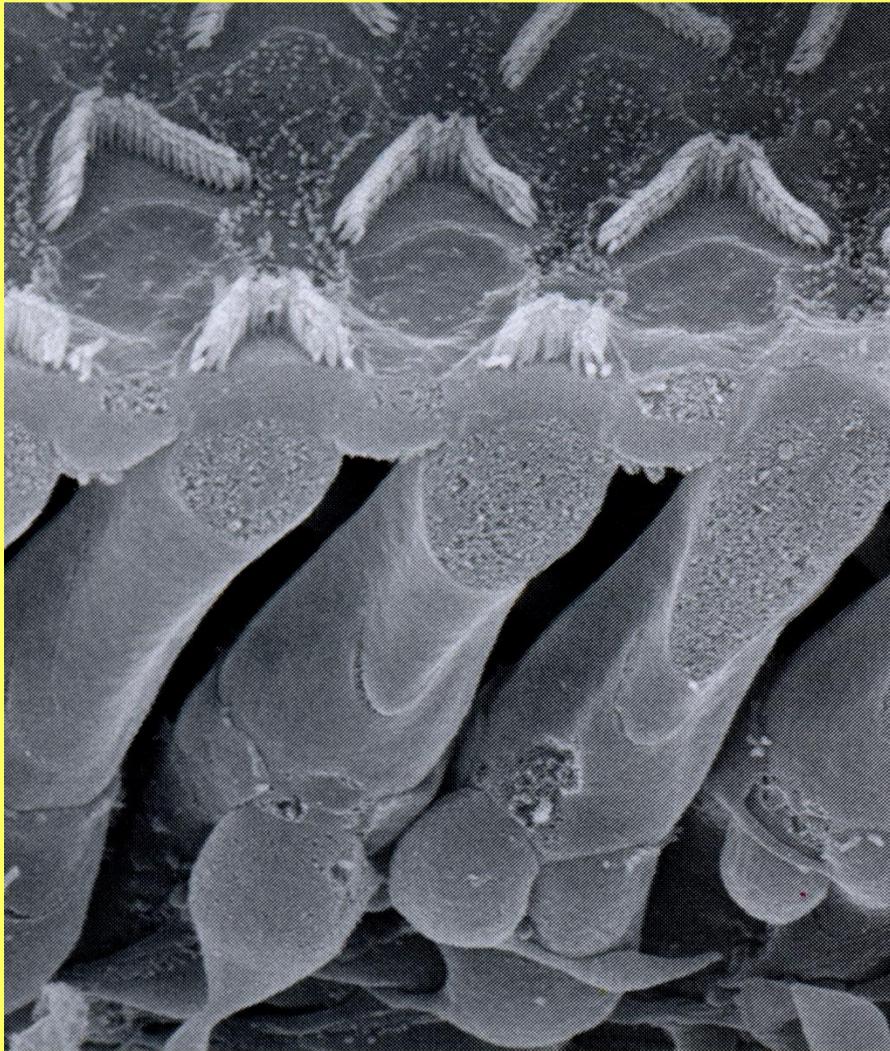


Transdução e análise da informação sensorial: Receptores Sensoriais

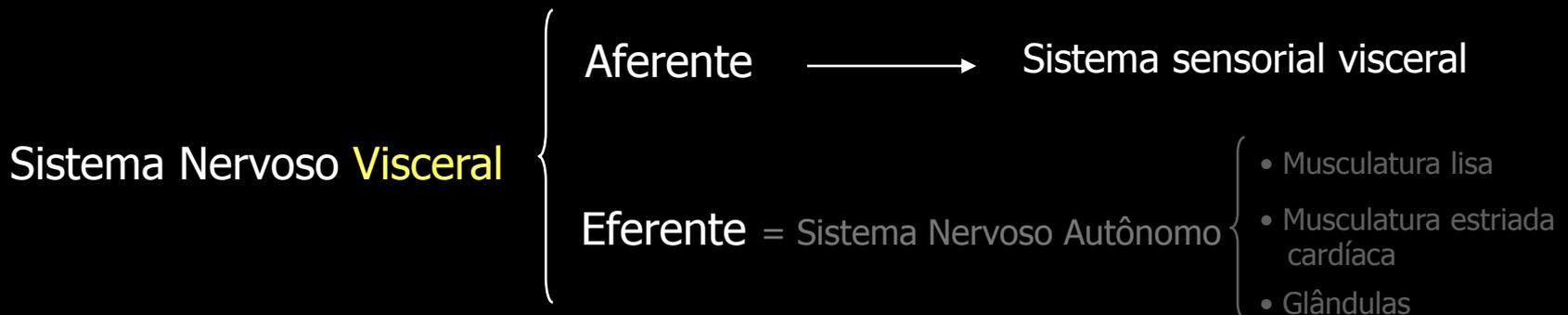
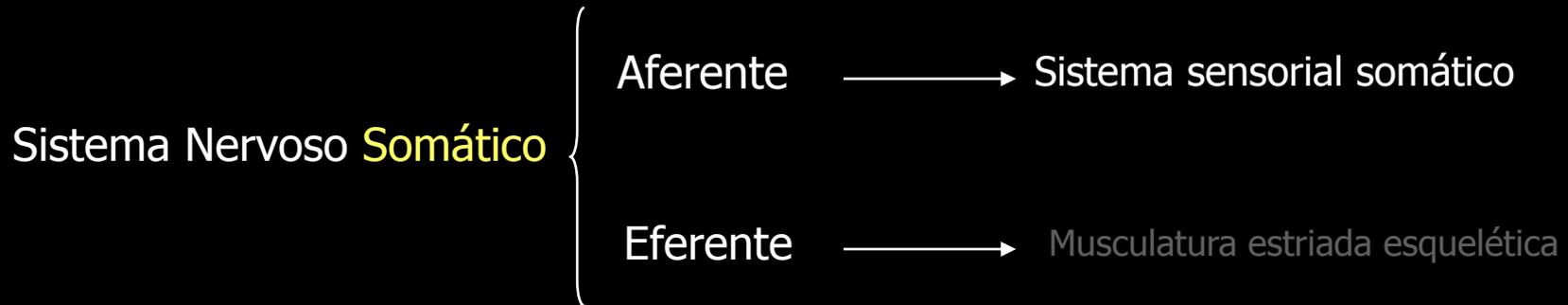


Prof. Guilherme Lucas
FMRP-USP

**Por que esta aula é importante para
o curso de Fisioterapia?**

Sistema Nervoso Somático x Visceral

Critério funcional

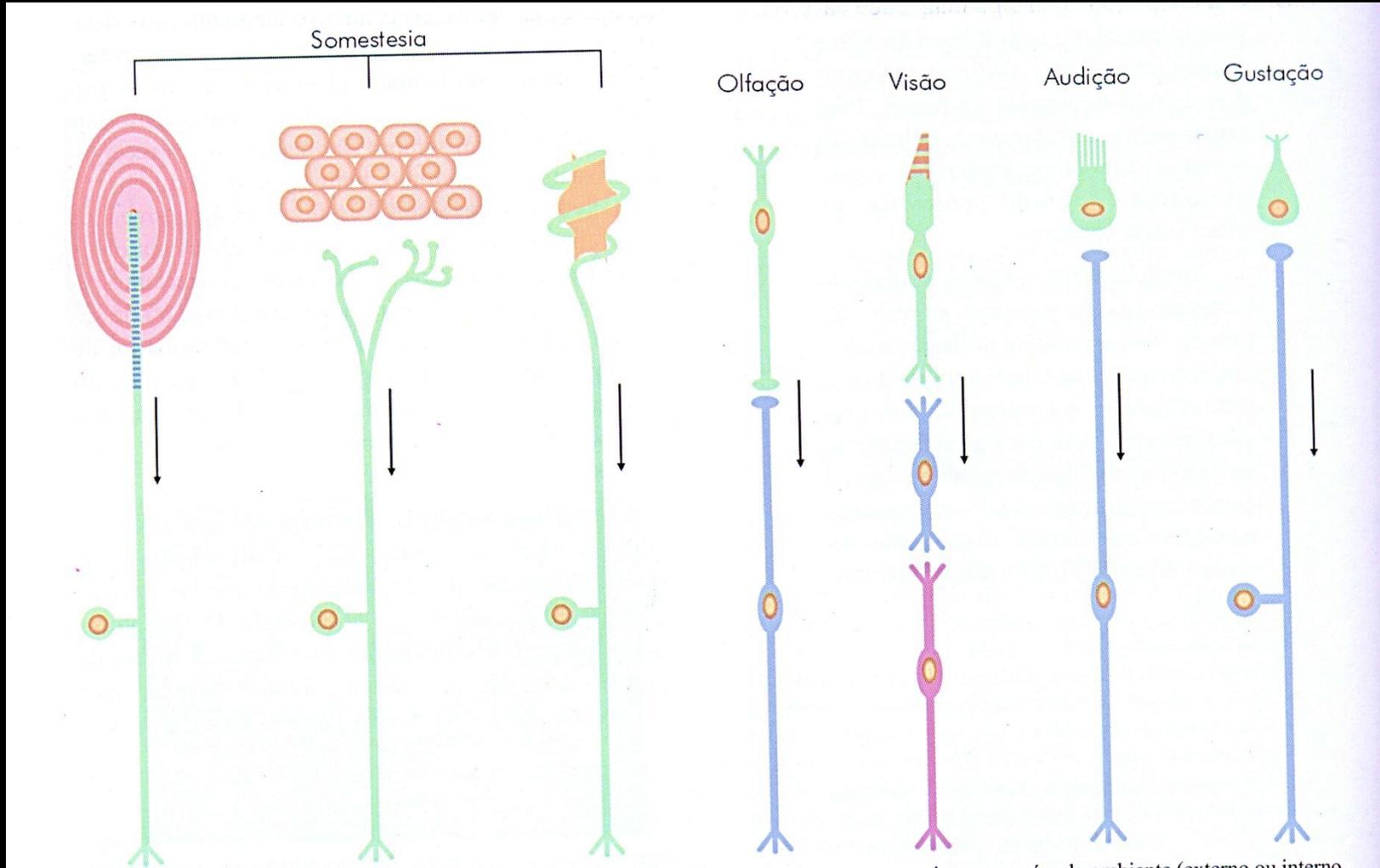


Conceitos

- 1 – **Sensação**: capacidade de codificar aspectos da energia física e química que nos circunda.
- 2 - **Sistemas sensoriais**: conjunto de regiões do SN que possibilitam a codificação das sensações
- 3 - **Modalidades sensoriais**: visão, audição, somestesia (tato?), gustação, olfação.
- 4 - **Submodalidades sensoriais**
- 5- **Receptores sensoriais**
- 6 – **Transdução** (potencial receptor → potencial de ação)
- 7 – **Codificação**

Tipos de receptores e sistemas sensoriais no homem

[Tato, sensibilidade térmica,
dor, propriocepção]



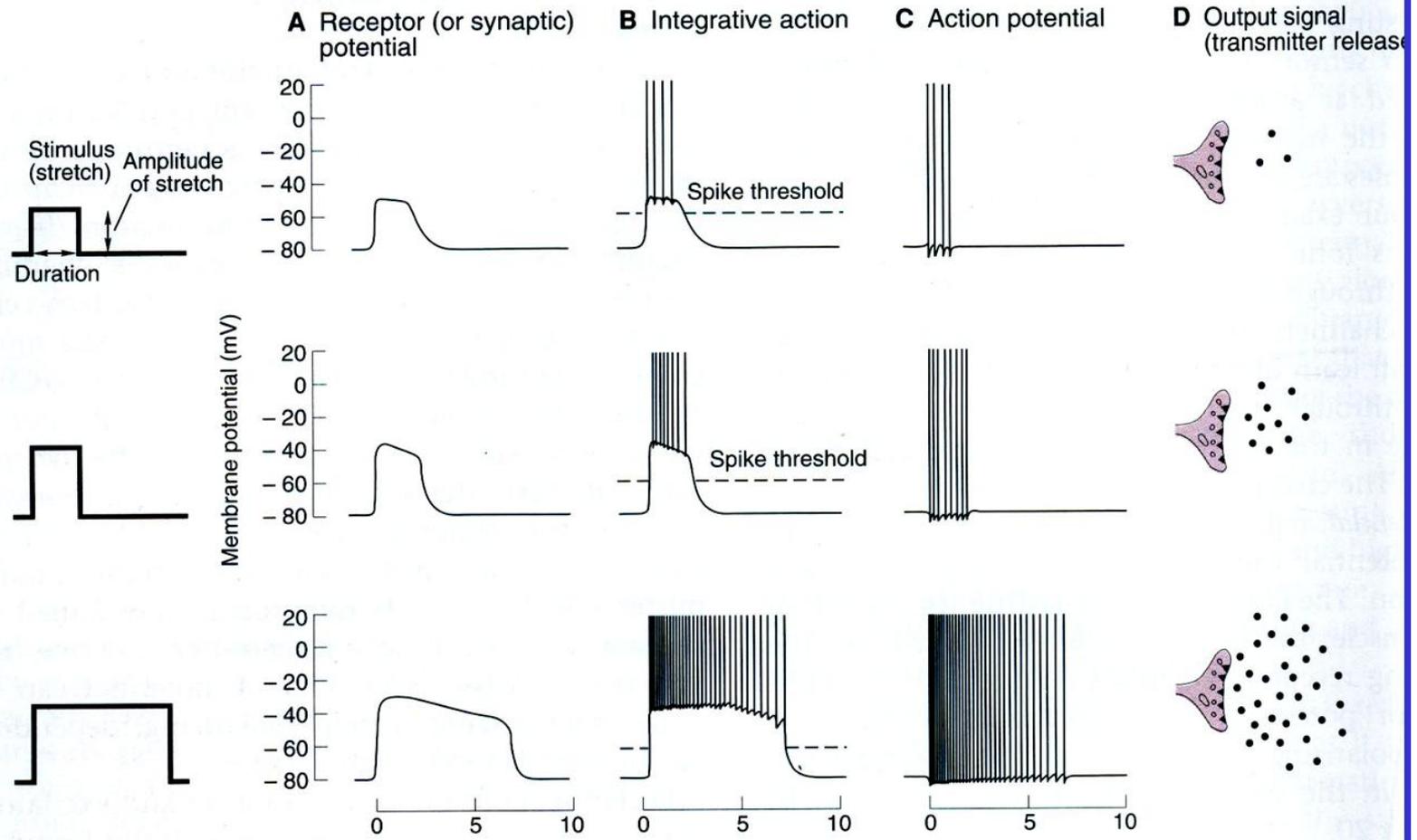
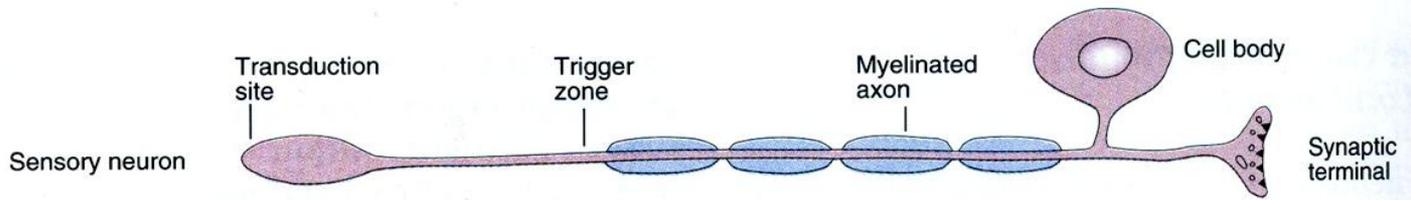
...do ambiente (externo ou interno)

Tipos de receptores e sistemas sensoriais no homem

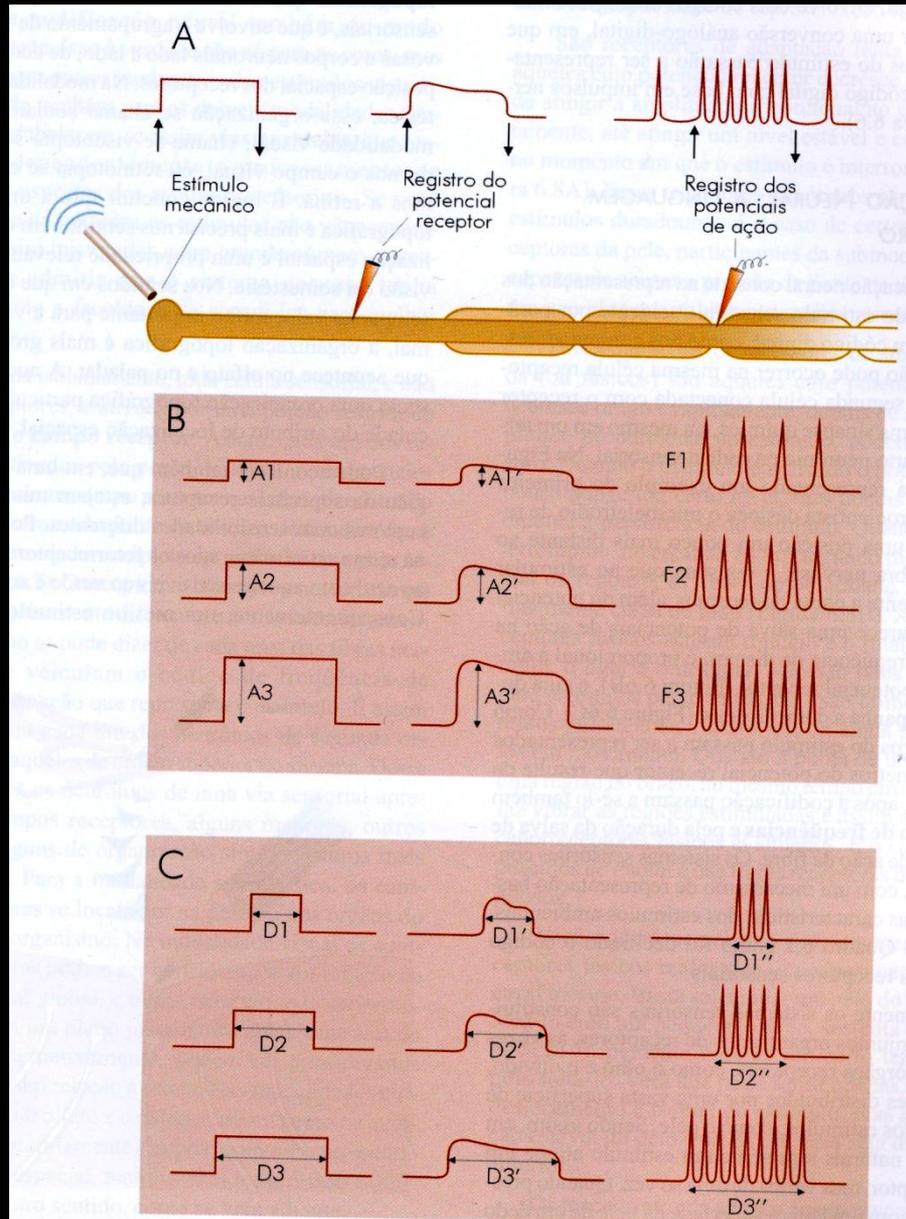
<i>Modalidade</i>	<i>Submodalidade</i>	<i>Estímulo Específico</i>	<i>Órgão Receptor</i>	<i>Tipo Funcional</i>	<i>Tipo Morfológico</i>
Visão	Todas	Luz	Olho	Fotorreceptores	Cones e bastonetes
Audição	Todas	Vibrações mecânicas do ar	Ouvido	Mecanoceptores auditivos	Células ciliadas da cóclea
Somestesia	Tato	Estímulos mecânicos	—	Mecanoceptores	Neurônios ganglionares da raiz dorsal
	Sensibilidade térmica	Calor e frio	—	Termoceptores	Neurônios ganglionares da raiz dorsal
	Dor	Estímulos mecânicos, térmicos e químicos intensos	—	Nociceptores	Neurônios ganglionares da raiz dorsal
	Propriocepção	Movimentos e posição estática do corpo	Fuso muscular, órgão tendinoso	Mecanoceptores	Neurônios ganglionares da raiz dorsal
Olfato	Todas	Substâncias químicas	Nariz	Quimioceptores	Neurônios da mucosa olfatória
Paladar	Todas	Substâncias químicas	Boca	Quimioceptores	Células das papilas gustativas

Receptores com Funções de Controle

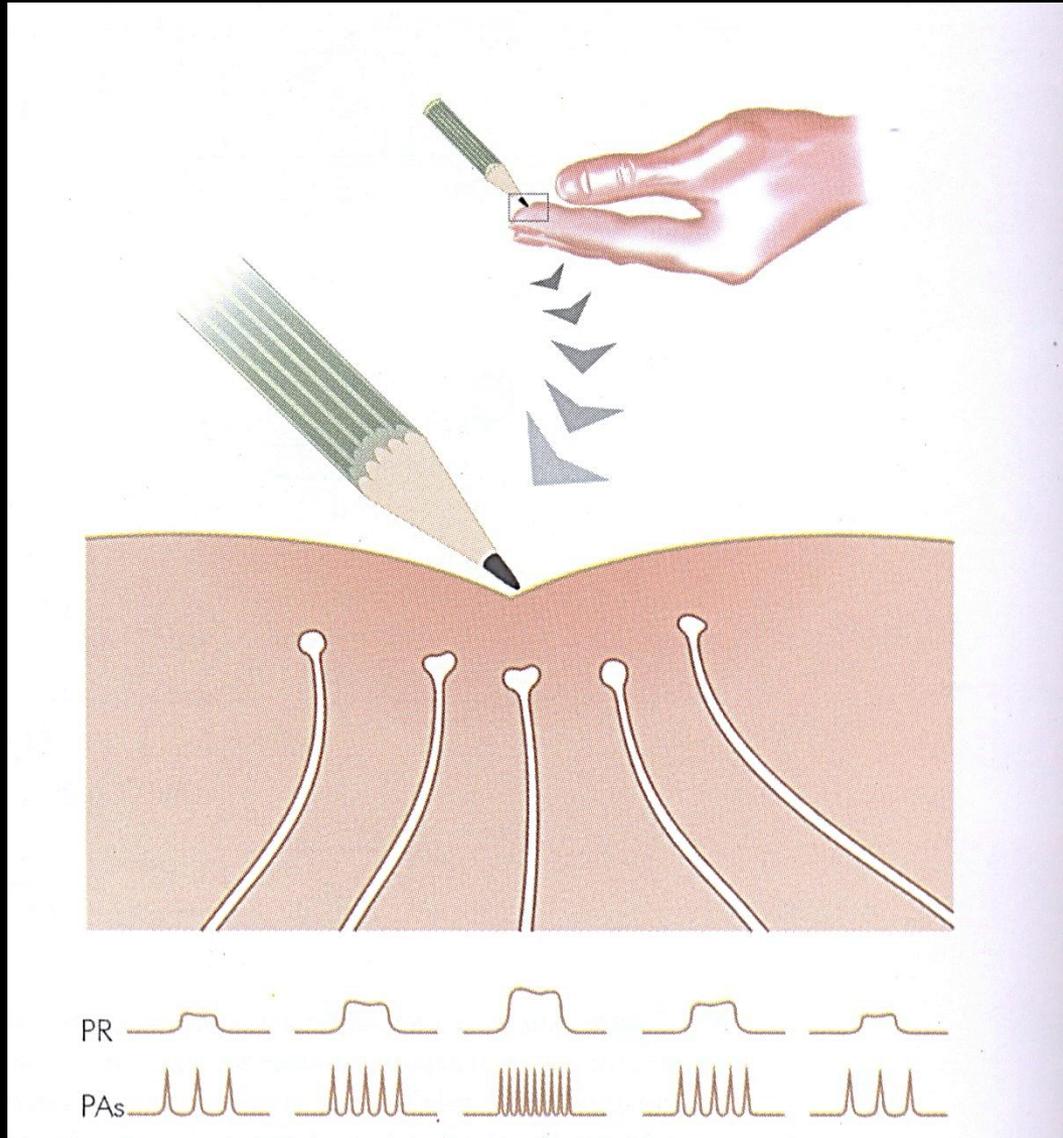
<i>Função</i>	<i>Estímulo Específico</i>	<i>Órgão Receptor</i>	<i>Tipo Funcional</i>	<i>Tipo Morfológico</i>
Equilíbrio	Posição e movimentos da cabeça	Labirinto	Mecanoceptores	Células ciliadas do labirinto
Controle motor	Estiramento muscular	Fuso muscular	Mecanoceptores	Neurônios ganglionares da raiz dorsal
Controle motor	Tensão muscular	Órgão tendinoso	Mecanoceptores	Neurônios ganglionares da raiz dorsal
Controle motor	Ângulo articular	—	Mecanoceptores	Neurônios ganglionares da raiz dorsal
Controle cardíovascular	Pressão sanguínea	Seio carotídeo	Mecanoceptores (Baroceptores)	Neurônios do tronco encefálico
Controle cardiorrespiratório	pH, pCO ₂ , pO ₂	—	Quimioceptores	Neurônios do hipotálamo
Controle da hidratação (sede)	Concentração sanguínea de Na ⁺ (osmolaridade)	Órgãos circunventriculares	Quimioceptores (Natrioceptores)	Neurônios do hipotálamo e tronco encefálico
Controle da alimentação (fome)	Concentração sanguínea de nutrientes	Órgãos circunventriculares	Quimioceptores	Neurônios do hipotálamo e tronco encefálico
Controle da temperatura corporal	Temperatura do sangue	Órgãos circunventriculares	Termoceptores	Neurônios do hipotálamo e tronco encefálico
Controle da digestão	Distensão visceral	—	Mecanoceptores	Neurônios do tronco encefálico



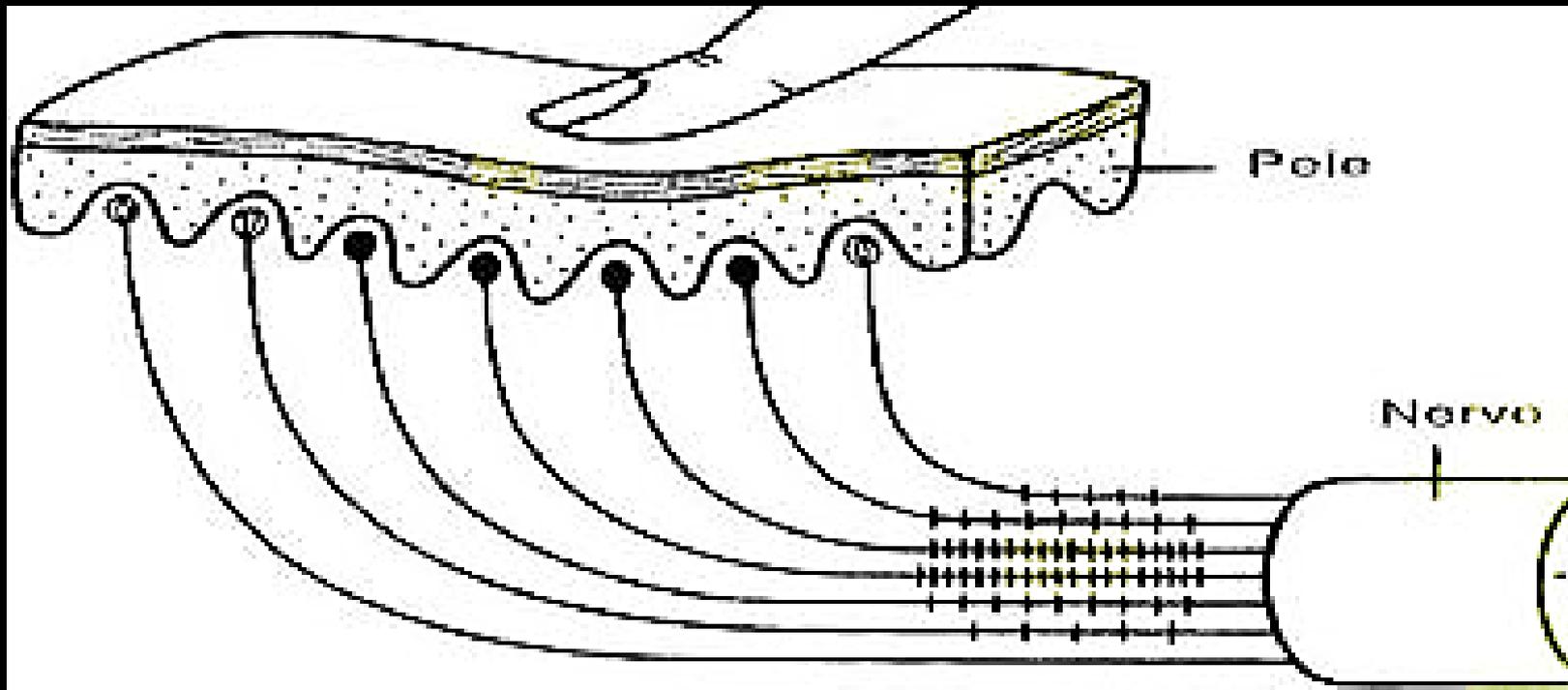
Código de frequências



Código de frequências

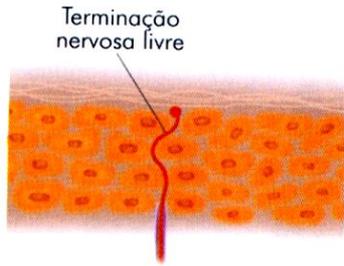


Código de frequências



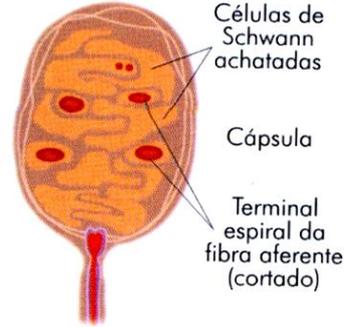
Tipo morfológicos de receptores sensoriais cutâneos

1



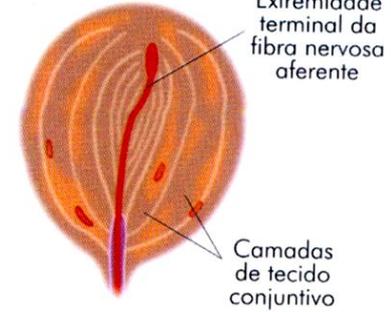
2

Corpúsculo de Meissner



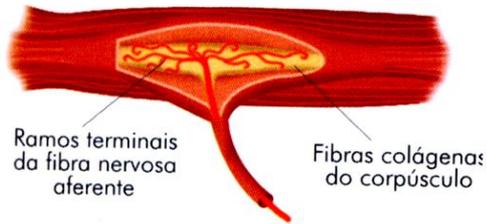
3

Corpúsculo de Pacini



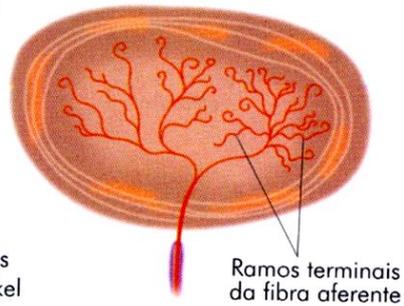
4

Corpúsculo de Ruffini



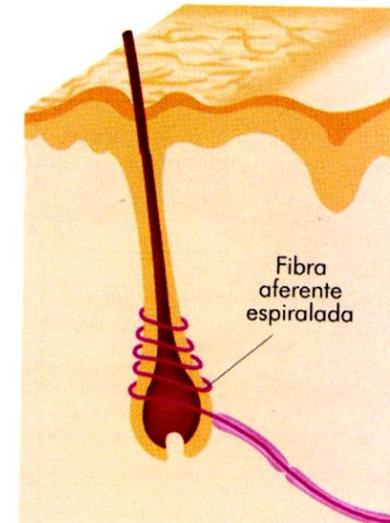
6

Bulbo de Krause



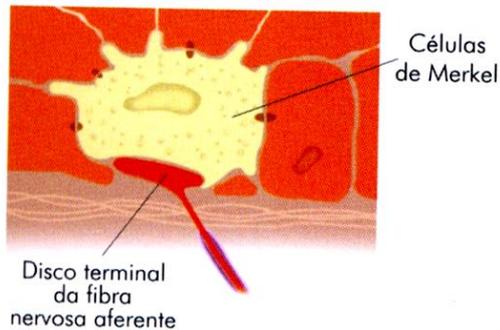
7

Folículo piloso

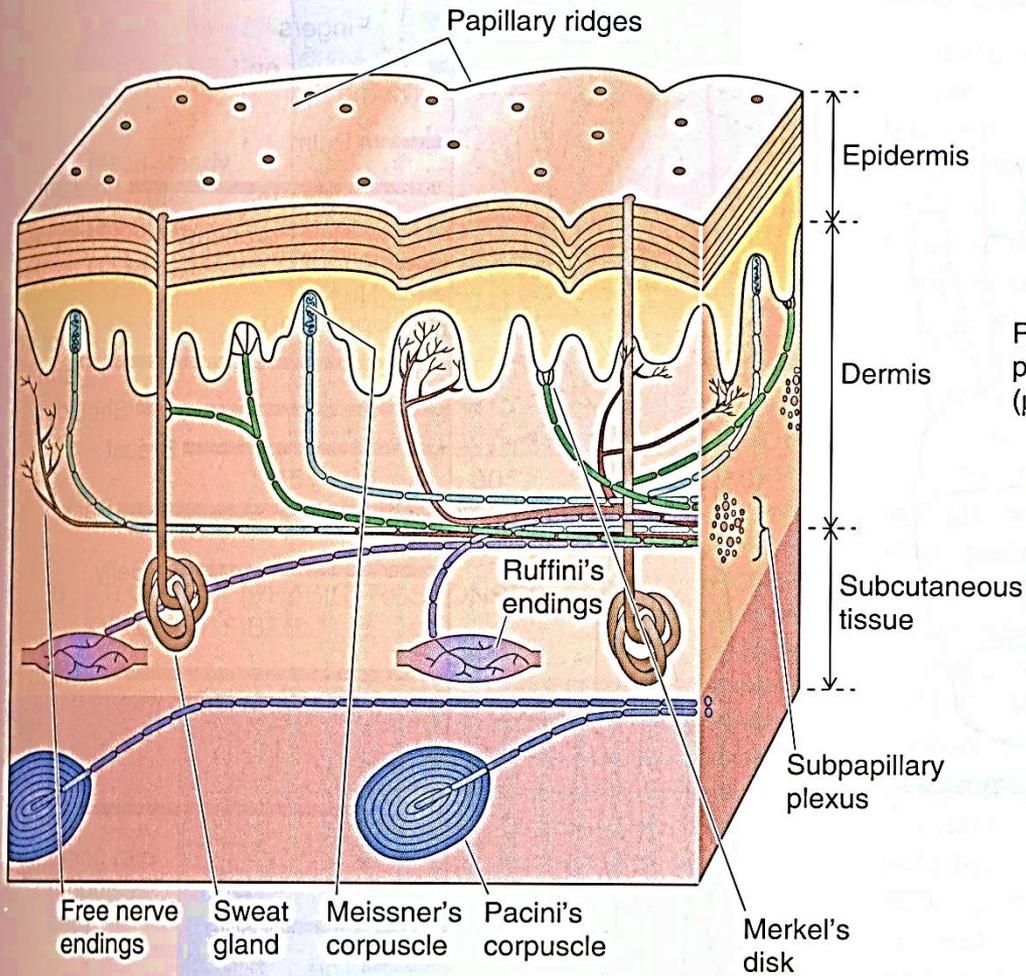


5

Disco de Merkel



A GLABROUS (HAIRLESS) SKIN



B PACINI'S CORPUSCLE

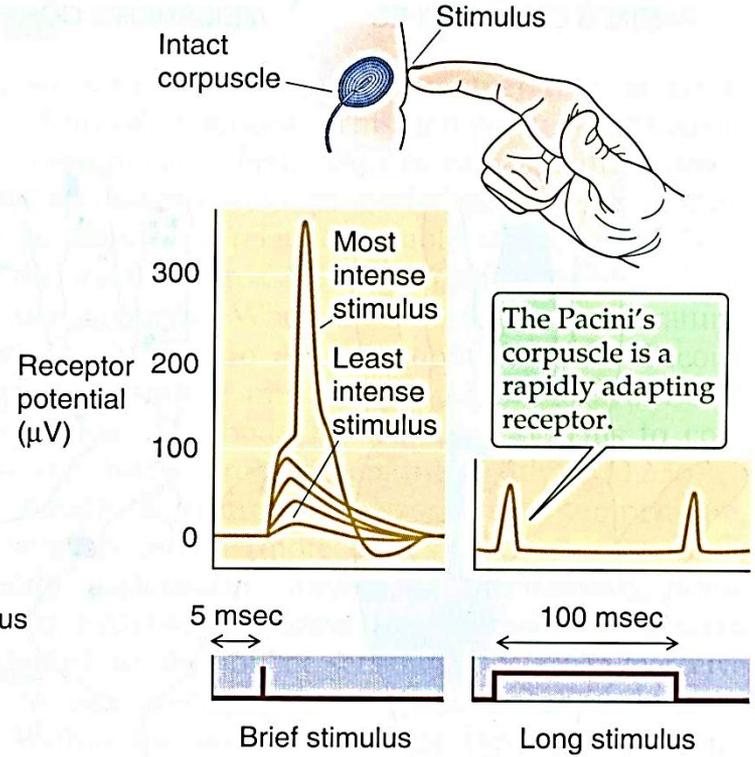
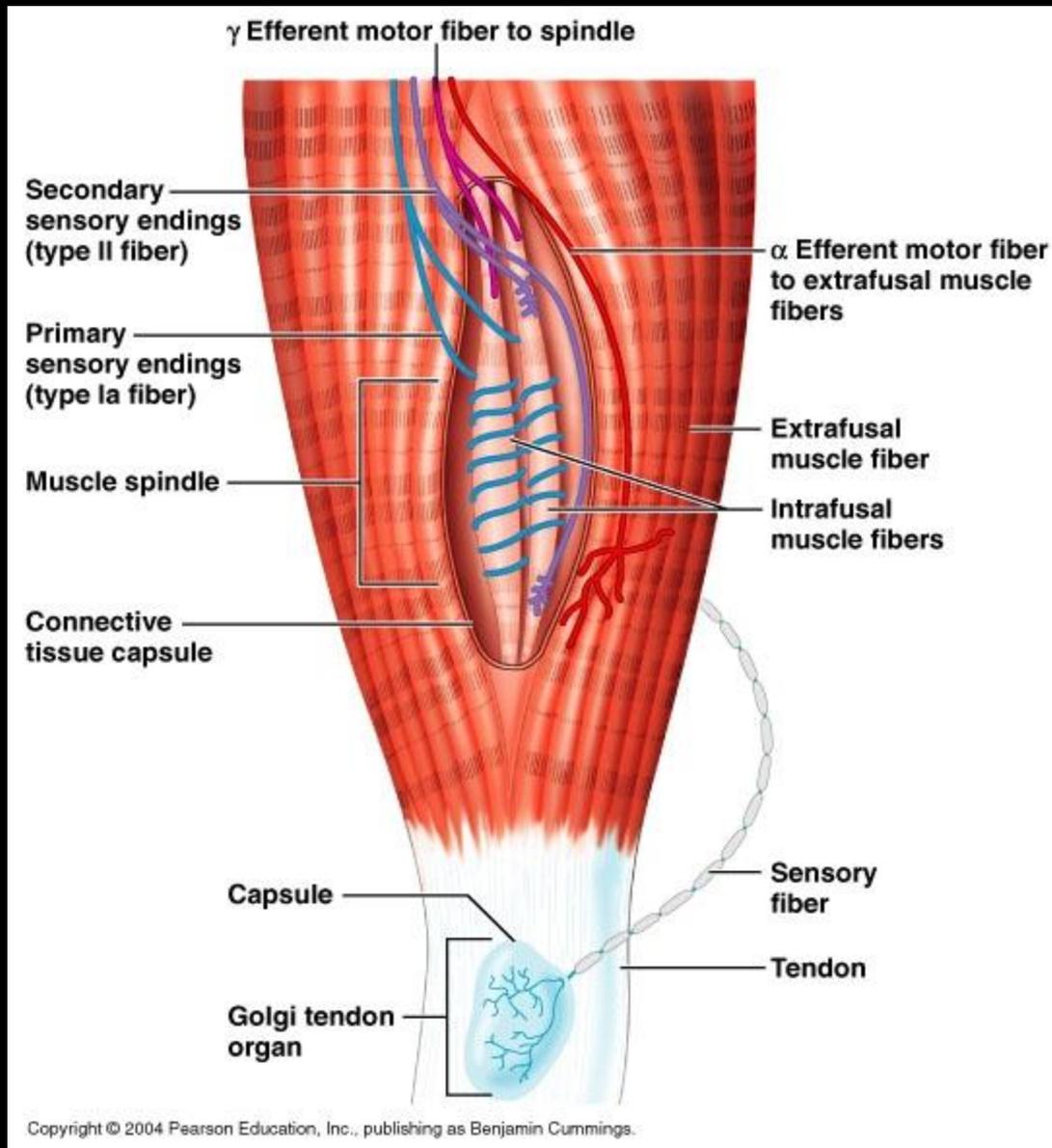


FIGURE 13-23. Sensors in the skin.

Orgão tendinoso de Golgi e Fuso intramuscular



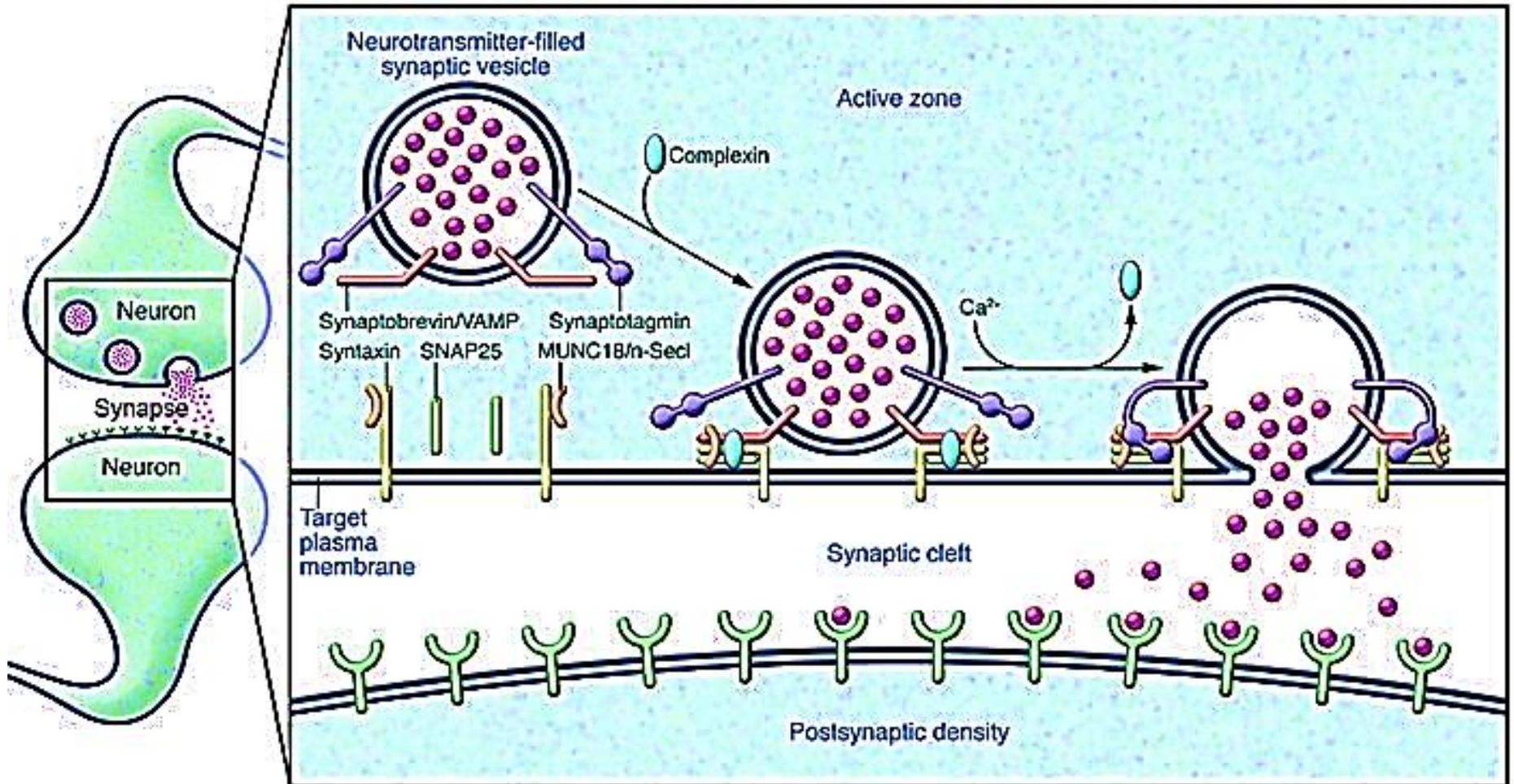
Sensory fiber types

Type	Erlanger-Gasser Classification	Diameter (μm)	Myelin	Conduction velocity	Associated sensory receptors
Ia	A α	13-20	Yes	80–120 m/s	Primary receptors of muscle spindle
Ib	A α	13-20	Yes	80–120 m/s	Golgi tendon organ
II	A β	6-12	Yes	33–75 m/s	Secondary receptors of muscle spindle All cutaneous mechanoreceptors
III	A δ	1-5	Thin	3–30 m/s	Free nerve endings of touch and pressure Nociceptors of neospinothalamic tract Cold thermoreceptors
IV	C	0.2-1.5	No	0.5-2.0 m/s	Nociceptors of paleospinothalamic tract Warmth receptors

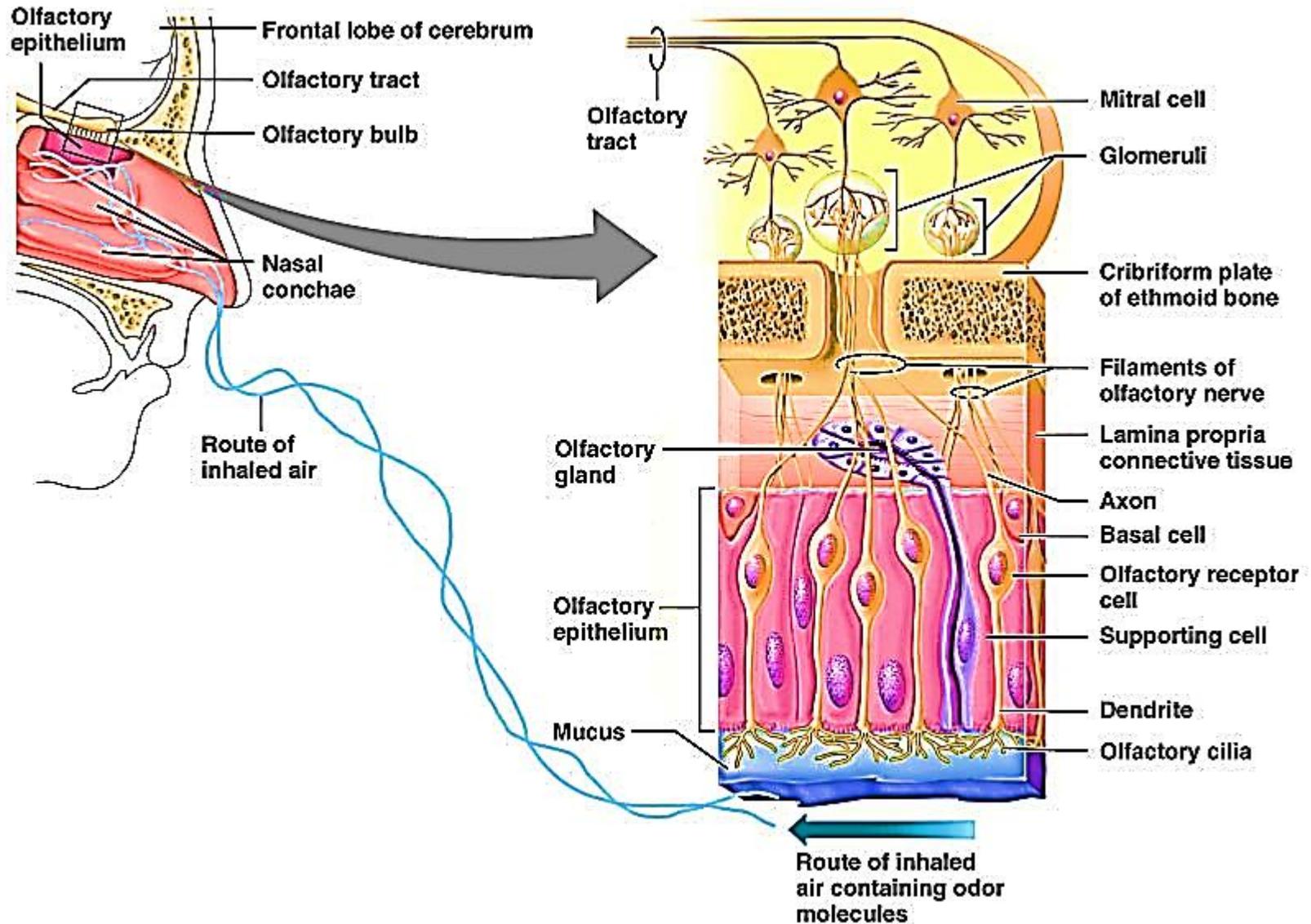
Os receptores de sensibilidade corporal

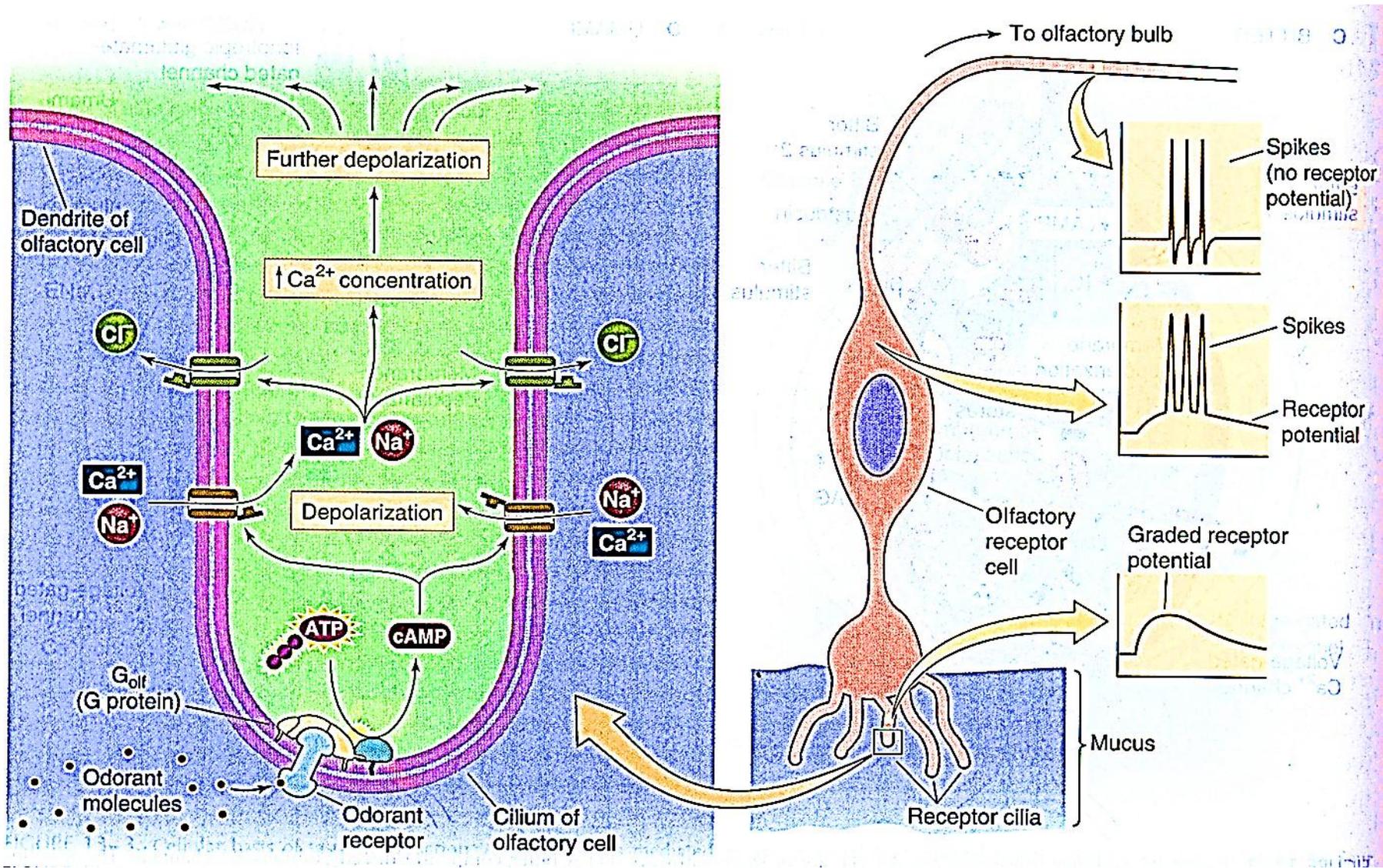
<i>Tipo Morfológico</i>	<i>Transdução</i>	<i>Tipo de Fibra*</i>	<i>Localização</i>	<i>Função</i>	<i>Adaptação</i>
Terminações livres	Mecanoelétrica, Termoelétrica, Quimioelétrica	C, A δ	Toda a pele, órgãos internos, vasos sanguíneos, articulações	Dor, temperatura, tato grosseiro, propriocepção	Lenta
Corpúsculos de Meissner	Mecanoelétrica	A β	Epiderme glabra	Tato, pressão vibratória	Rápida
Corpúsculos de Pacini	Mecanoelétrica	A β	Derme, periósteo, paredes das vísceras	Pressão vibratória	Rápida
Corpúsculos de Ruffini	Mecanoelétrica	A β	Toda a derme	Indentação da pele	Lenta
Discos de Merkel	Mecanoelétrica	A β	Toda a epiderme glabra e pilosa	Tato, pressão estática	Lenta
Bulbos de Krause	Mecanoelétrica	A β	Bordas da pele com as mucosas	Tato?	Lenta?
Folículos pilosos	Mecanoelétrica	A β	Pele pilosa	Tato	Rápida
Órgãos tendinosos de Golgi	Mecanoelétrica	Ib	Tendões	Propriocepção	Lenta
Fusos musculares	Mecanoelétrica	Ia e II	Músculos esqueléticos	Propriocepção	Lenta e rápida

Excitose, cálcio e liberação de neurotransmissor

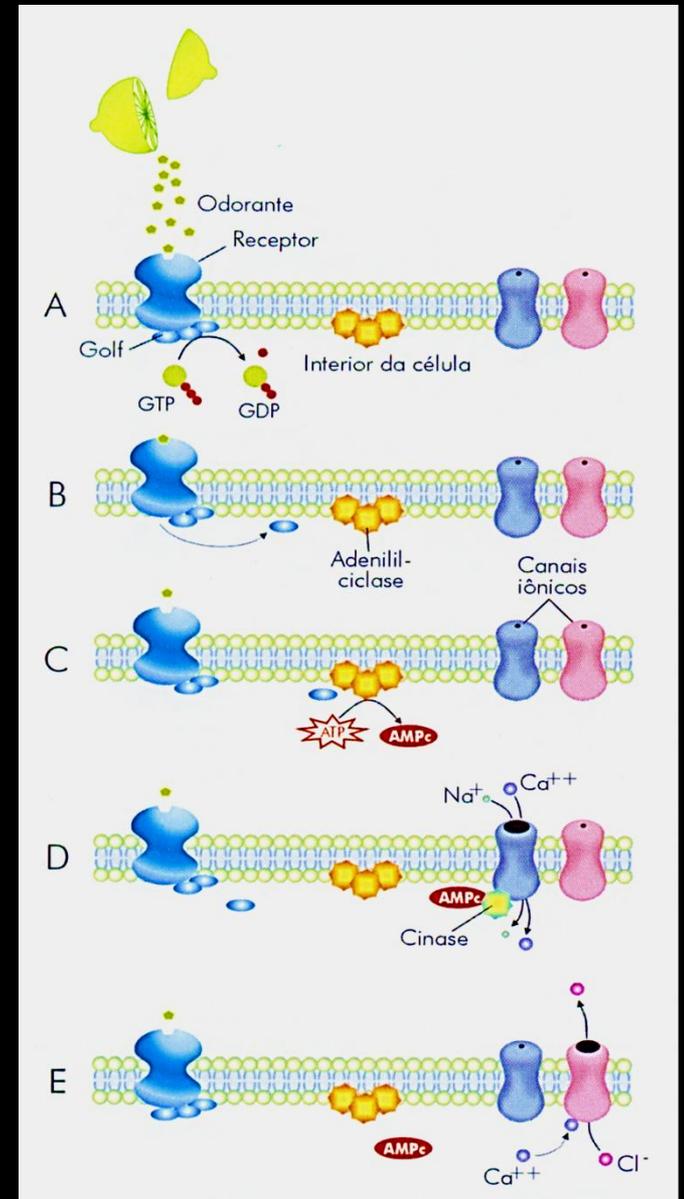
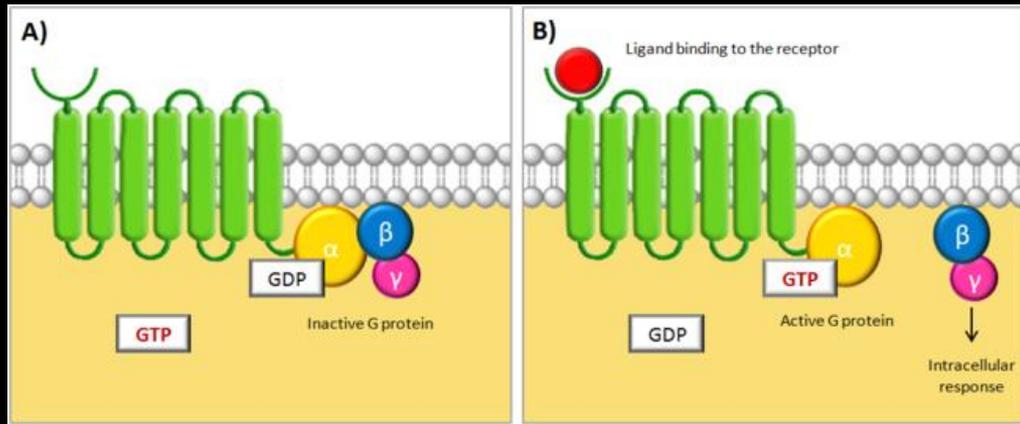


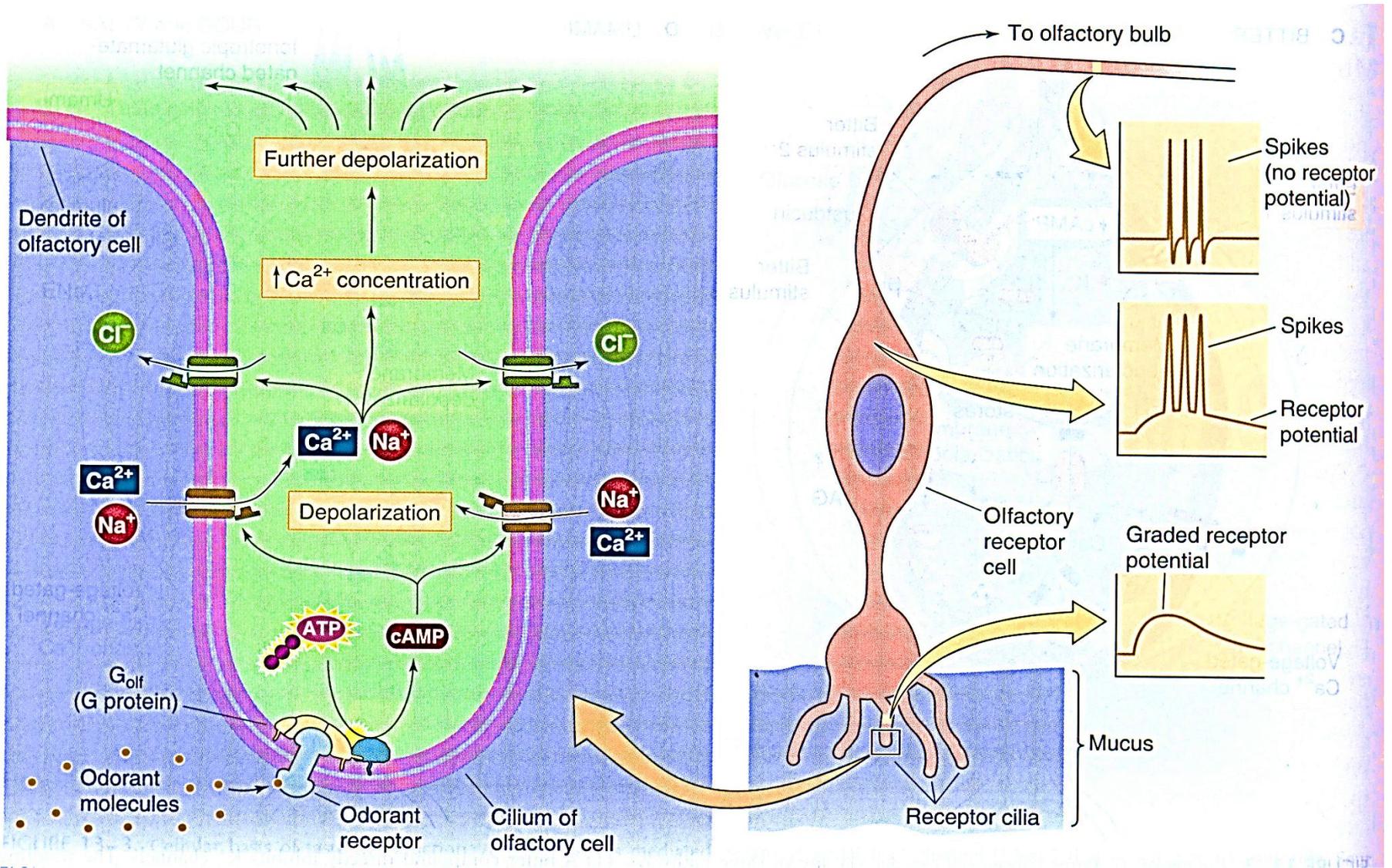
Receptores da Olfacção





Receptores que se ligam à proteína G





— sensory fibres
— motor fibres

Optic (II)
sensory: eye



Trochlear (IV)
motor: superior oblique muscle



Olfactory (I)
sensory: nose



Intermediate motor:
submaxillary and sublingual gland

sensory:
anterior part of tongue and soft palate

Glossopharyngeal (IX)
motor: pharyngeal musculature
sensory: posterior part of tongue, tonsil, pharynx

Abducent (VI)
motor: external rectus muscle

Oculomotor (III)
motor: all eye muscles except those supplied by IV and VI



Trigeminal (V)
sensory: face, sinuses, teeth, etc.
motor: muscles of mastication



Facial (VII)
motor: muscles of the face

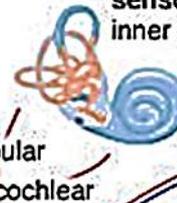


Hypoglossal (XII)
motor: muscles of the tongue



Intermediate nerve

Vestibulocochlear (VIII)
sensory: inner ear

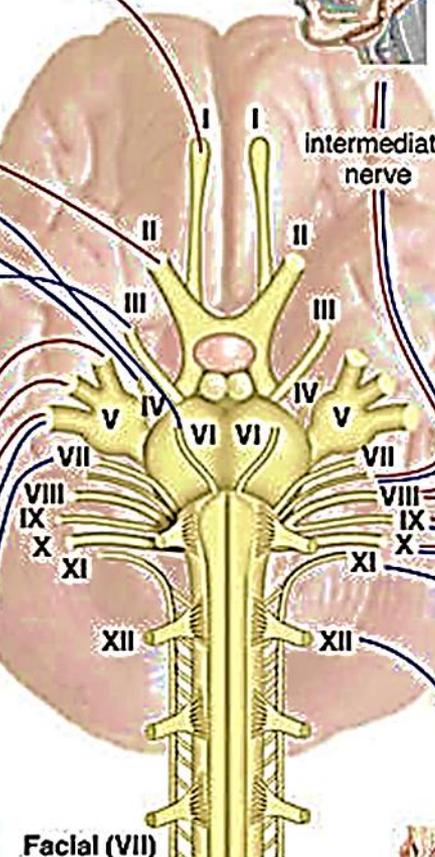


vestibular cochlear

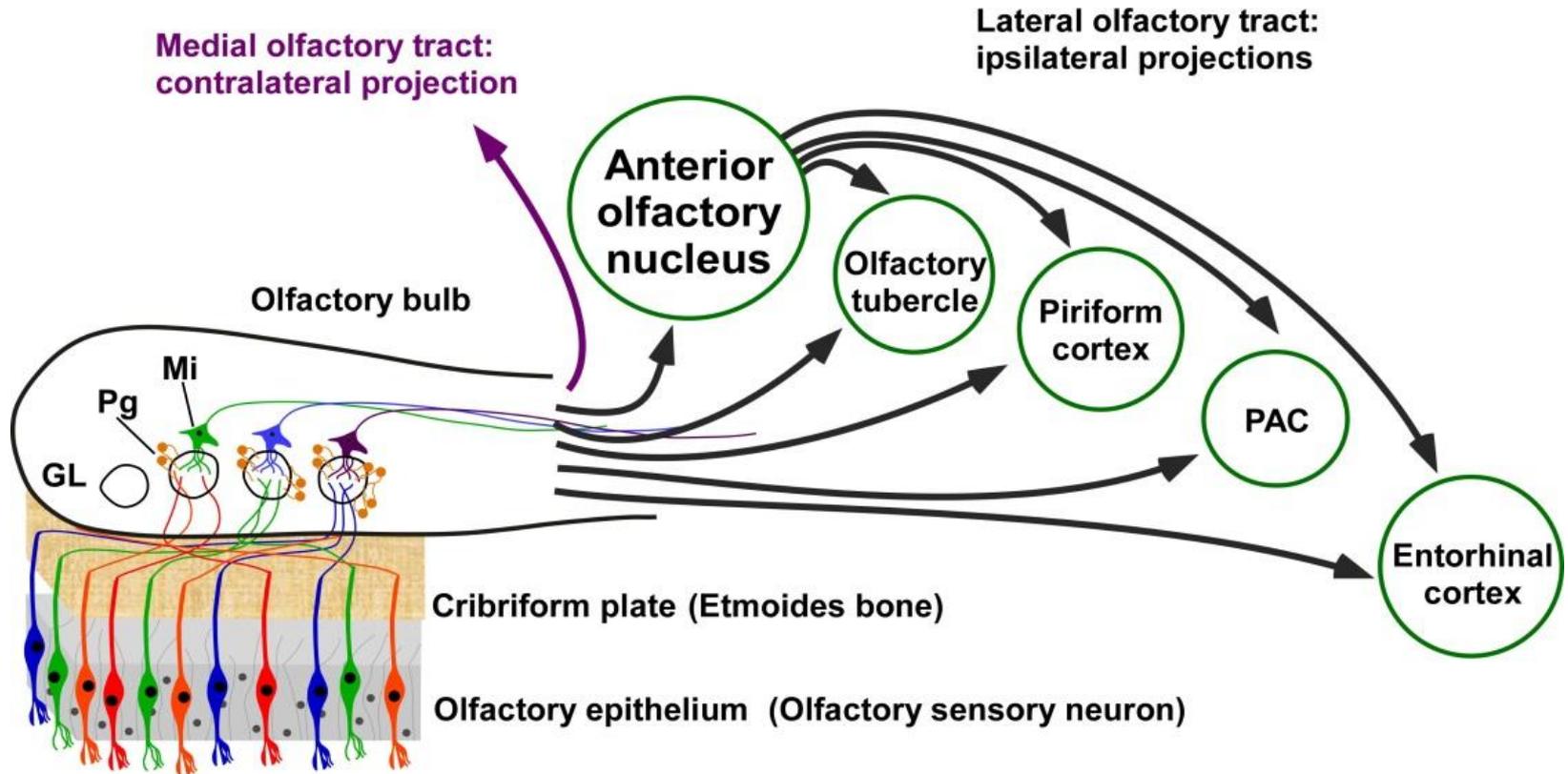


Vagus (X)
motor: heart, lungs, bronchi, gastrointestinal tract
sensory: heart, lungs, bronchi, trachea, larynx, pharynx, gastrointestinal tract, external ear

Accessory (XI)
motor: sternocleidomastoid and trapezius muscles

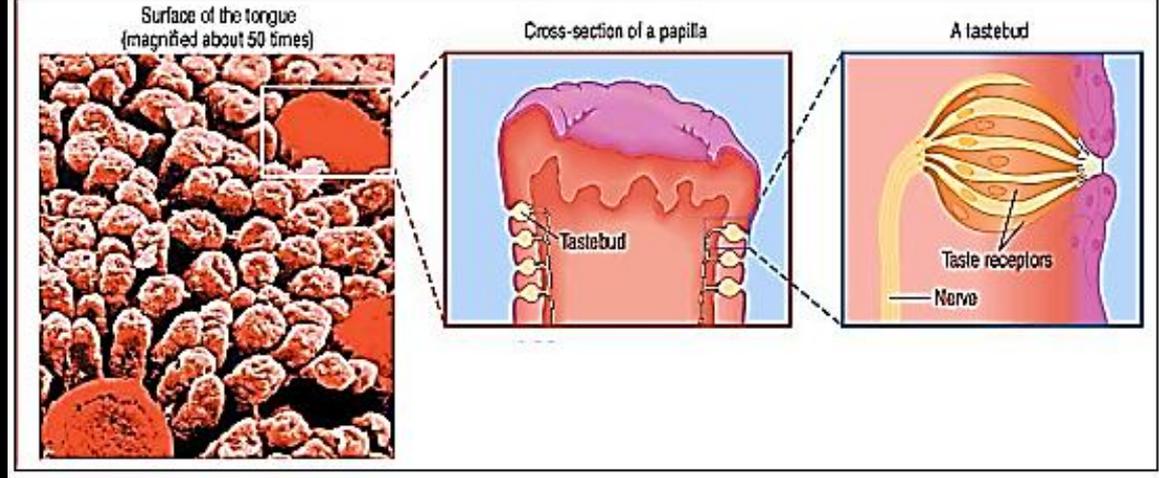
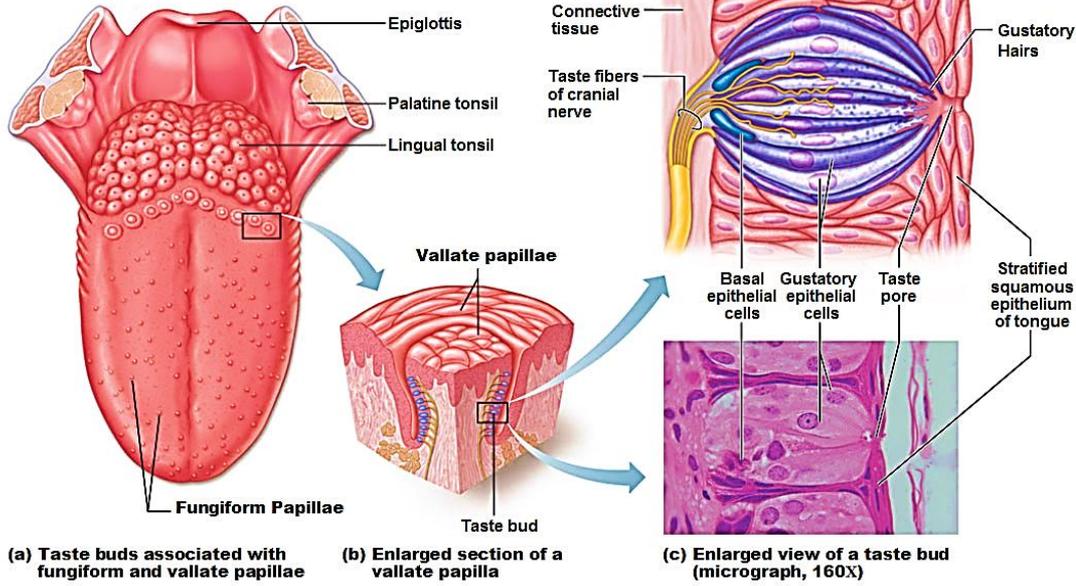


Circuito neural associado a olfação

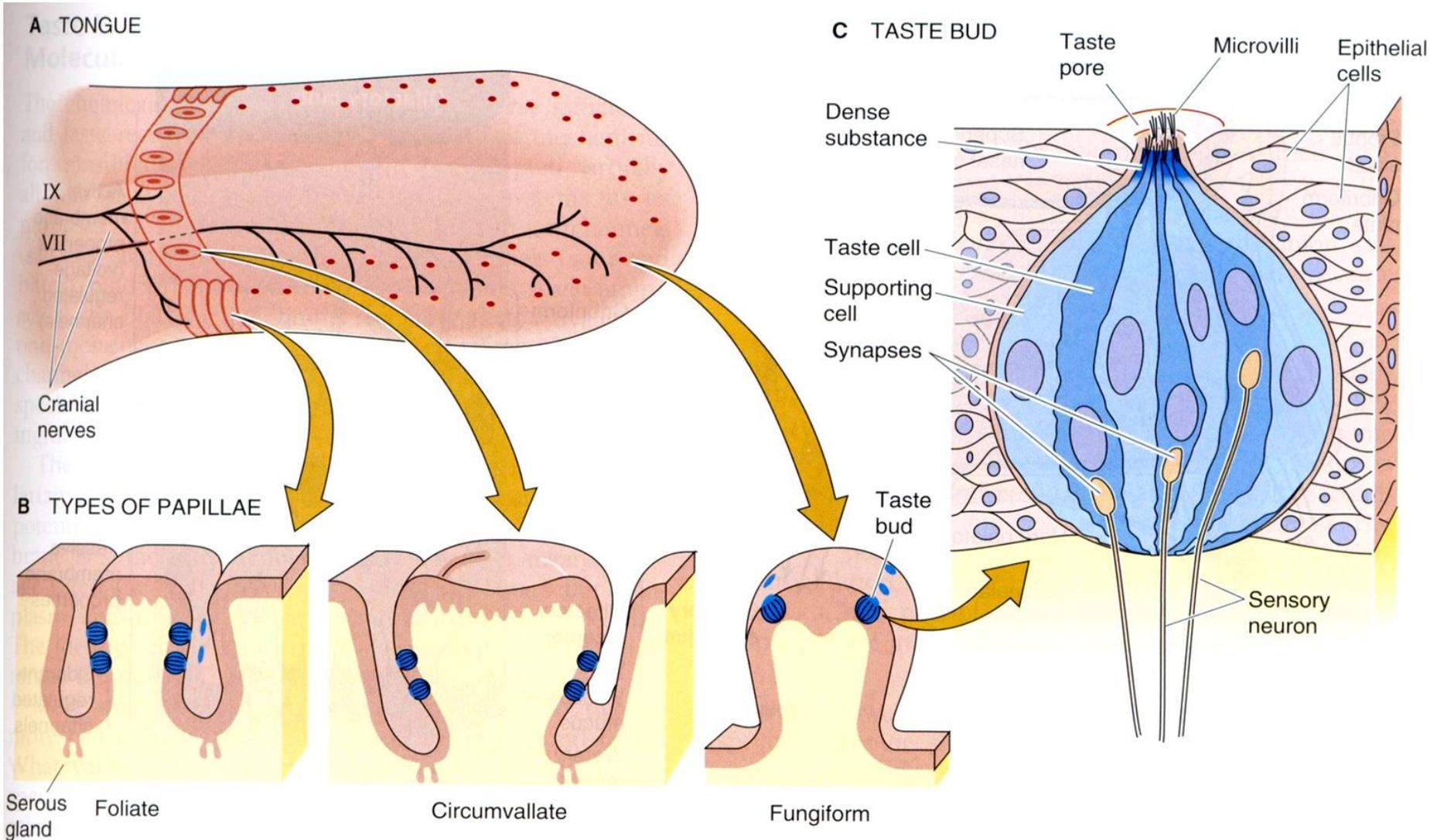


Receptores da Gostação

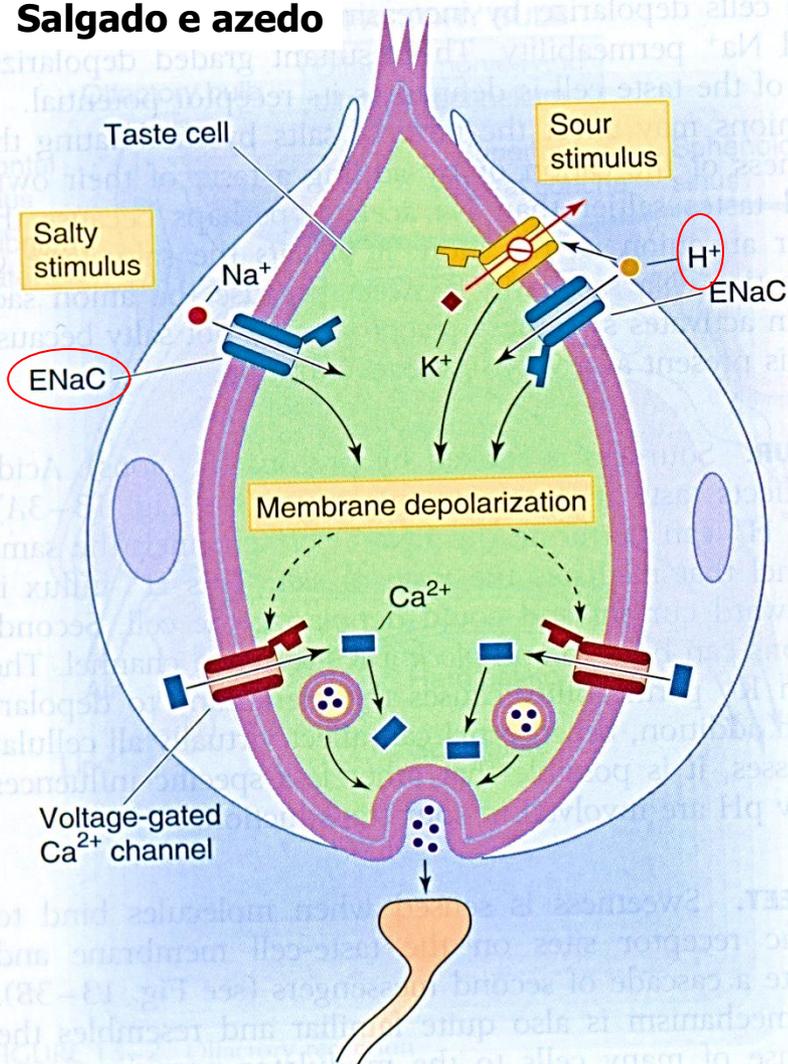
Taste Buds



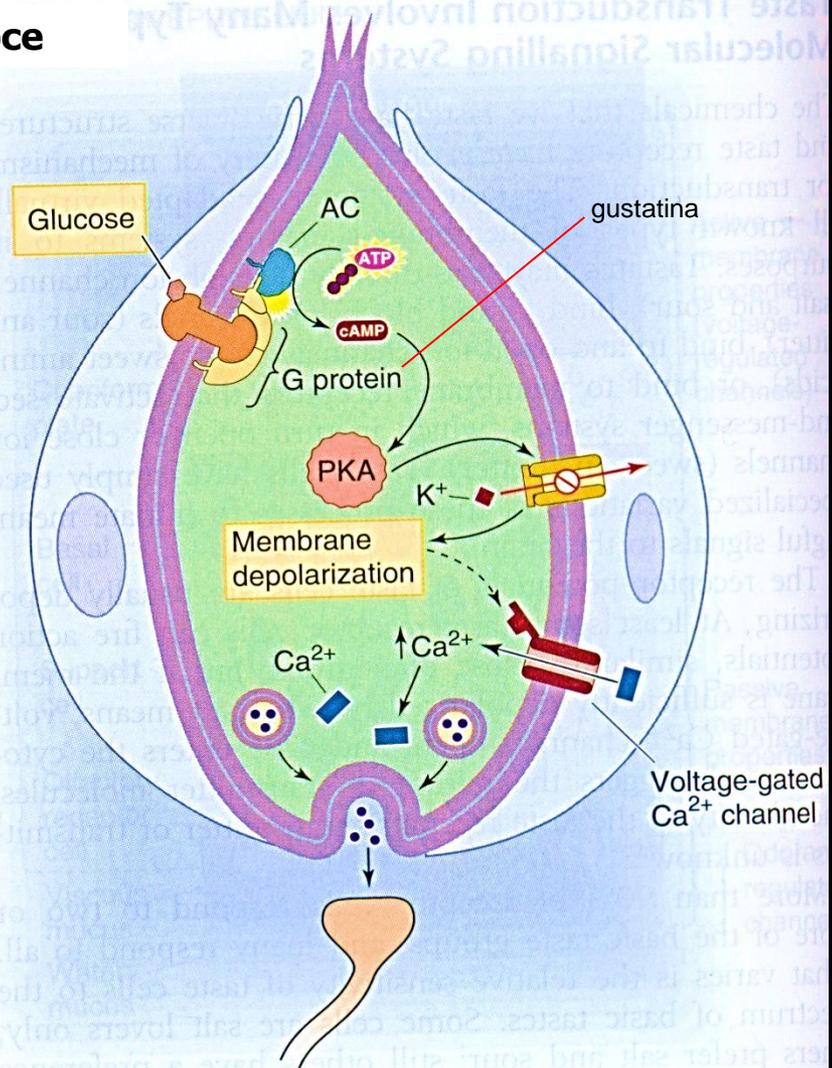
Receptor da Gustação



Salgado e azedo



Doce



Amargo

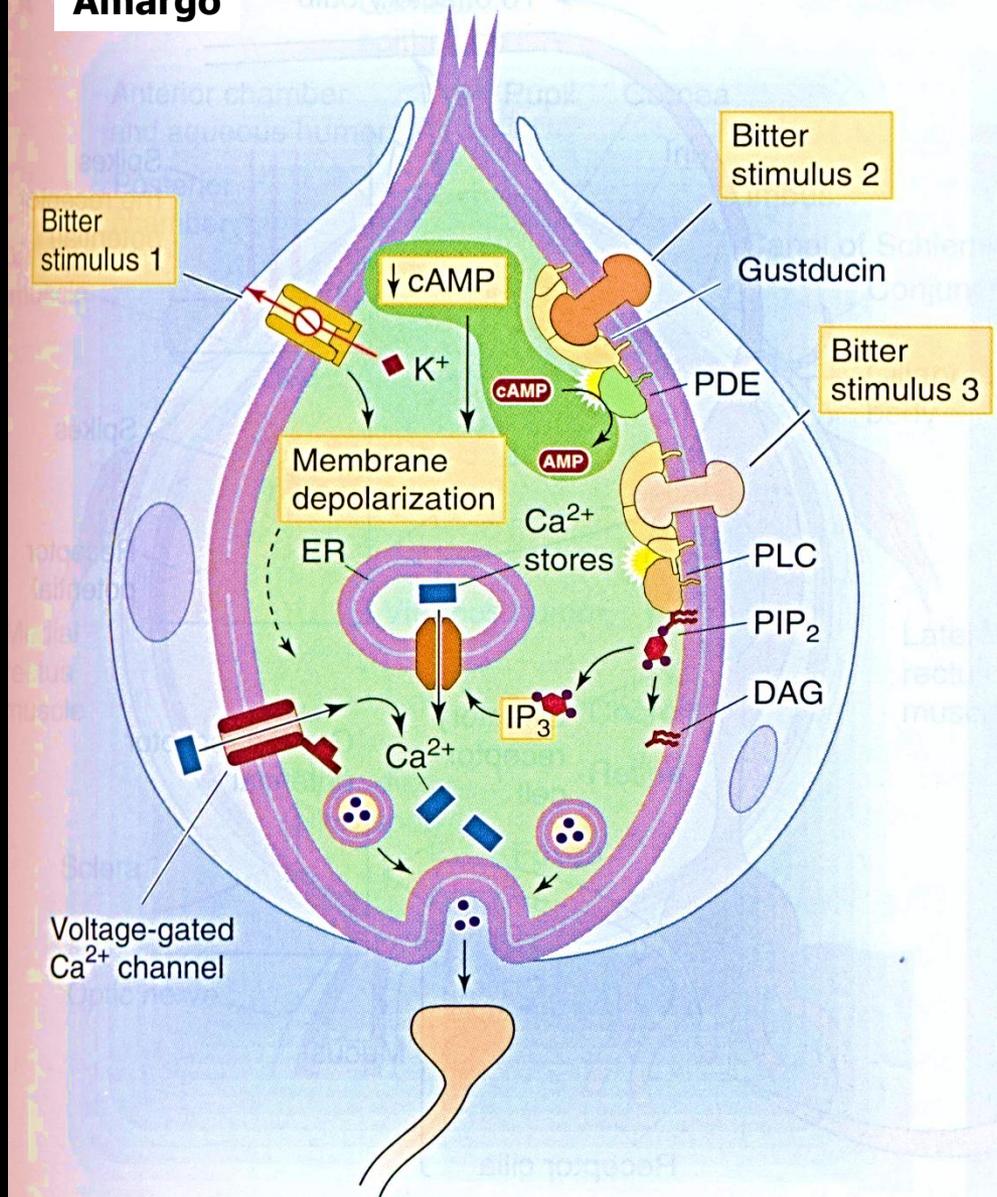
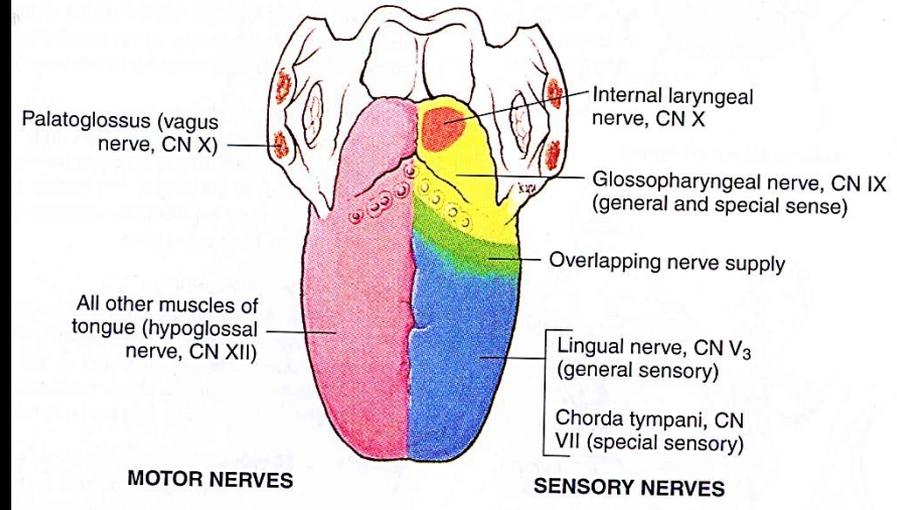
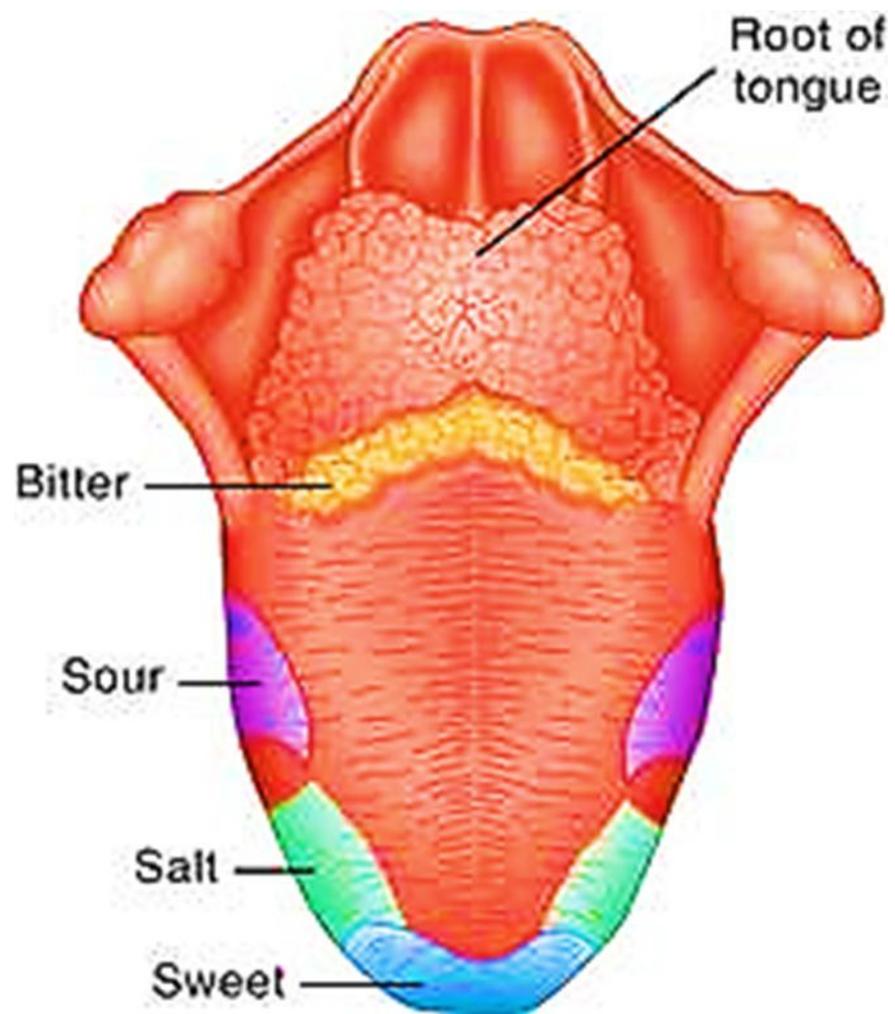


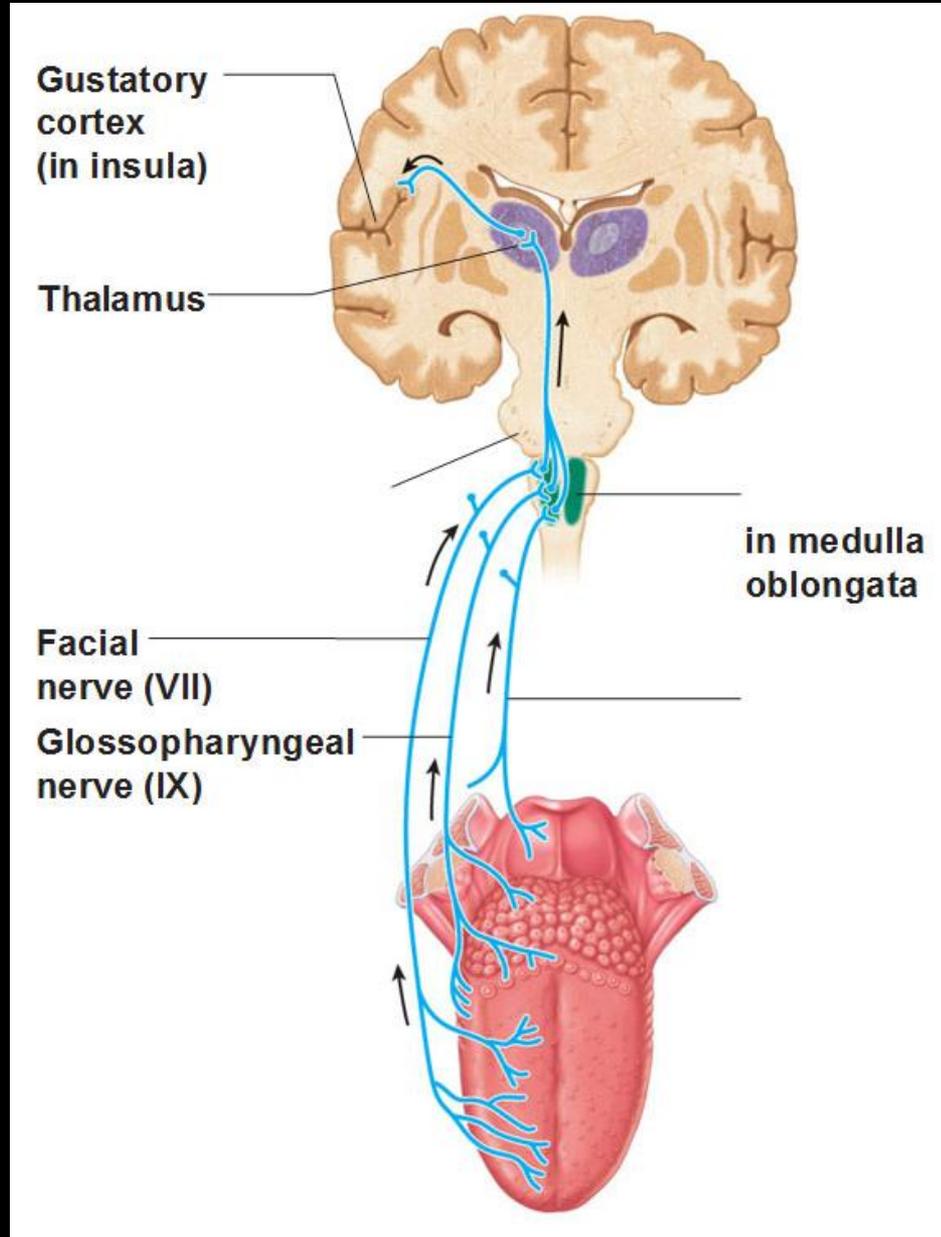
Tabela
Os Nervos Cranianos e suas Funções

Nervo craniano	Fibras Componentes	Alvo ou Origem Periférica	Funções
I. Olfatório	Sensoriais	Epitélio olfatório	Olfação
II. Óptico	Sensoriais	Retina	Visão
III. Oculomotor	Motoras	Músculos extra-oculares: retos sup., inf. e med.; oblíquo inf.; elevador da pálpebra	Movimentos oculares
	Autônômicas (parassimpáticas)	Músculos intra-oculares: constritor da pupila e ciliar	Miose e acomodação
IV. Troclear	Motoras	Músculo extra-ocular: oblíquo sup.	Movimentos oculares
V. Trigêmeo	Sensoriais	Pele da face, córnea, cavidades nasal e oral, dura-máter	Somestesia
	Motoras	Músculos da mastigação; músculo tensor do tímpano	Abertura e fechamento da boca; regulação da tensão do tímpano
VI. Abducente	Motoras	Músculo extra-ocular: reto lat.	Abdução do globo ocular
VII. Facial	Sensoriais	2/3 anteriores da língua	Gustação
	Motoras	Músculos mímicos; músculo estapédio	Movimentos da face; regulação da tensão da cadeia ossicular
	Autônômicas (parassimpáticas)	Glândulas salivares e lacrimais	Salivação e lacrimejamento
VIII. Vestibulo-coclear	Sensoriais	Cóclea e aparelho vestibular	Audição e equilíbrio
IX. Glossofaríngeo	Sensoriais	1/3 posterior da língua; faringe; trompa de Eustáquio, ouvido médio; corpo carotídeo	Gustação, somestesia, quimiorrecepção, barorrecepção ^G
	Motoras	Músculo estilofaríngeo	Deglutição
	Autônômicas (parassimpáticas)	Glândula parótida	Salivação
X. Vago	Sensoriais	Faringe, laringe, esôfago, ouvido externo, corpúsculos aórticos, vísceras torácicas e abdominais	Somestesia, quimio- e barorrecepção; sensibilidade visceral
	Motoras Autônômicas (parassimpáticas)	Palato mole, faringe, laringe e esôfago Vísceras torácicas e abdominais	Fala, deglutição Controle das funções orgânicas
XI. Acessório	Motoras	Músculos do pescoço e ombros: esternocleidomastóideo e trapézio	Movimentos da cabeça e ombros
XII. Hipoglosso	Motoras	Músculos da língua	Movimentos da língua





Circuito neural associado a gustação



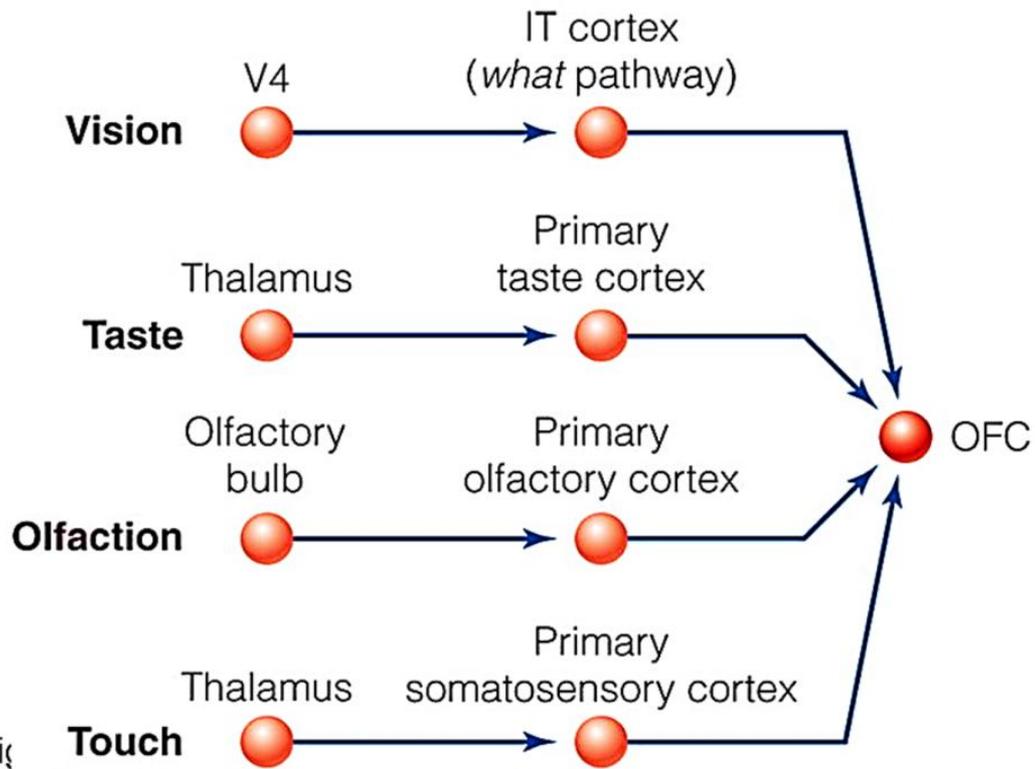
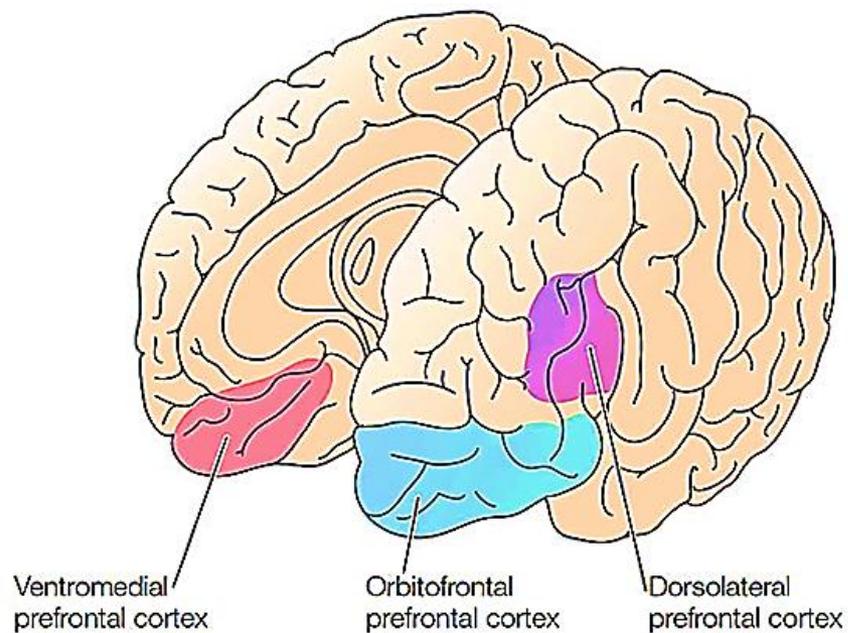
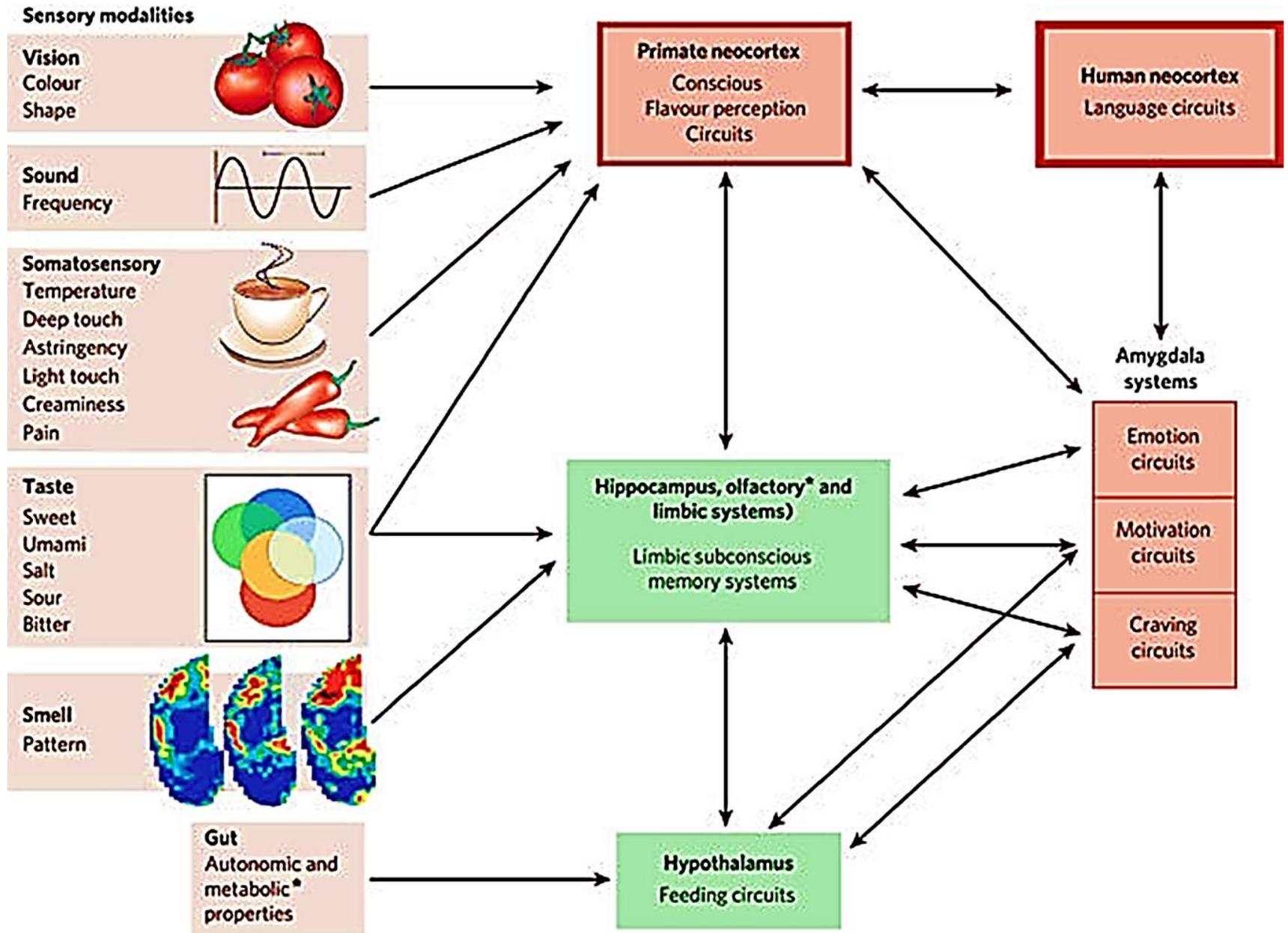
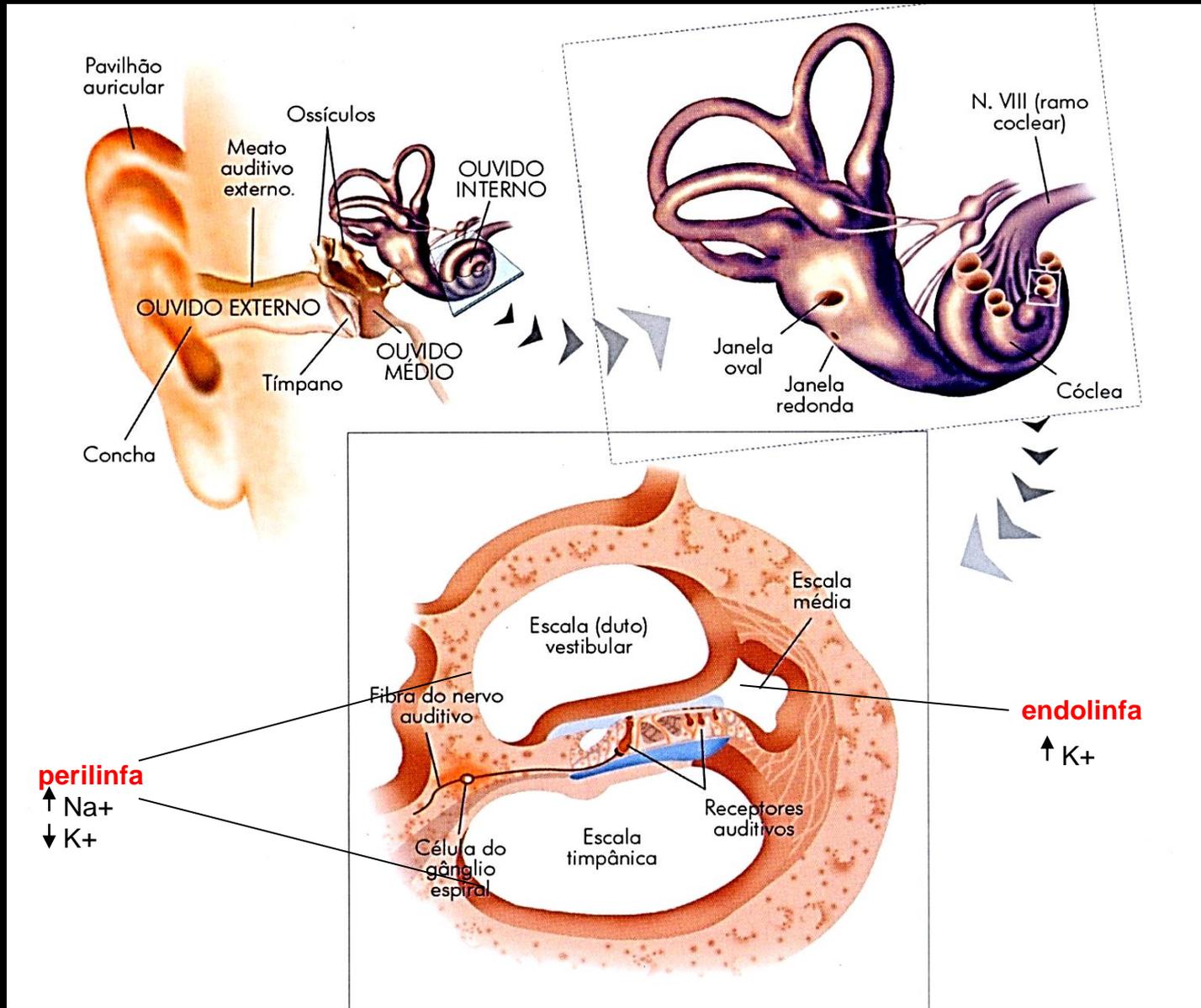


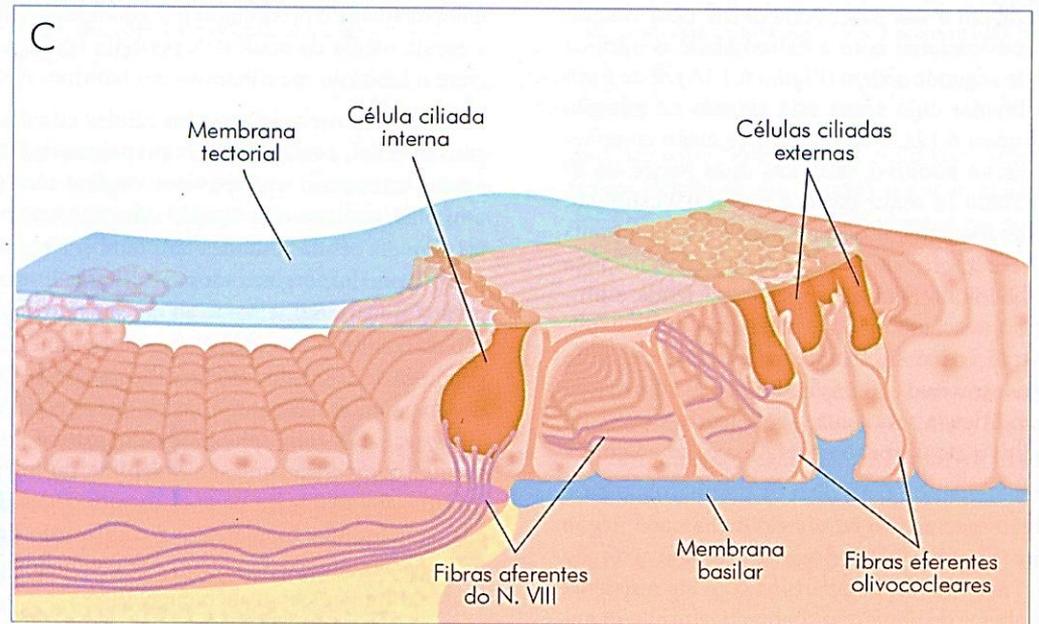
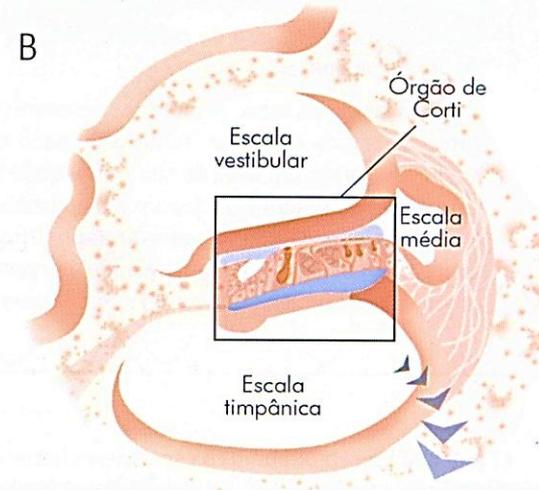
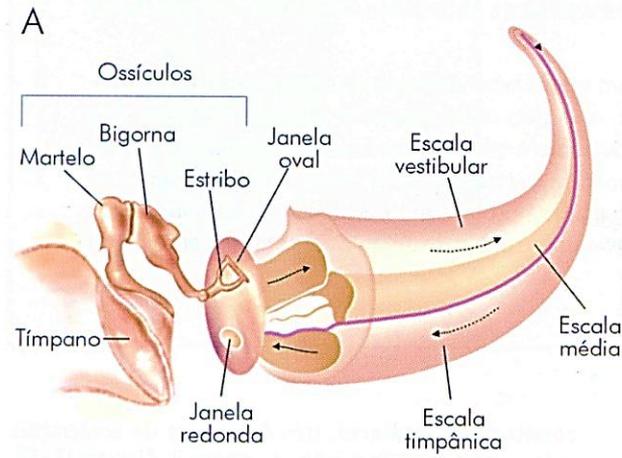
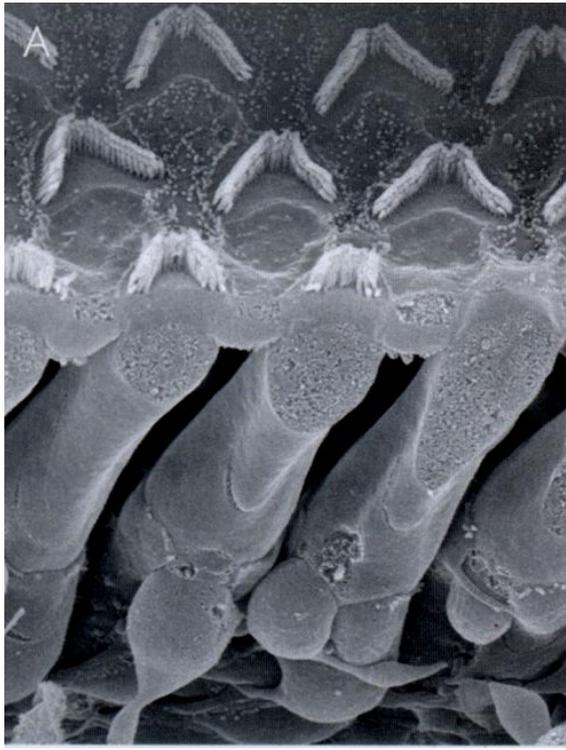
Fig 10.12

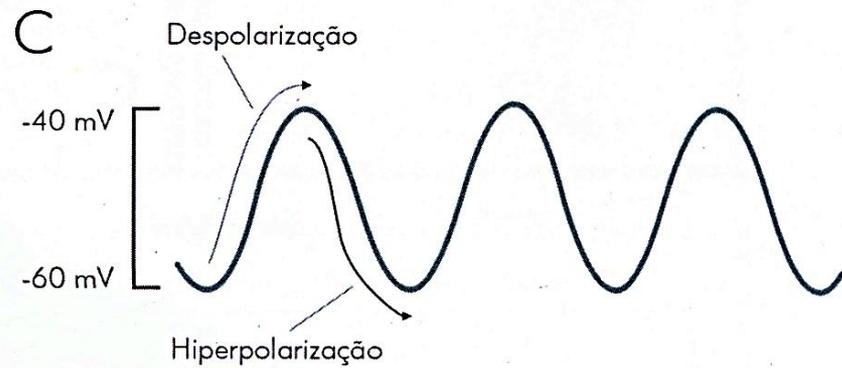
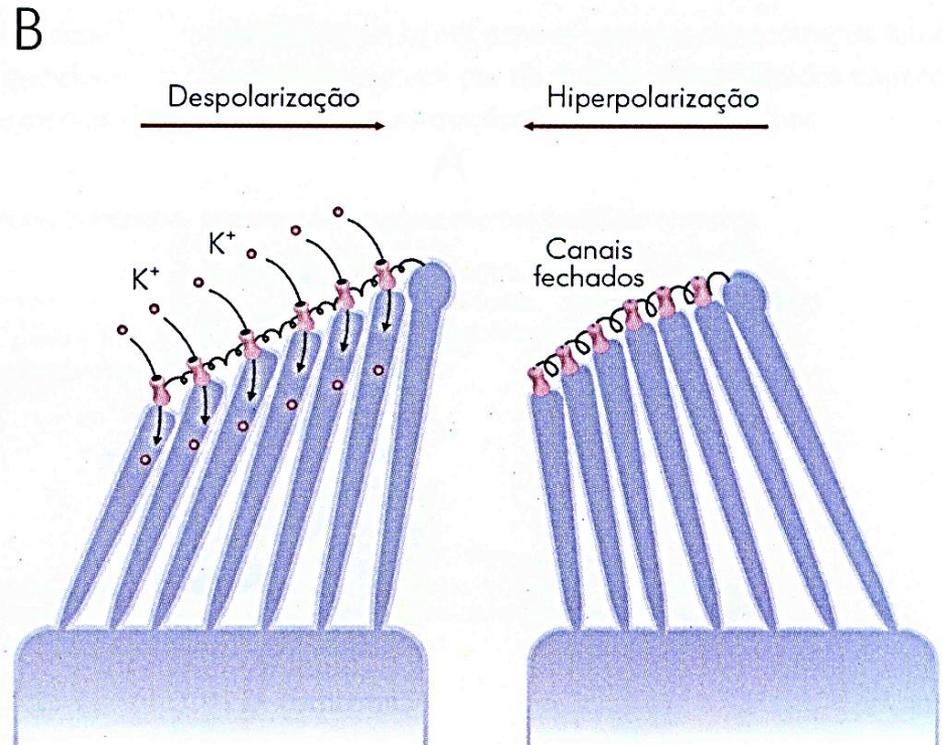
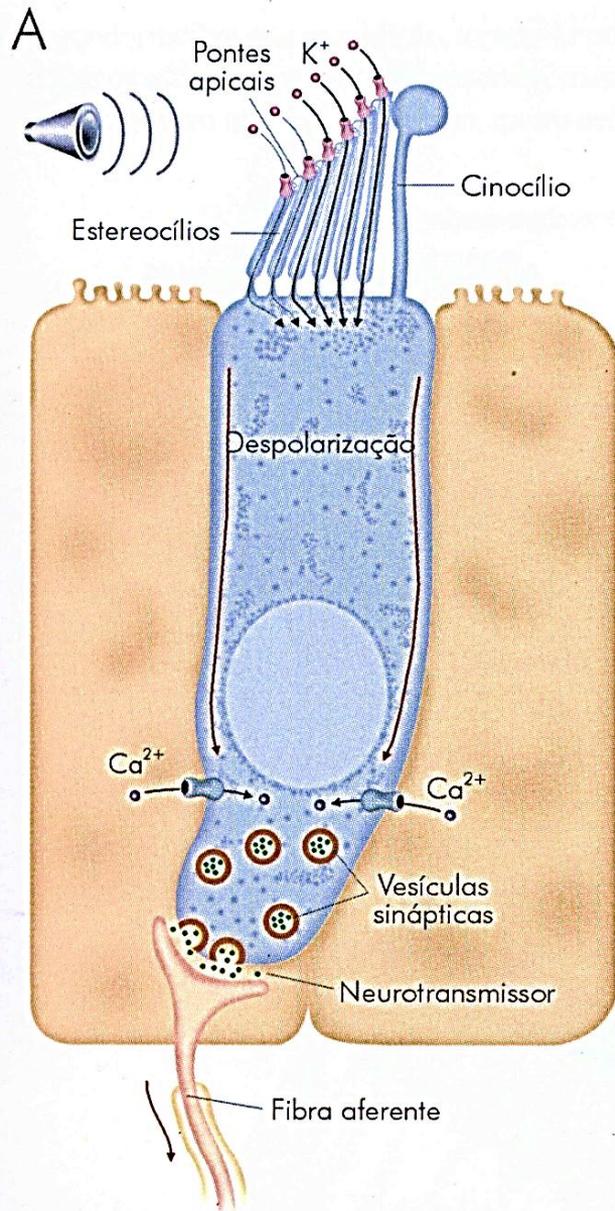




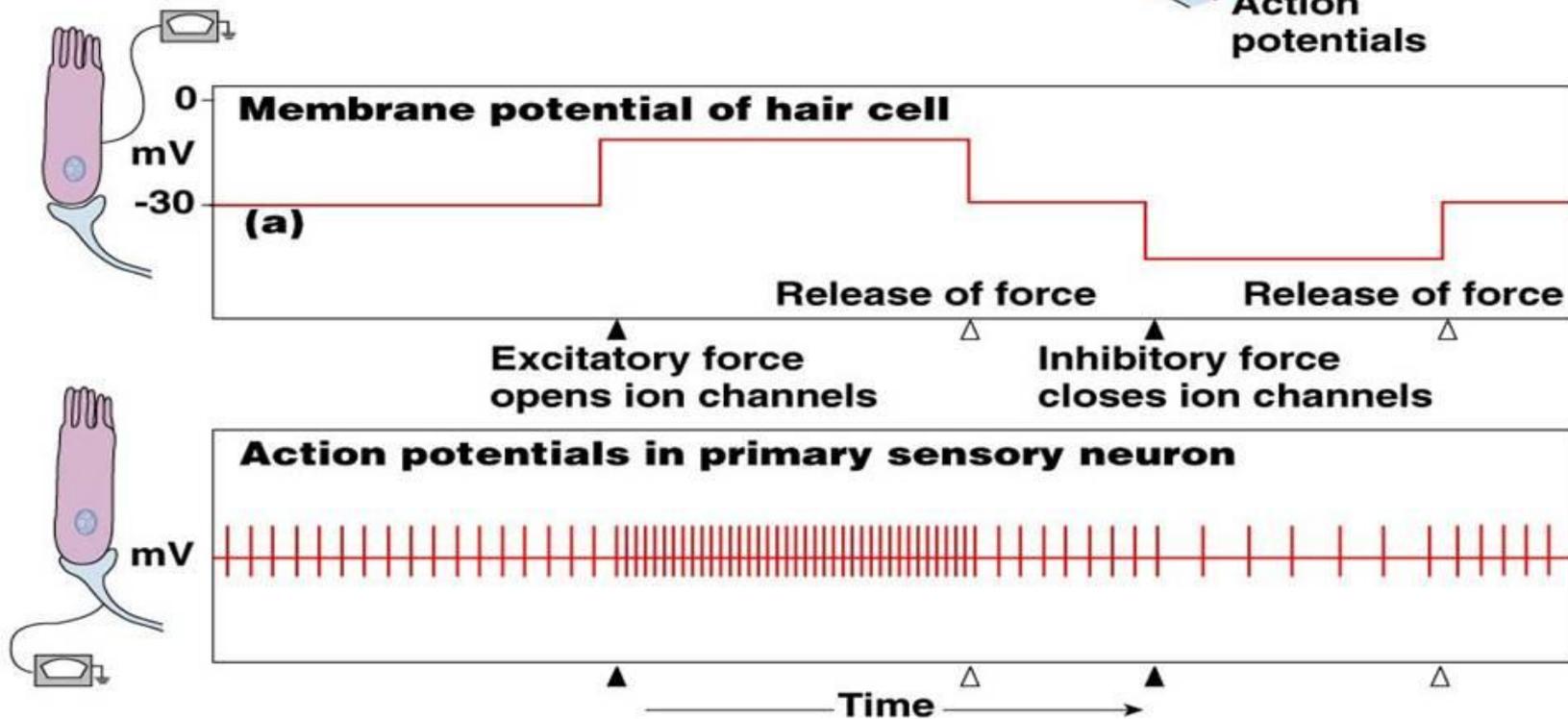
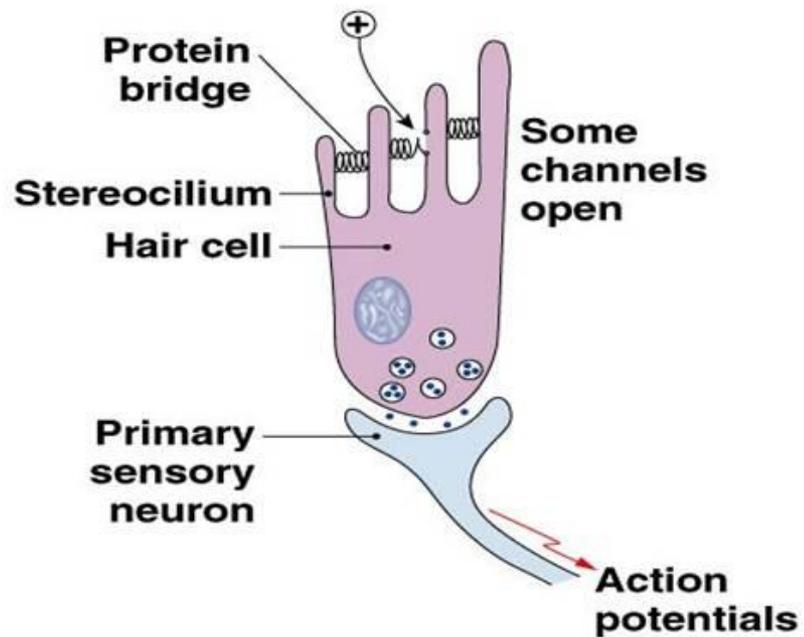
Orgão receptor da audição







(a) At rest: About 10% of the ion channels are open and a tonic signal is sent by the sensory neuron.



— sensory fibres
— motor fibres

Optic (II)
sensory: eye



Trochlear (IV)
motor: superior oblique muscle



Olfactory (I)
sensory: nose

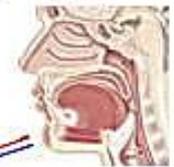


Intermediate motor:
submaxillary and sublingual gland

sensory:
anterior part of tongue and soft palate

Glossopharyngeal (IX)
motor:
pharyngeal musculature
sensory:
posterior part of tongue, tonsil, pharynx

Vestibulocochlear (VIII)
sensory: inner ear



Vagus (X)
motor:
heart, lungs, bronchi, gastrointestinal tract
sensory:
heart, lungs, bronchi, trachea, larynx, pharynx, gastrointestinal tract, external ear

Abducent (VI)
motor: external rectus muscle

Oculomotor (III)
motor: all eye muscles except those supplied by IV and VI



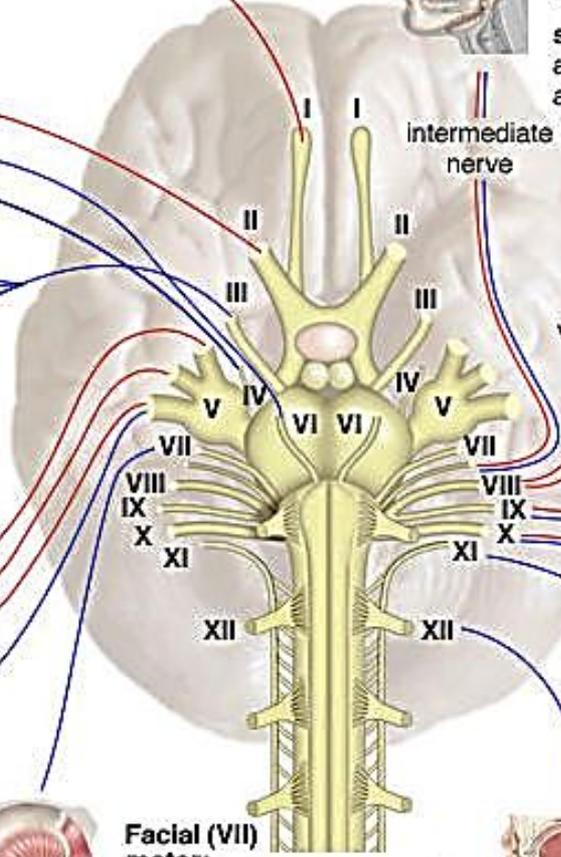
Facial (VII)
motor: muscles of the face

Hypoglossal (XII)
motor: muscles of the tongue

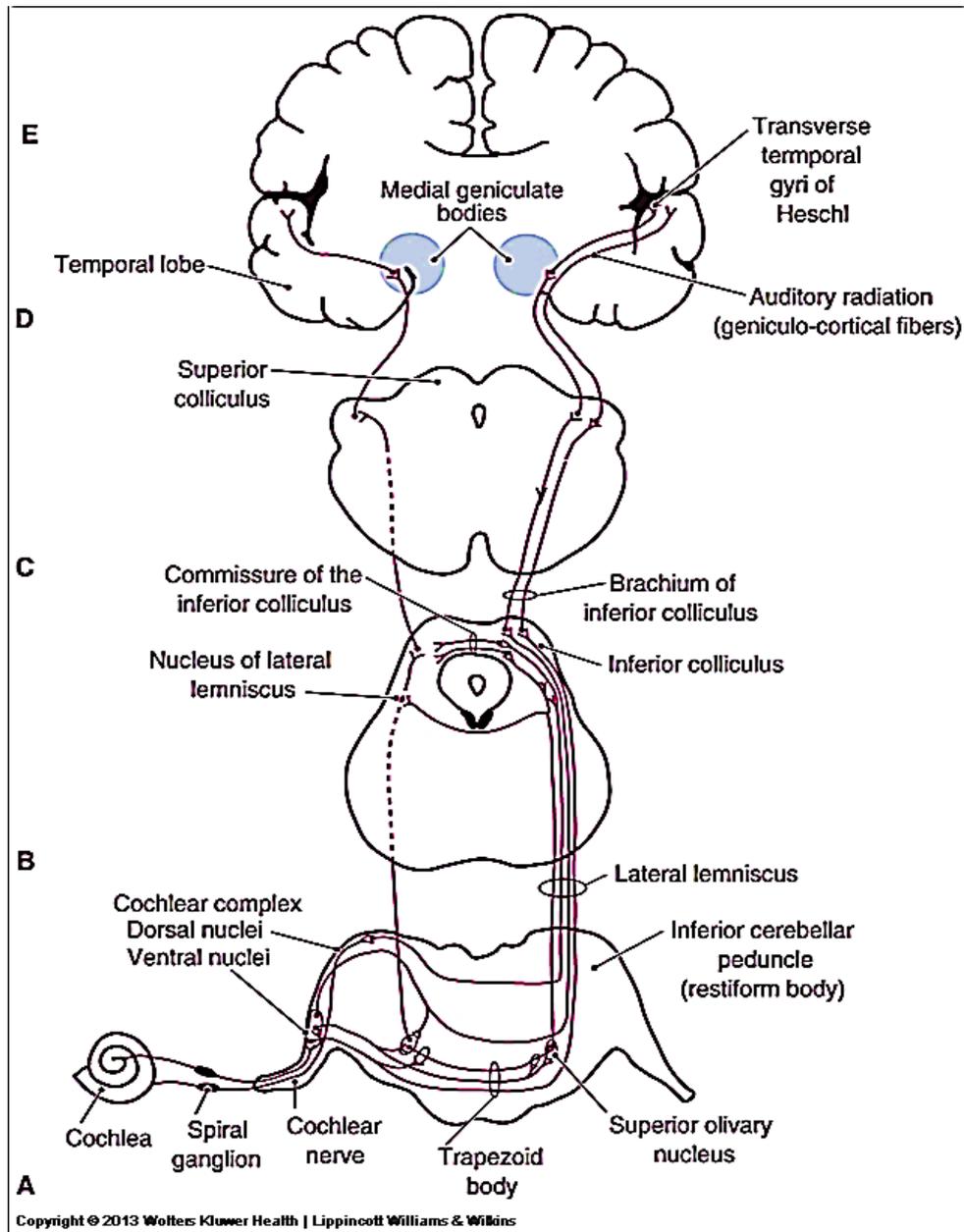
Trigeminal (V)
sensory: face, sinuses, teeth, etc.
motor: muscles of mastication



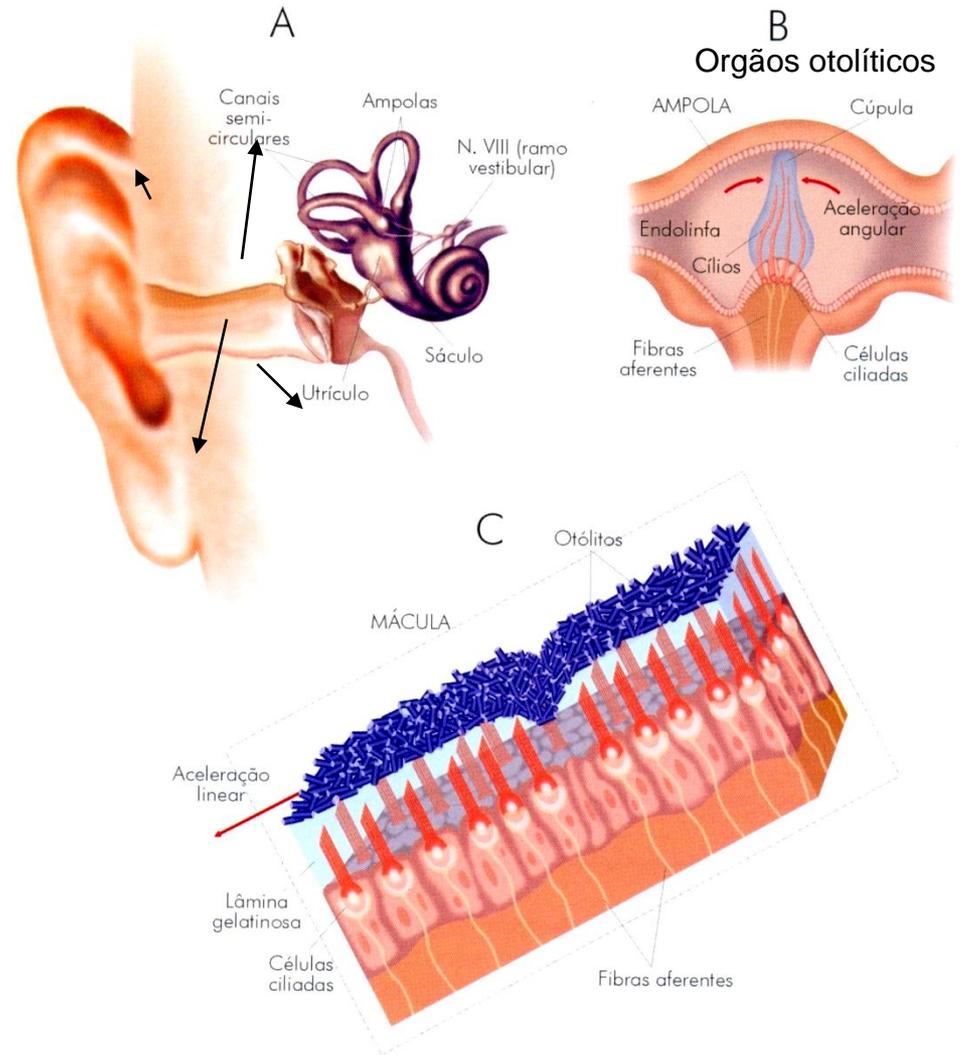
Accessory (XI)
motor: sternocleidomastoid and trapezius muscles



Circuito neural associado a audição



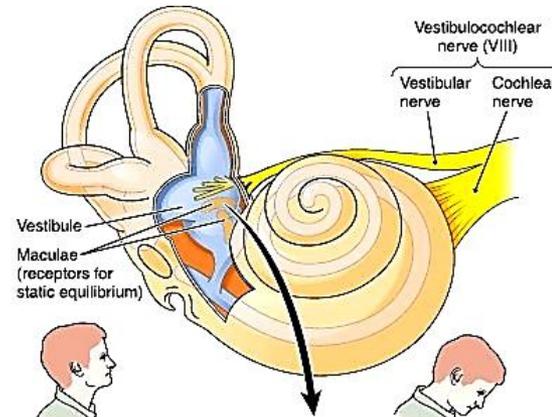
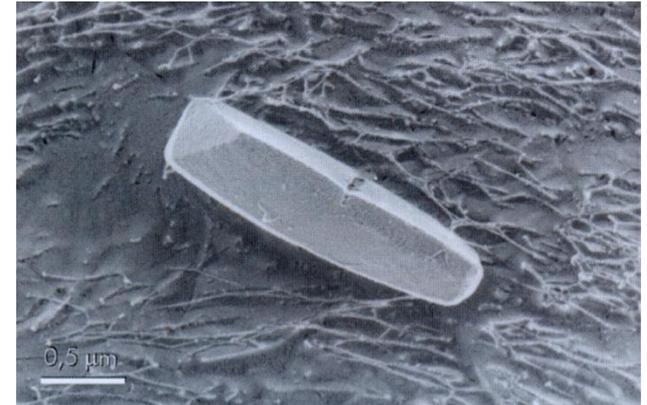
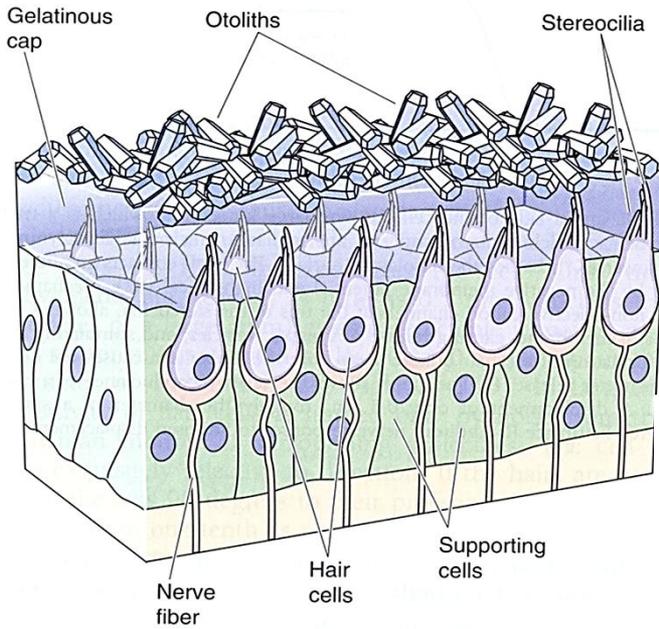
Orgão receptor do equilíbrio (orgão vestibular)



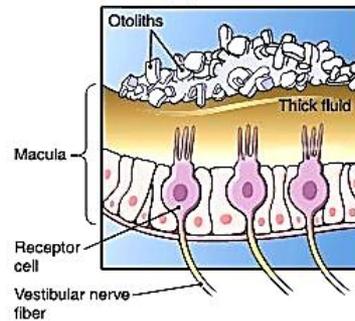
Orgãos otolíticos (sáculo e utrículo) { **Posição estática**
Aceleração linear

Canais semicirculares { **Aceleração rotacional**
(angular)

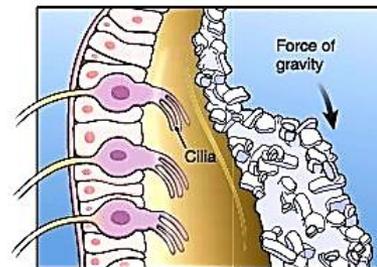
Orgão receptor do equilíbrio (orgão vestibular)



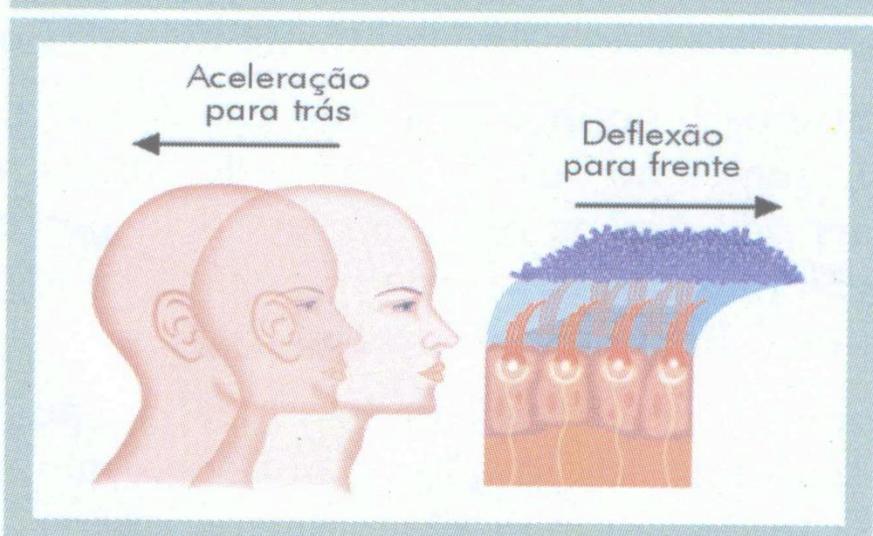
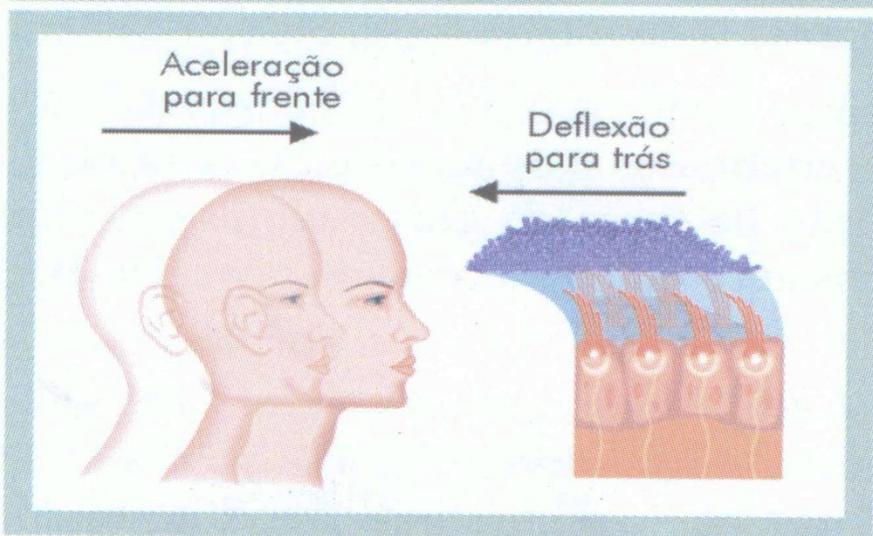
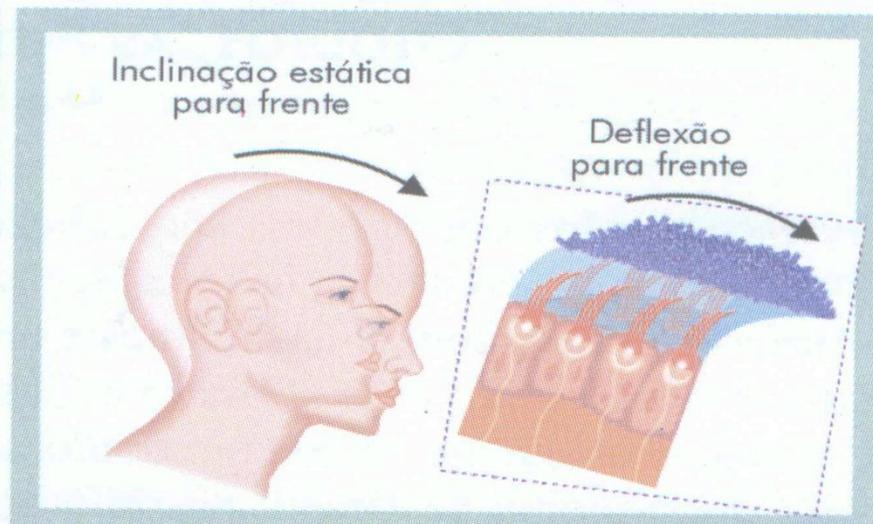
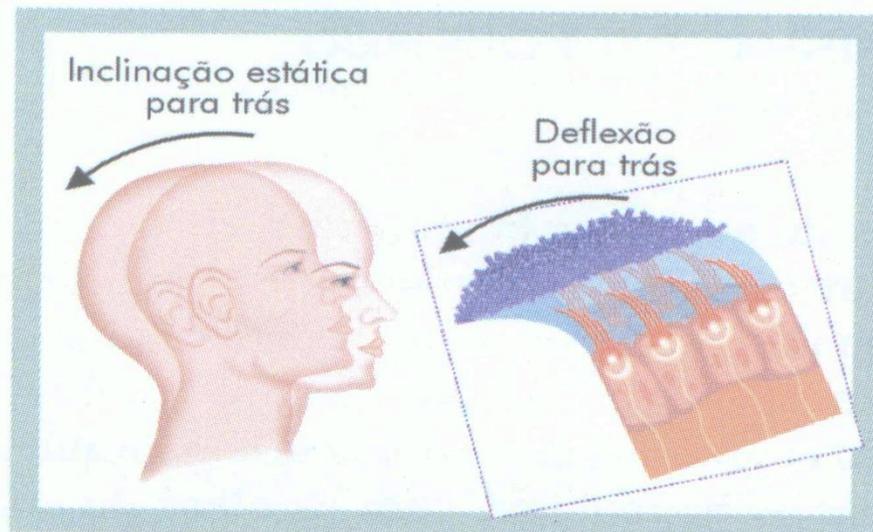
A Head upright



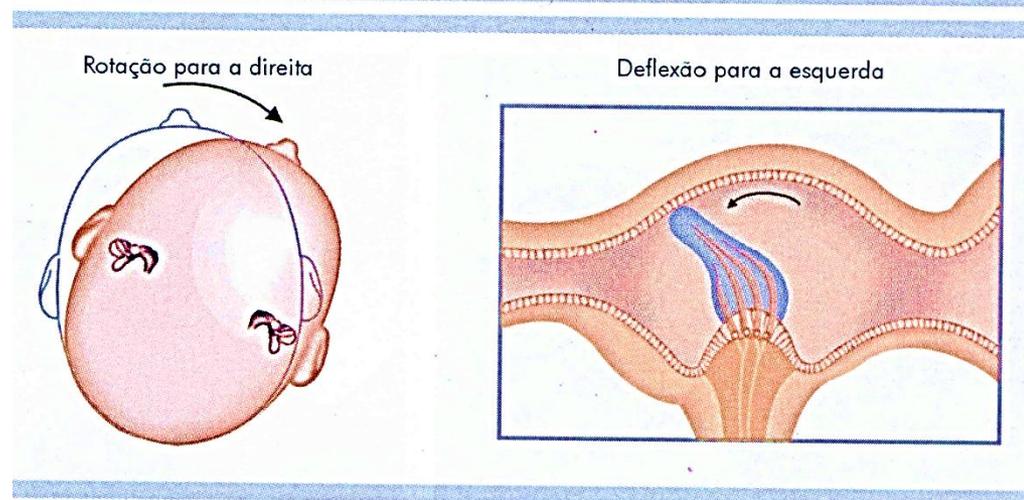
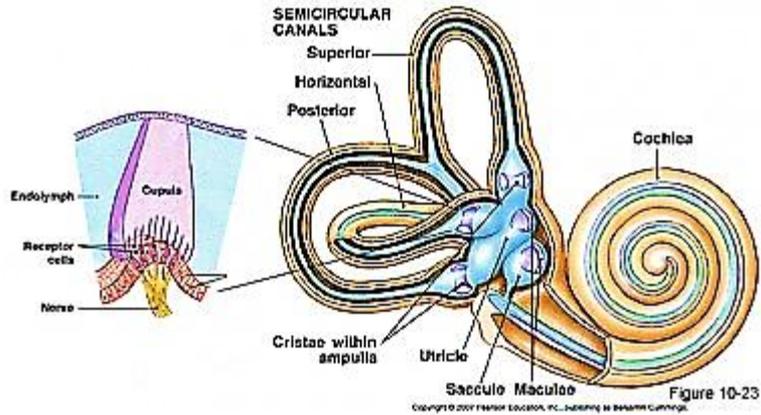
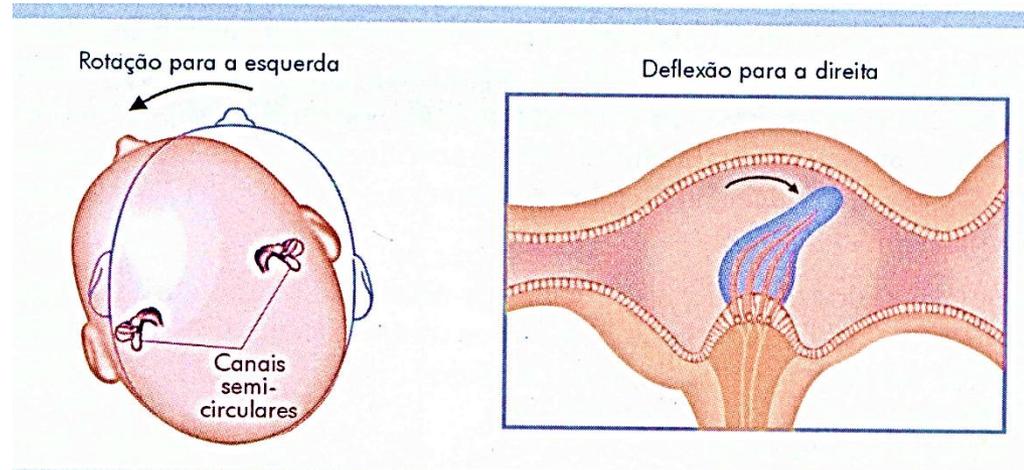
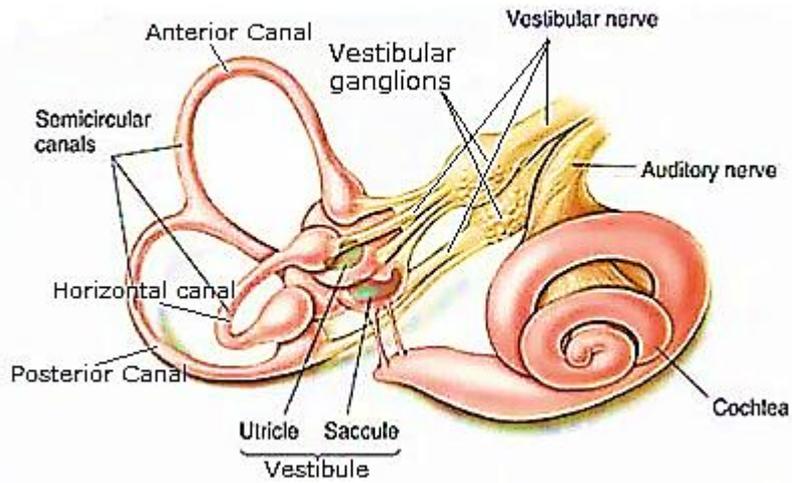
B Head bent forward



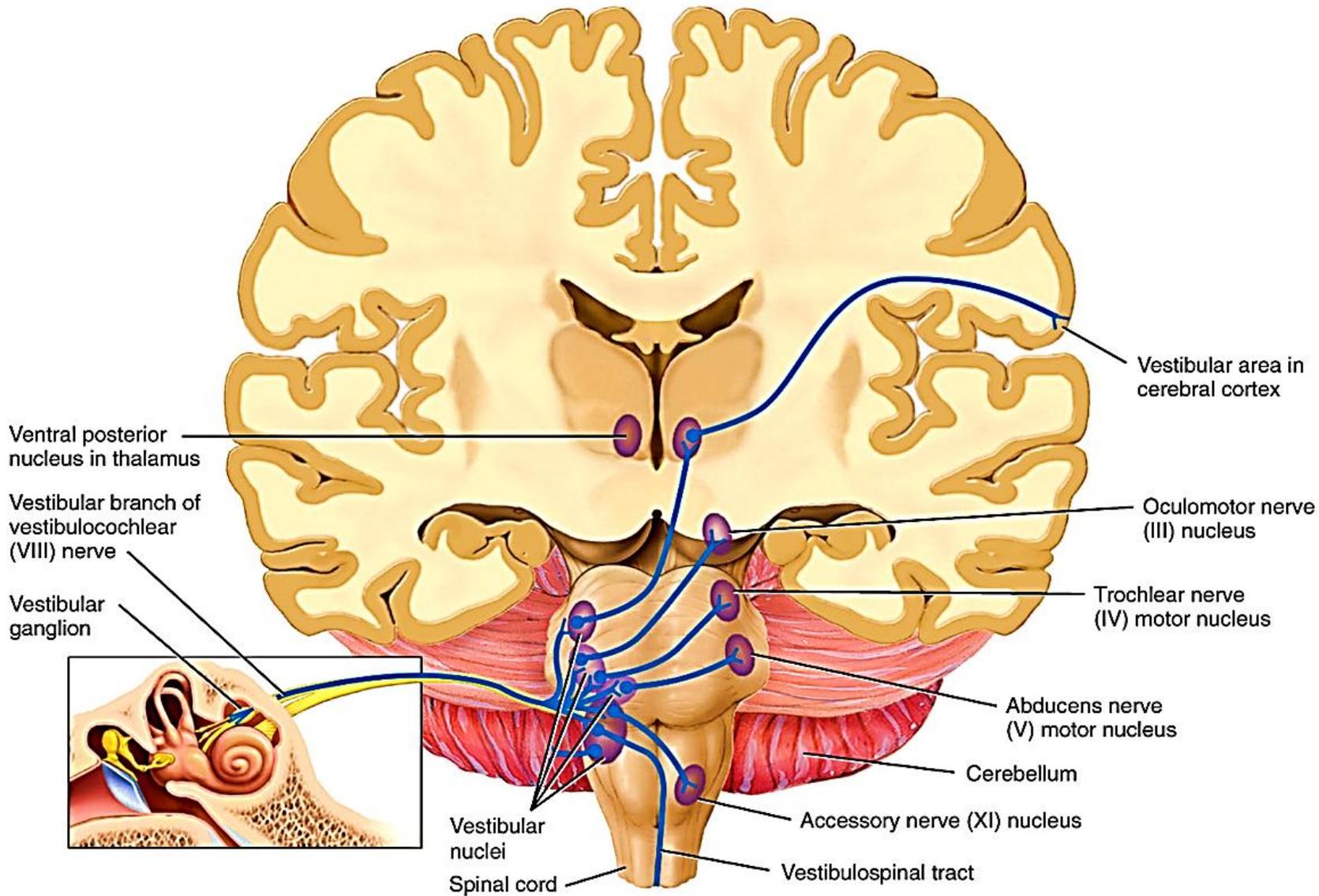
Orgão receptor do equilíbrio (orgão vestibular)



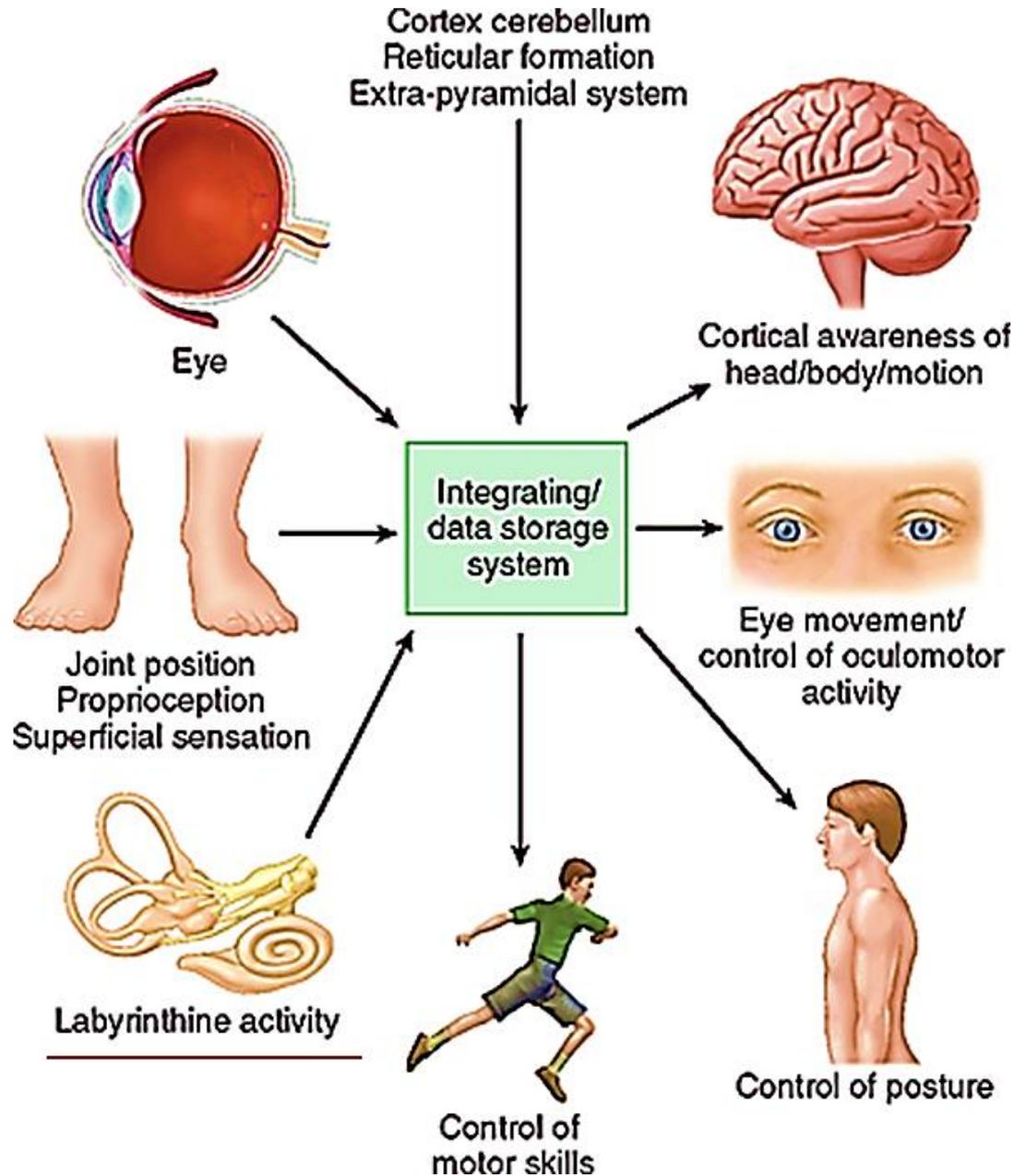
Orgão receptor do equilíbrio (orgão vestibular)



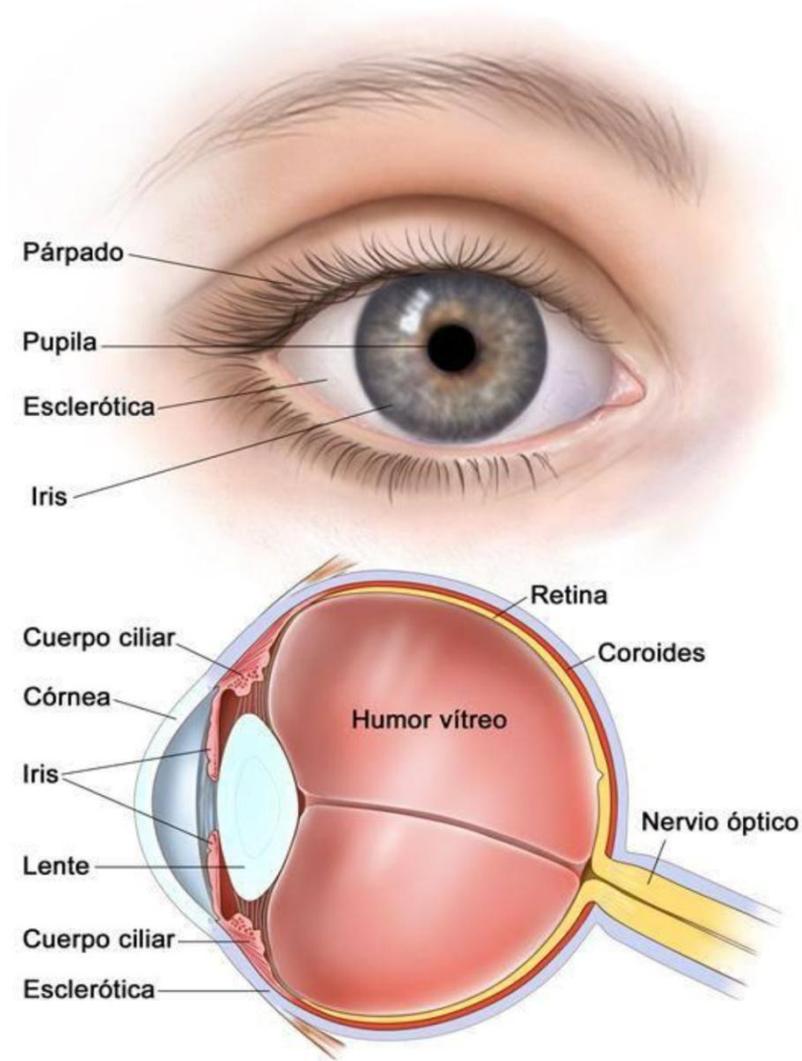
Circuitos neurais associados ao equilíbrio e controle postural

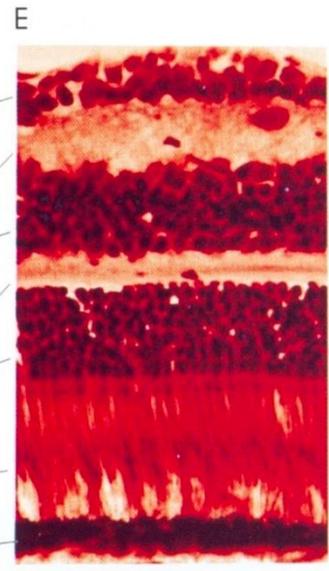
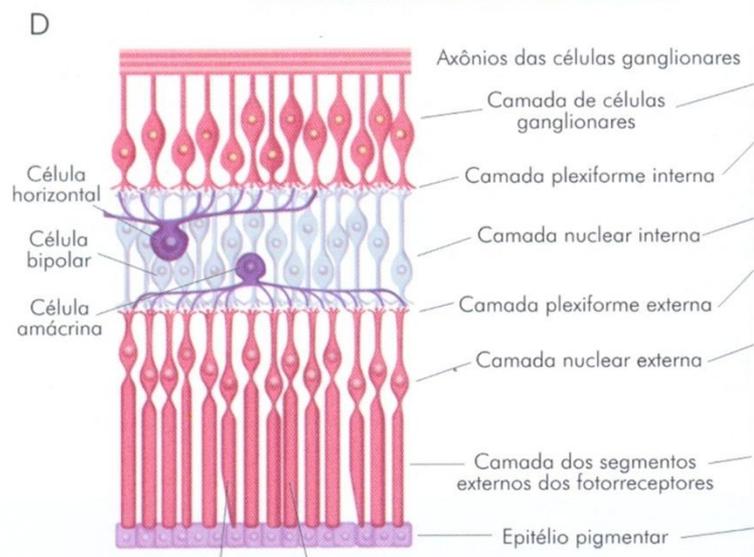
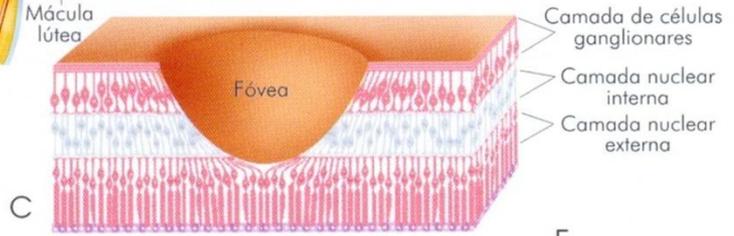
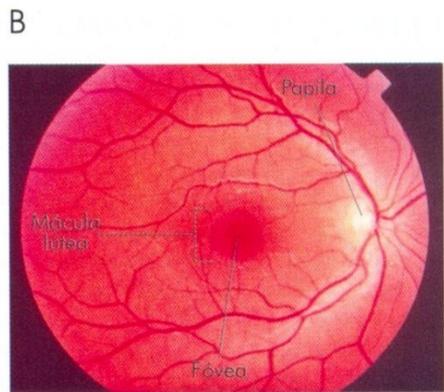
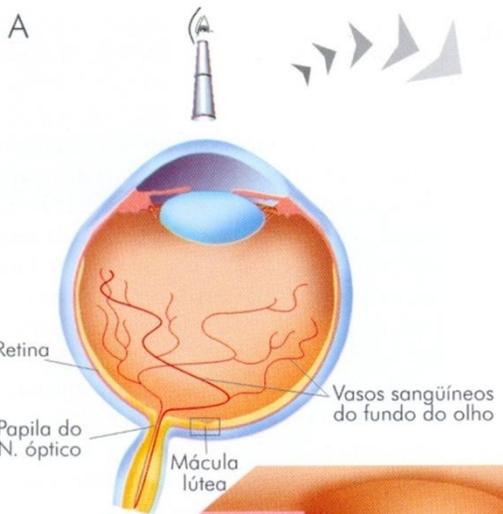


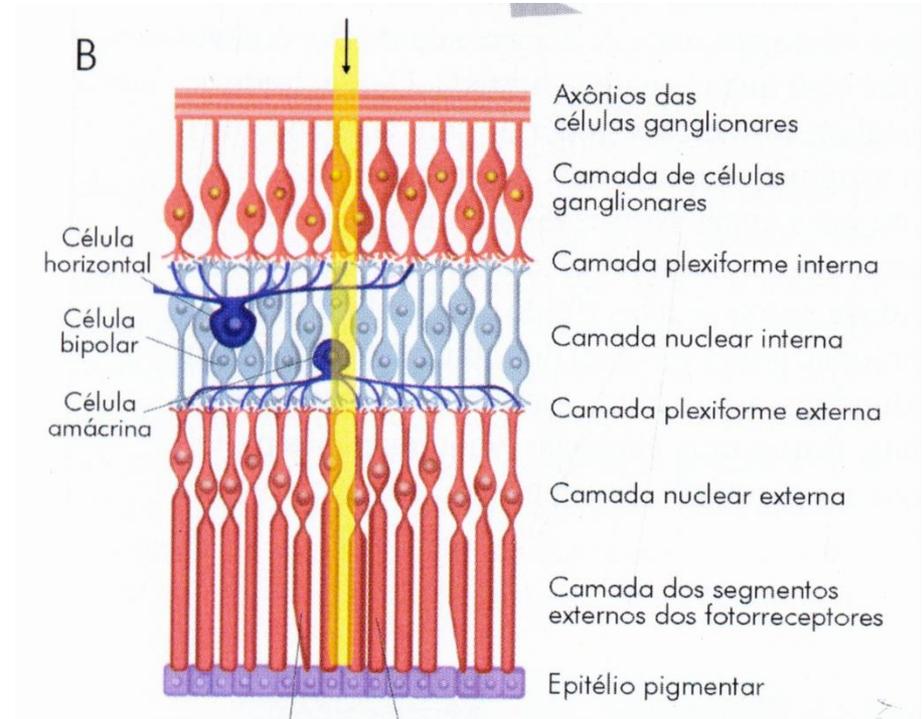
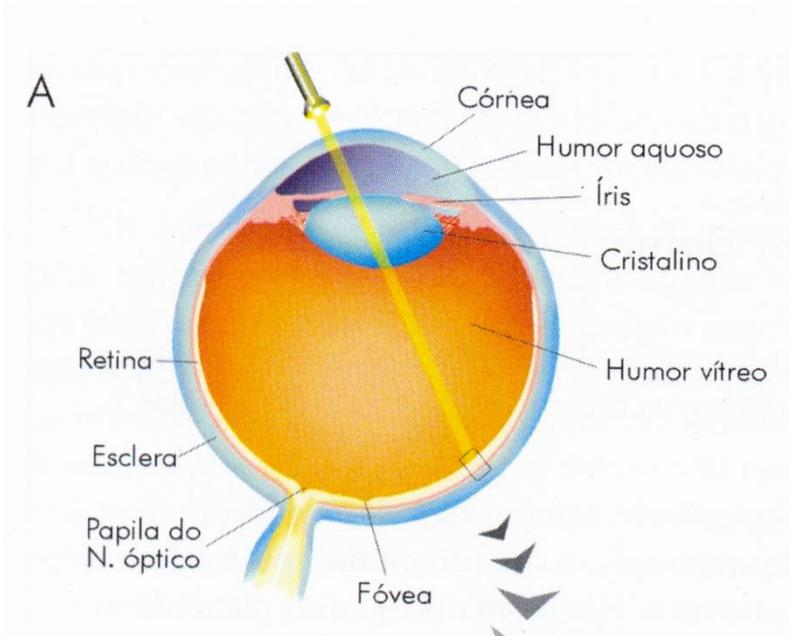
Circuitos neurais associados ao equilíbrio e controle postural



Receptores do Sistema Visual







— sensory fibres
— motor fibres

Optic (II)
sensory: eye



Trochlear (IV)
motor: superior oblique muscle



Olfactory (I)
sensory: nose

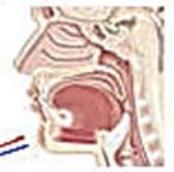


Intermediate motor:
submaxillary and sublingual gland

sensory:
anterior part of tongue and soft palate

Glossopharyngeal (IX)
motor: pharyngeal musculature
sensory: posterior part of tongue, tonsil, pharynx

Vestibulocochlear (VIII)
sensory: inner ear

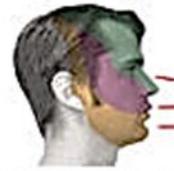


Vagus (X)
motor: heart, lungs, bronchi, gastrointestinal tract
sensory: heart, lungs, bronchi, trachea, larynx, pharynx, gastrointestinal tract, external ear

Accessory (XI)
motor: sternocleidomastoid and trapezius muscles

Abducent (VI)
motor: external rectus muscle

Oculomotor (III)
motor: all eye muscles except those supplied by IV and VI

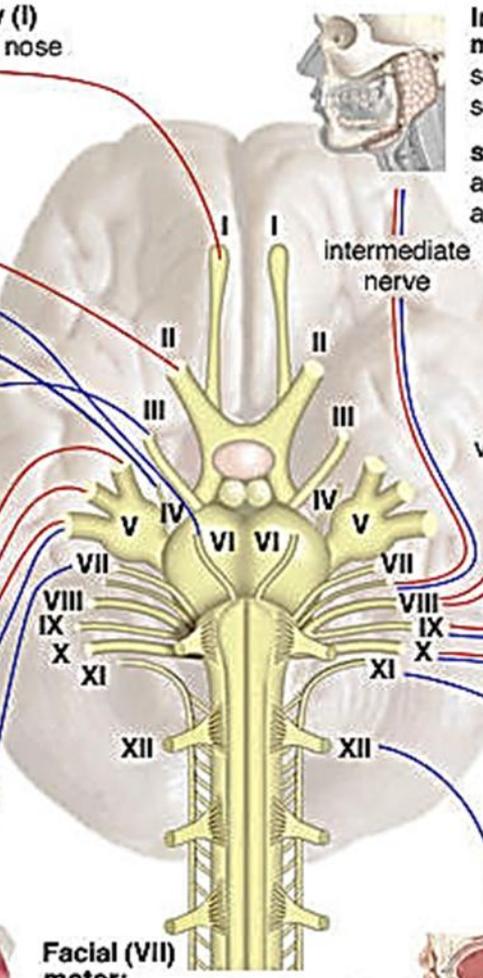


Trigeminal (V)
sensory: face, sinuses, teeth, etc.
motor: muscles of mastication



Facial (VII)
motor: muscles of the face

Hypoglossal (XII)
motor: muscles of the tongue



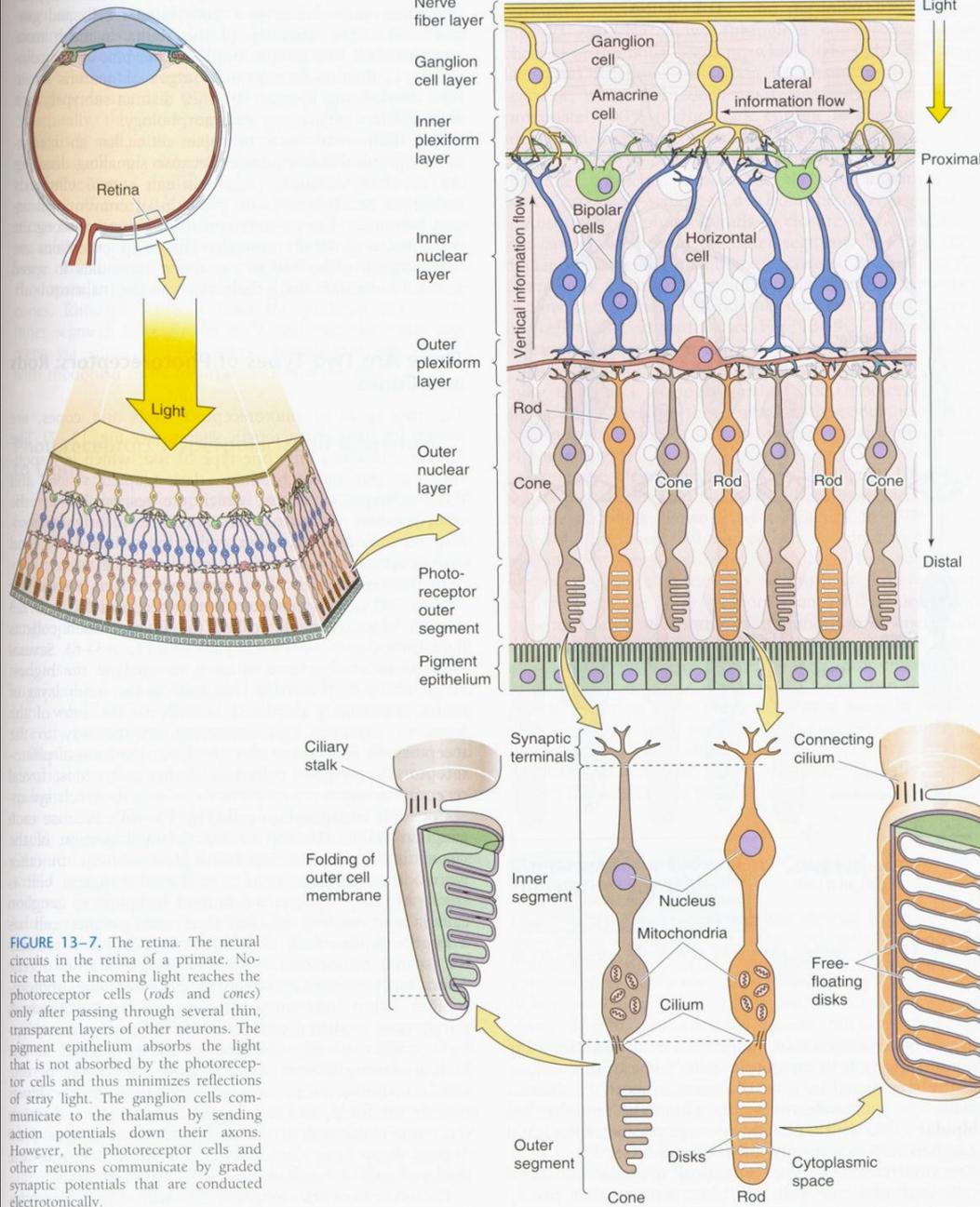
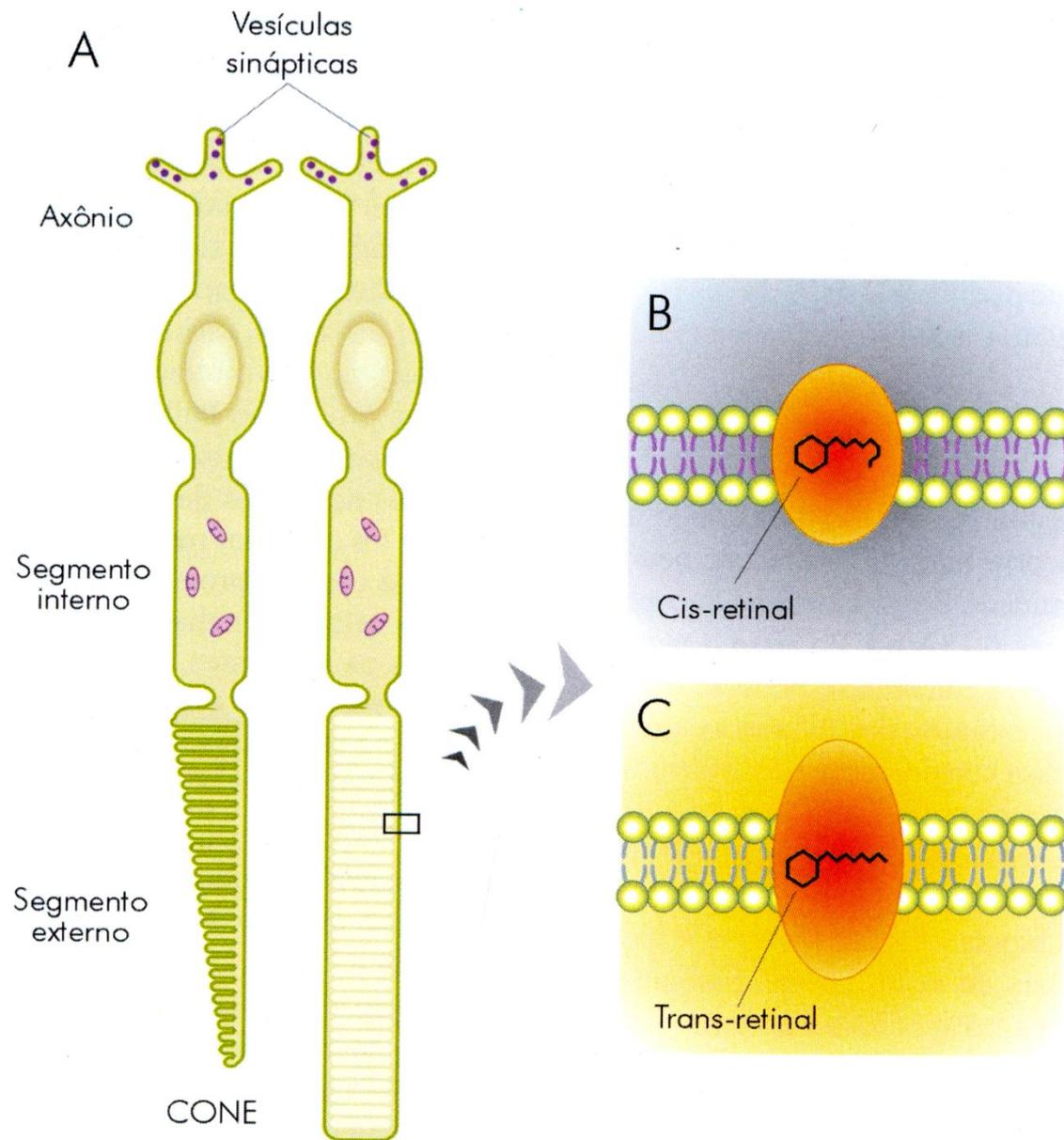
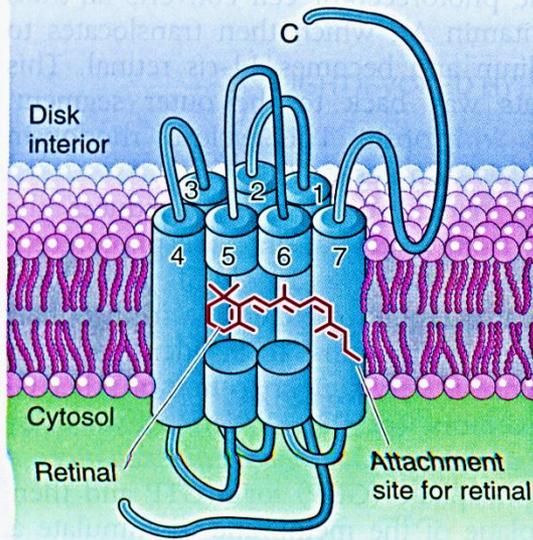


FIGURE 13-7. The retina. The neural circuits in the retina of a primate. Notice that the incoming light reaches the photoreceptor cells (*rods* and *cones*) only after passing through several thin, transparent layers of other neurons. The pigment epithelium absorbs the light that is not absorbed by the photoreceptor cells and thus minimizes reflections of stray light. The ganglion cells communicate to the thalamus by sending action potentials down their axons. However, the photoreceptor cells and other neurons communicate by graded synaptic potentials that are conducted electronically.



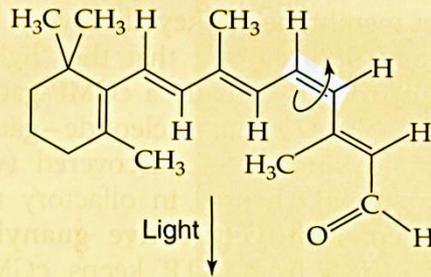
BASTONETE (rodopsina = opsina + retinal)

A OPSIN



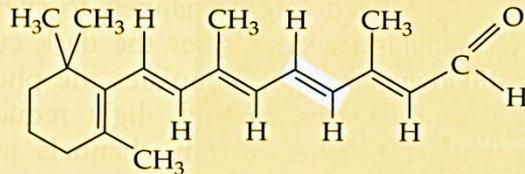
B RETINAL

11-*cis* retinal



Light ↓

All-*trans* retinal



C VISUAL TRANSDUCTION

