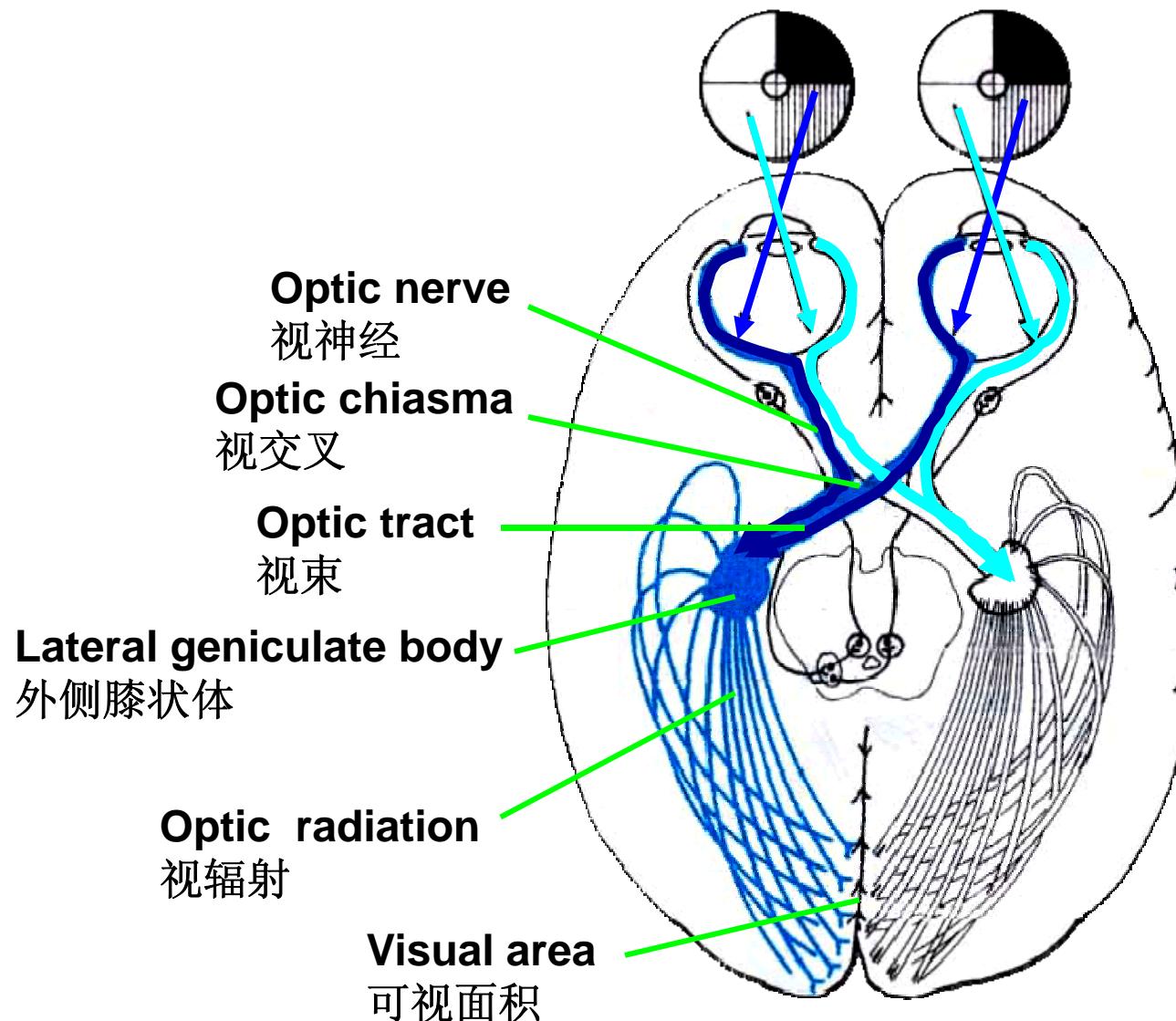
# Pain, temperature and simple touch

## pathway of head and face

头面部痛、温度  
和简单触觉通路



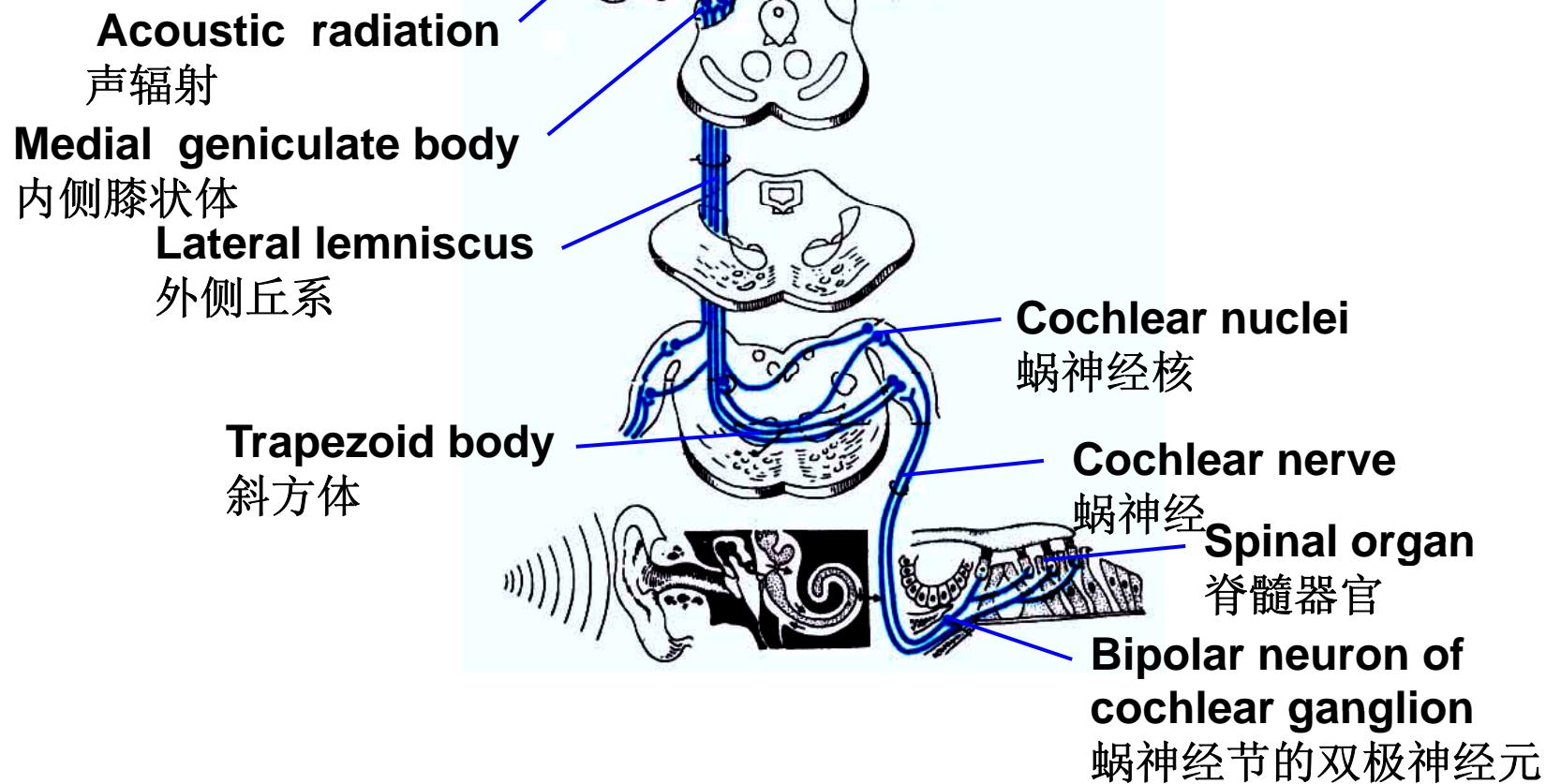
# Visual pathway 视通路



# Auditory pathway

## 听觉通路

Transverse temporal gyrus  
颞横回



# Corticospinal tract

皮层脊髓束

