# RIFLESSI TRONCOENCEFALICI

per le lezioni del prof. P. Paolo Battaglini

v 3.1

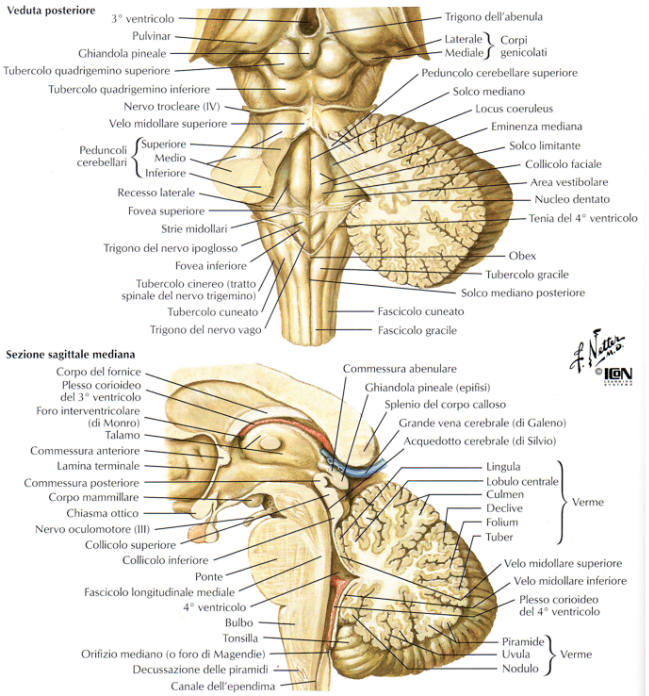
Principali fonti delle figure:

Purves et al., NEUROSCIENZE, Zanichelli
Kandel et al., PRINCIPI DI NEUROSCIENZE, Ambrosiana

## QUADRO GENERALE

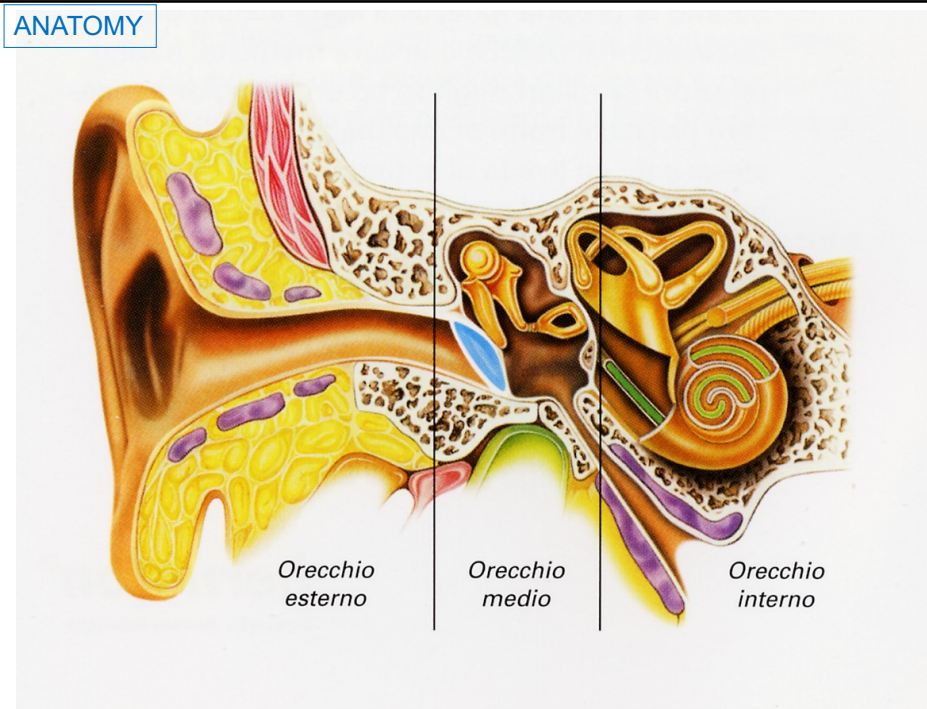
Veduta d'insieme del tronco dell'encefalo
orecchio interno
apparato vestibolare
recettori vestibolari
transduzione sensoriale
vie vestibolari
nistagmo vestibolare
nistagmo optocinetico
movimenti oculari
retina, fovea e macchia cieca
muscoli estrinseci dell'occhio
vie motorie per i movimenti oculari
stabilità della percezione visiva
soppressione saddica
muscoli intrinseci degli occhi
riflessi pupillari
riflesso di orinetamento
vie visive
funzioni visive del collicolo superiore

BRAINSTEM




VESTIBULAR REFLEXS

## ANATOMY




## VESTIBULAR APPARATUS

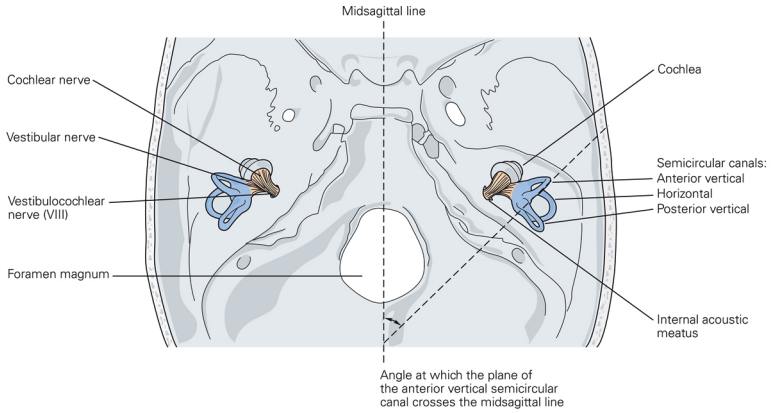
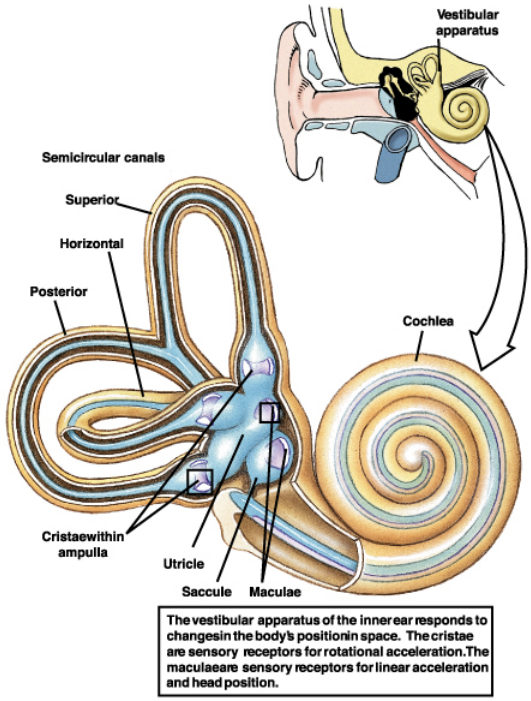


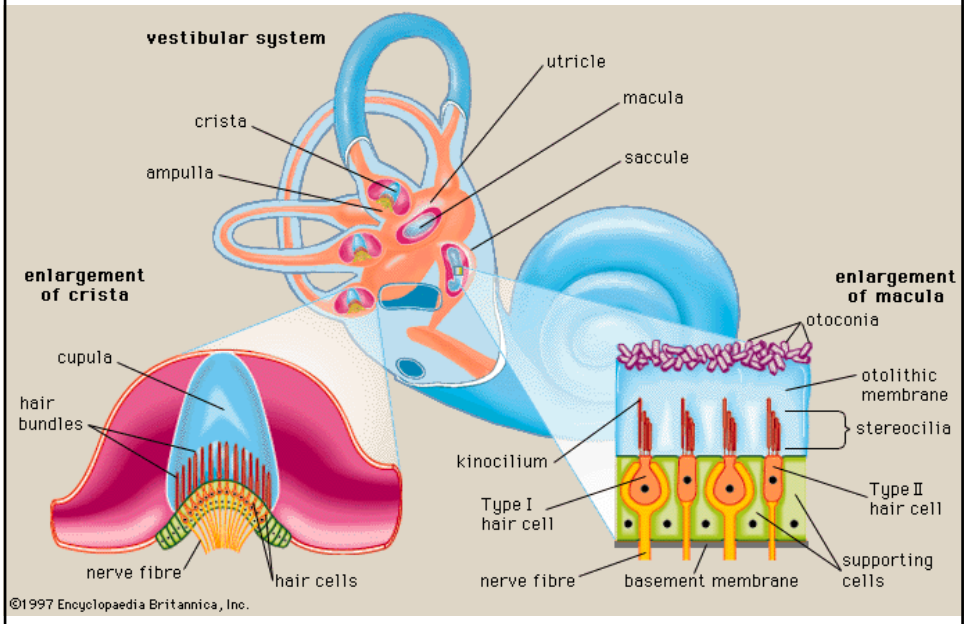

**Figure 40–4 The bilateral symmetry of the semicircular canals.** The horizontal canals on both sides lie in approximately the same plane and therefore are functional pairs. The bilateral vertical canals have a more complex relationship. The anterior canal on one side and the posterior canal on the opposite side lie in parallel planes and therefore constitute a functional pair.

Da Kandel et al., Principles of Neural Sciences, Mc Graw Hill

## INNER EAR




## VESTIBULAR APPARTUS



## MOVEMENTS OF THE CUPOLA

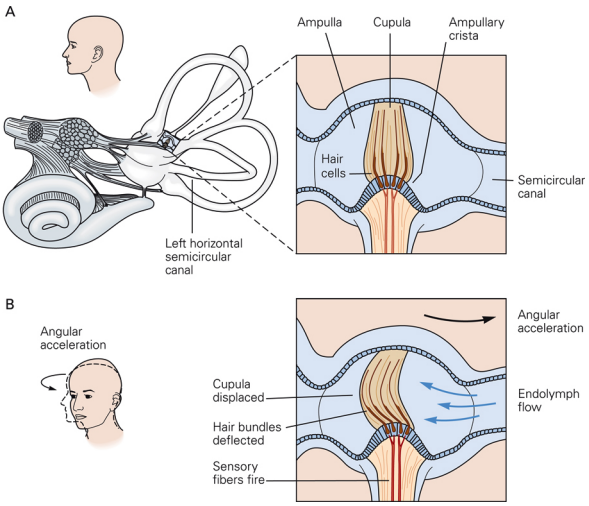



**Figure 40–3** The ampulla of a semicircular canal.

**A.** A thickened zone of epithelium, the ampullary crista, contains the hair cells. The hair bundles of the hair cells extend into a gelatinous diaphragm, the cupula, which stretches from the crista to the roof of the ampulla.

**B.** The cupula is displaced by the flow of endolymph when the head moves. As a result, the hair bundles are also displaced. Their movement is greatly exaggerated in the diagram.

Da Kandel et al., Principles of Neural Sciences, Mc Graw Hill

## HAIR CELLS

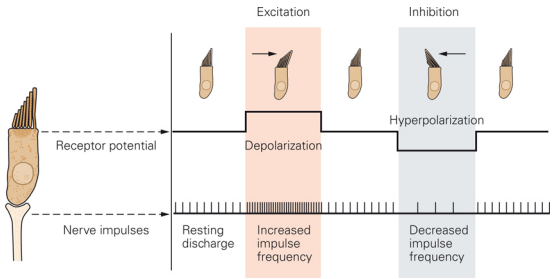
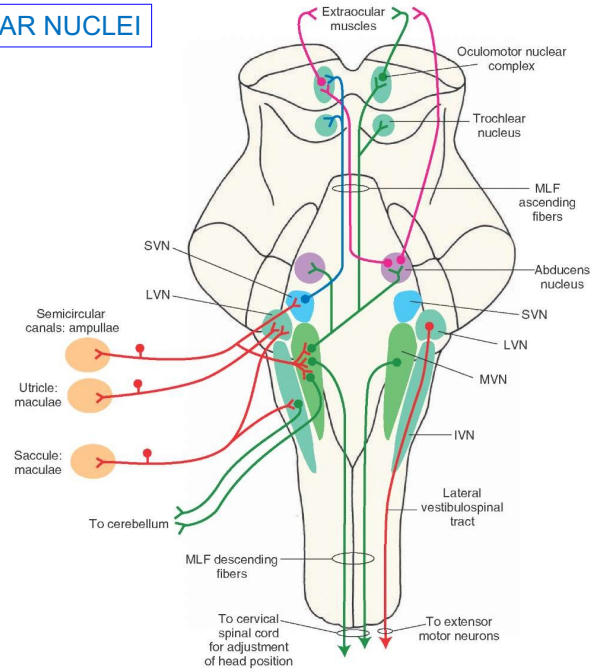



**Figure 40–2** Hair cells in the vestibular labyrinth transduce mechanical stimuli into neural signals. At the apex of each cell is a hair bundle, the stereocilia of which increase in length toward a single kinocilium. The membrane potential of the receptor cell depends on the direction in which the hair bundle is bent. Deflection toward the kinocilium causes the cell to depolarize and thus increases the rate of firing in the afferent fiber. Bending away from the kinocilium causes the cell to hyperpolarize, thus decreasing the afferent firing rate. (Adapted, with permission, from Flock 1965.)

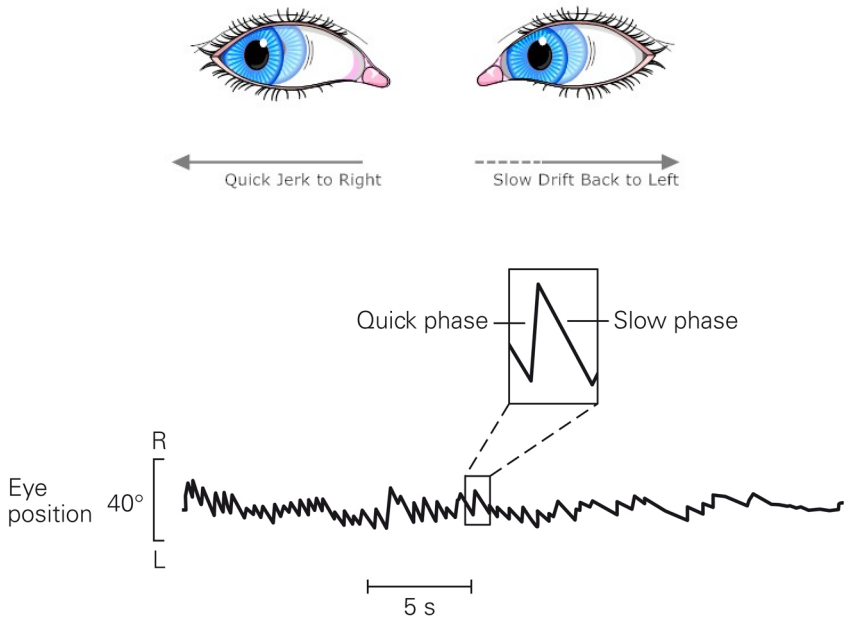
Da Kandel et al., Principles of Neural Sciences, Mc Graw Hill

## VESTIBULAR NUCLEI



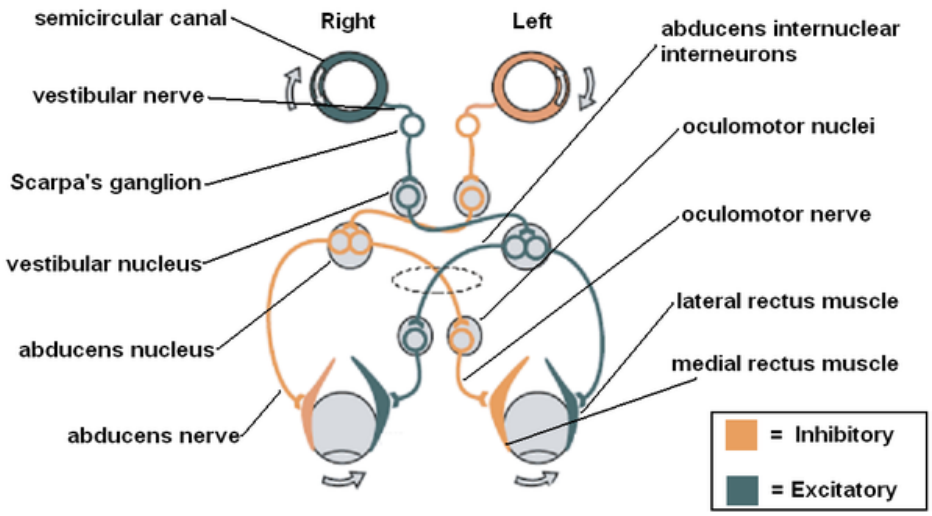

Da Kandel et al., Principles of Neural Sciences, Mc Graw Hill

## VESTIBULAR NYSTAGMUS

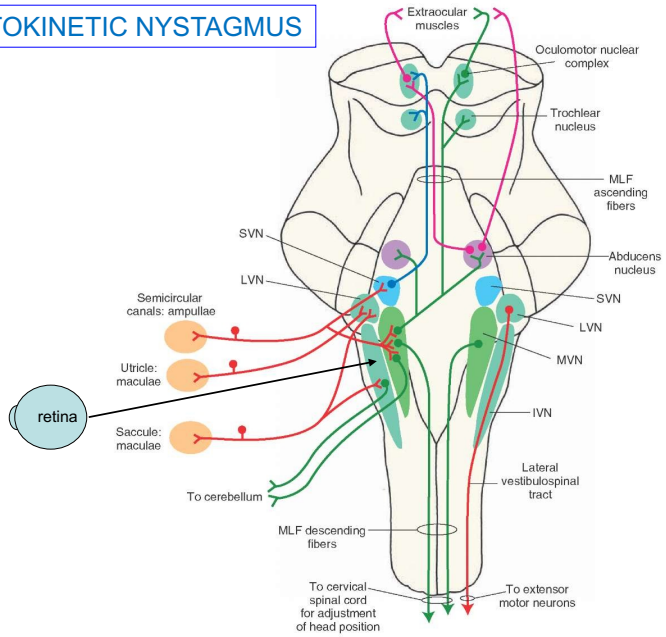



Da Kandel et al., Principles of Neural Sciences, Mc Graw Hill

## VESTIBULAR NYSTAGMUS




## OPTOKINETIC NYSTAGMUS



## VESTIBULAR CORTEX

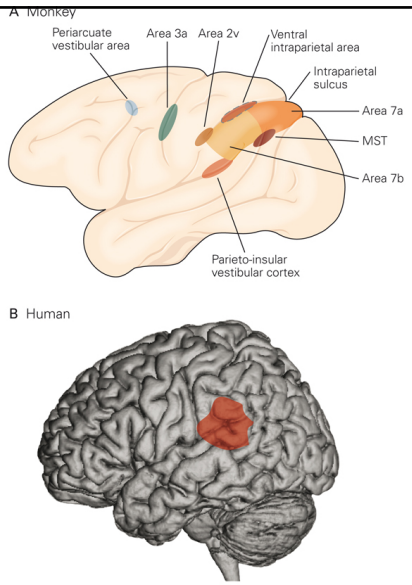



**Figure 40–13** The vestibular cortex.

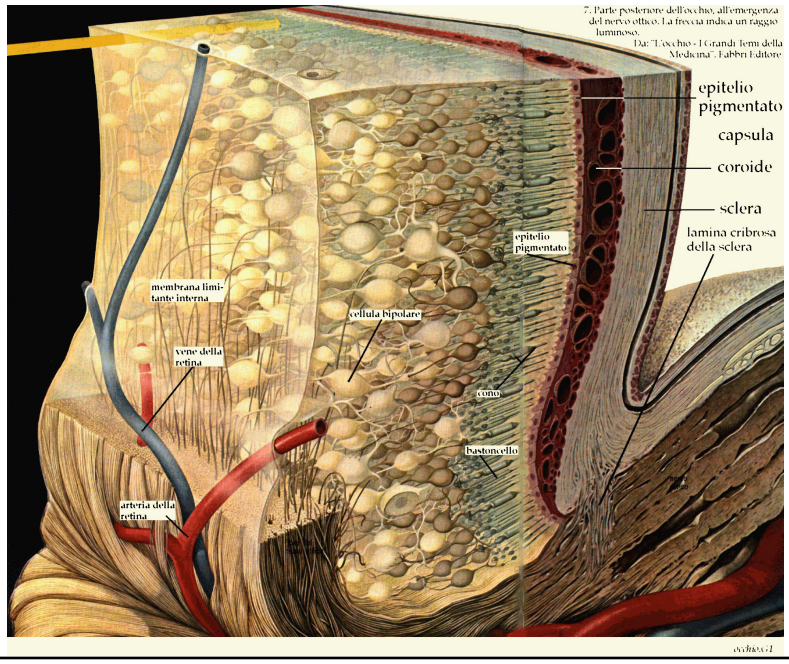
A. This lateral view of a monkey's brain shows the areas of cerebral cortex in which vestibular responses have been recorded. (MST, medial superior temporal area.)

B. Areas of human cortex that respond selectively to galvanic stimulation of the vestibular system. (Adapted, with permission, from Brandt and Dietrich 1999.)

Da Kandel et al., Principles of Neural Sciences, Mc Graw Hill

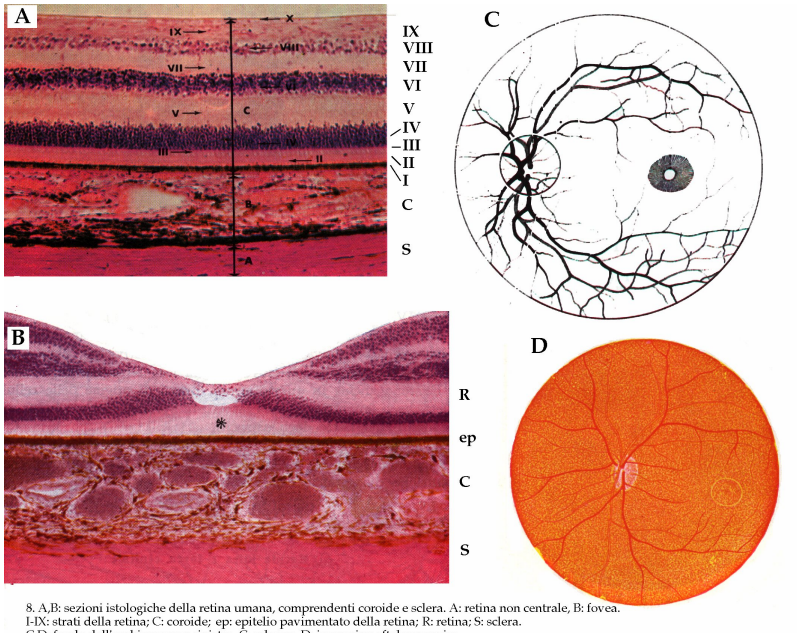
## EYE MOVEMENTS

## RETINA




7. Parte posteriore dell'occhio, all'emergenza del nervo ottico. La freccia indica un raggio luminoso.
Da: "L'occhio - I Grandi Temi della Medicina", Fabbri Editore

## FOVEA



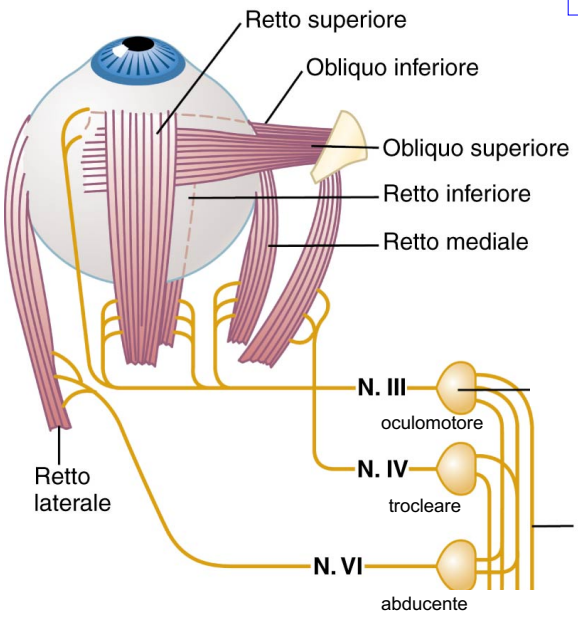

8. A,B: sezioni istologiche della retina umana, comprendenti coroide e sclera. A: retina non centrale, B: fovea.
I-IX: strati della retina; C: coroide; ep: epitelio pavimentato della retina; R: retina; S: sclera.
C,D: fondo dell'occhio umano sinistro. C: schema. D: immagine oftalmoscopica.
A: da "L'occhio, i Grandi Temi della Medicina", Fabbri Editore. B, D: da G. Chiarugi, "Istituzioni di Anatomia dell'Uomo". Vallardi Editore. C: da "Enciclopedia Medica". USES.

occhio.L1

## FOVEA

n m l i h g f e d c b a 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 a b c d e f g h i l m n
n m l i h g f e d c b a 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 a b c d e f g h i l m n
n m l i h g f e d c b a 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 a b c d e f g h i l m n
n m l i h g f e d c b a 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 a b c d e f g h i l m n
n m l i h g f e d c b a 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 a b c d e f g h i l m n
n m l i h g f e d c b a 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 a b c d e f g h i l m n
n m l i h g f e d c b a 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 a b c d e f g h i l m n
n m l i h g f e d c b a 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 a b c d e f g h i l m n
n m l i h g f e d c b a 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 a b c d e f g h i l m n
n m l i h g f e d c b a 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 a b c d e f g h i l m n
n m l i h g f e d c b a 9 8 7 6 5 4 3 2 1 o 1 2 3 4 5 6 7 8 9 a b c d e f g h i l m n
n m l i h g f e d c b a 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 a b c d e f g h i l m n
n m l i h g f e d c b a 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 a b c d e f g h i l m n
n m l i h g f e d c b a 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 a b c d e f g h i l m n
n m l i h g f e d c b a 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 a b c d e f g h i l m n
n m l i h g f e d c b a 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 a b c d e f g h i l m n
n m l i h g f e d c b a 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 a b c d e f g h i l m n
n m l i h g f e d c b a 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 a b c d e f g h i l m n
n m l i h g f e d c b a 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 a b c d e f g h i l m n
n m l i h g f e d c b a 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 a b c d e f g h i l m n

## EXTRAOCULAR MUSCLES

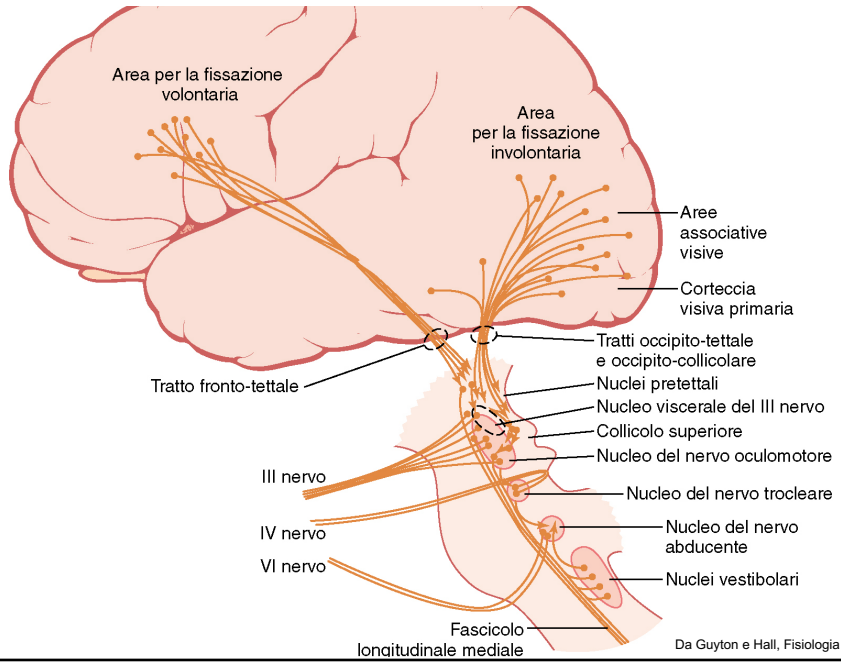



SMALL EYE MOVEMENTS
tremors
drifts
micro-saccades

LARGE EYE MOVEMENTS
vestibular
optocinetic
saccadic
tracking
vergence

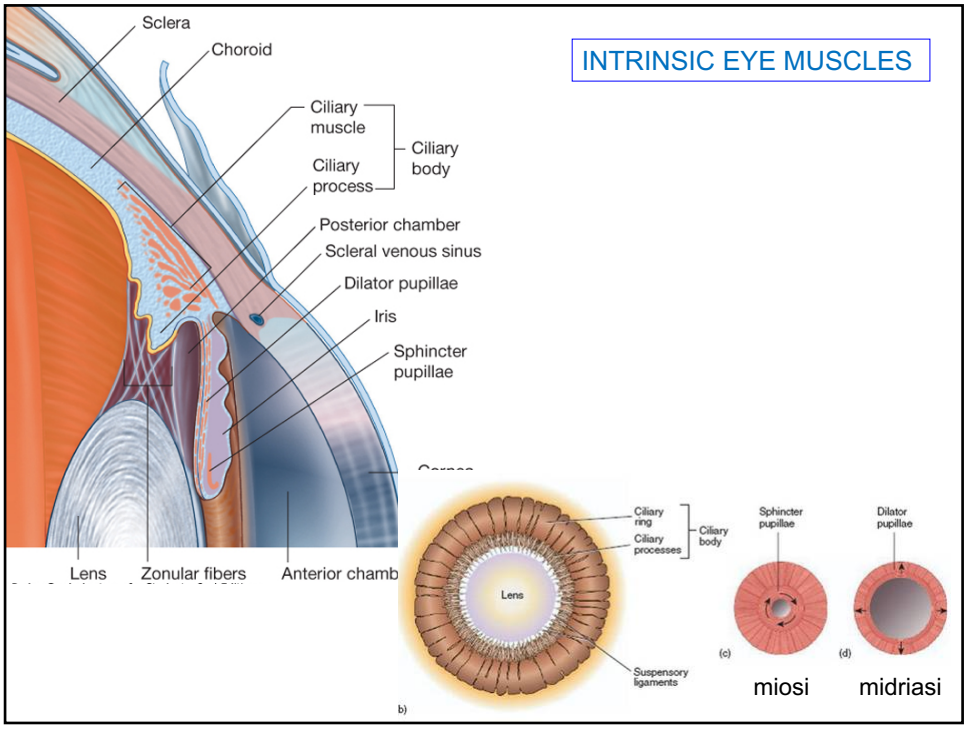
Da Guyton e Hall, Fisiologia medica

## NEURONAL PATHWAYS FOR EYE MOVEMENTS

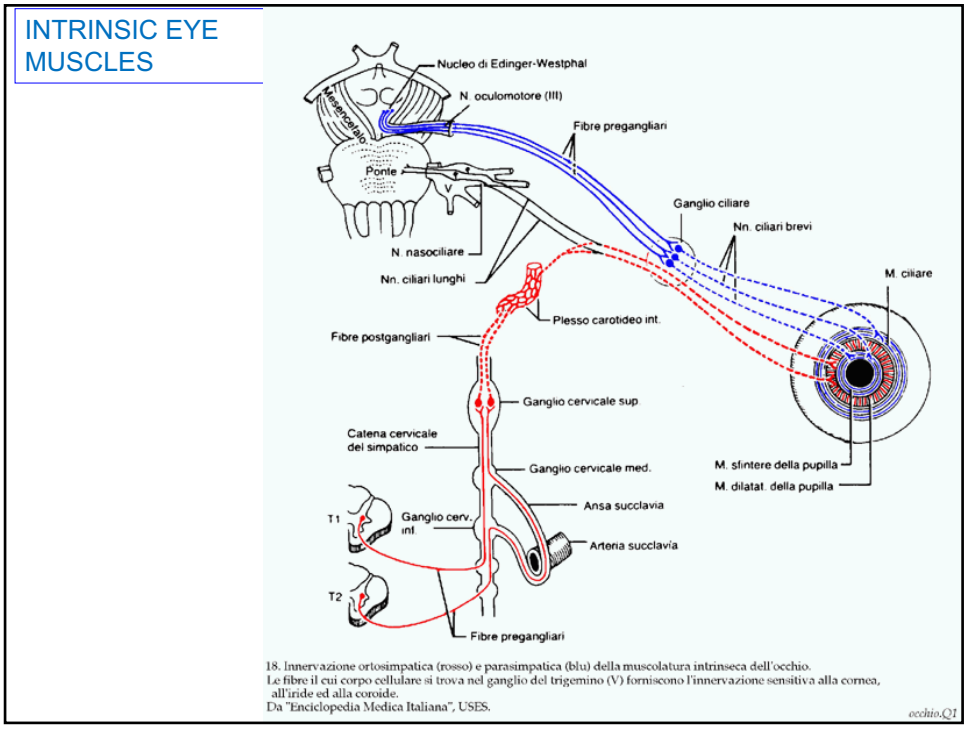



## SOPPRESSIONE SACCADICA

## INTRINSIC EYE MUSCLES



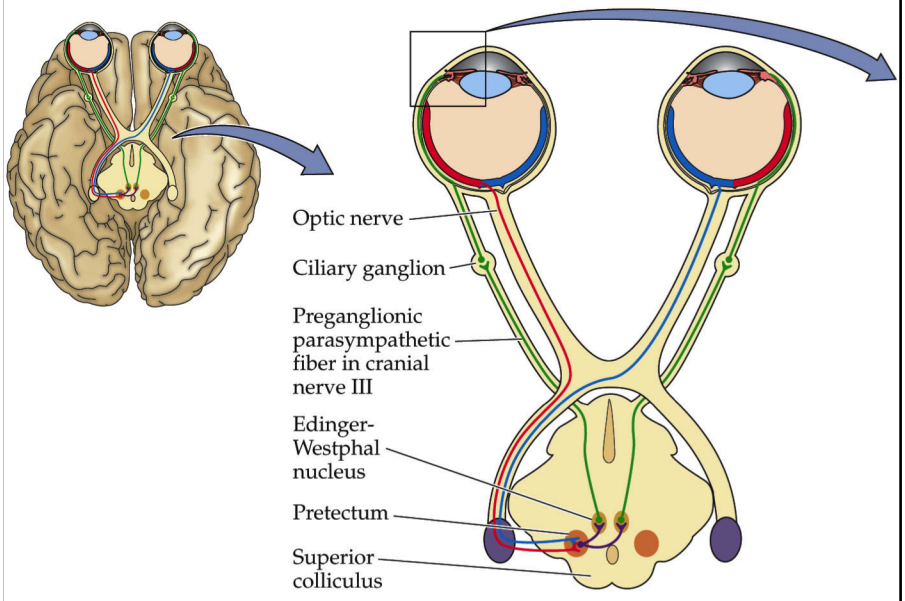

## INTRINSIC EYE MUSCLES




18. Innervazione ortosimpatica (rosso) e parasimpatica (blu) della muscolatura intrinseca dell'occhio. Le fibre il cui corpo cellulare si trova nel ganglio del trigemino (V) forniscono l'innervazione sensitiva alla cornea, all'iride ed alla coroide.
Da "Enciclopedia Medica Italiana", USES.

occhio.Q1

LIGHT REFLEX

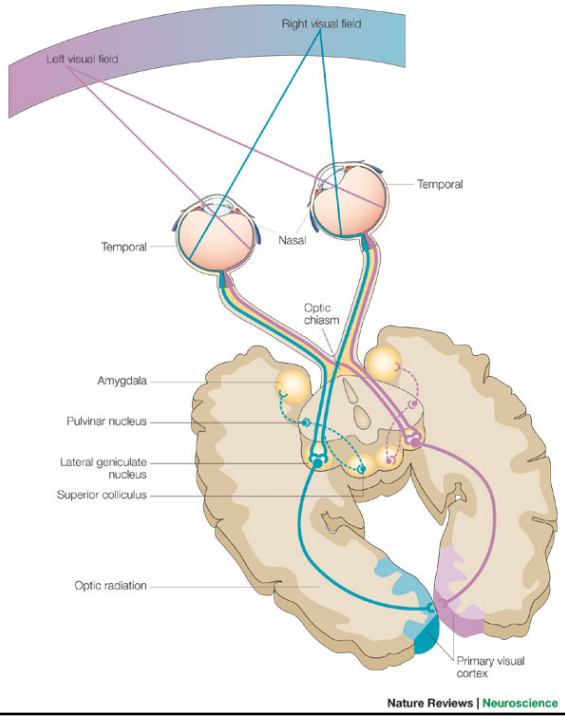



***NEUROSCIENCE, Fourth Edition*, Figure 12.2 (Part 1)**



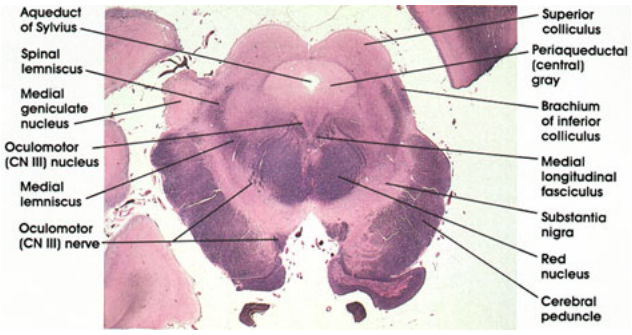
ORIENTING REFLEX

## VISUAL PATHWAYS




## SUPERIOR COLLICULUS

The mammalian superior colliculus (SC) constitutes a major node in processing sensory information, incorporating cognitive factors, and issuing motor commands. The resulting action of orienting toward or away from a stimulus can be accomplished as an integrated movement across oculomotor, cephalomotor, and skeletomotor effectors. The SC also participates in preserving fixation during intersaccadic intervals. [Gandhi and Katnani, Annu. Rev. Neurosci. 2011. 34:205-31]




Many researchers have claimed that there is an alignment of auditory, somatosensory, visual and motor maps in the superior colliculus

## SUPERIOR COLLICULUS

The general function of the tectal system is to direct behavioral responses toward specific points in egocentric ("body-centered") space. Each layer of the tectum contains a topographic map of the surrounding world in retinotopic coordinates, and activation of neurons at a particular point in the map evokes a response directed toward the corresponding point in space. The tectum is also involved in generating spatially directed head turns and arm-reaching movements.

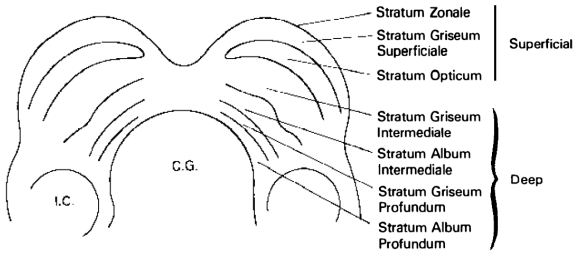



*Figure 1* Alternating fiber and cell layers of monkey superior colliculus. A drawing of a coronal section through the colliculus is shown. The seven layers indicated on the right are divided into three layers designated as the superficial division and four layers designated as the deep division. I. C., inferior colliculus; C. G., central gray.

[From Wurtz RH and Albano JA, Annu. Rev. Neurosci. 1980.3:189-226]