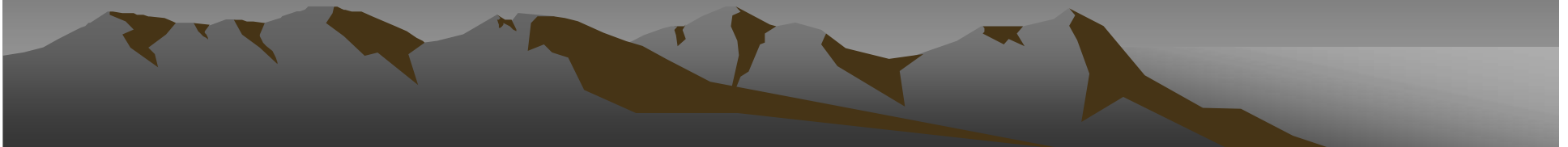


# Obecná fyziologie smyslů

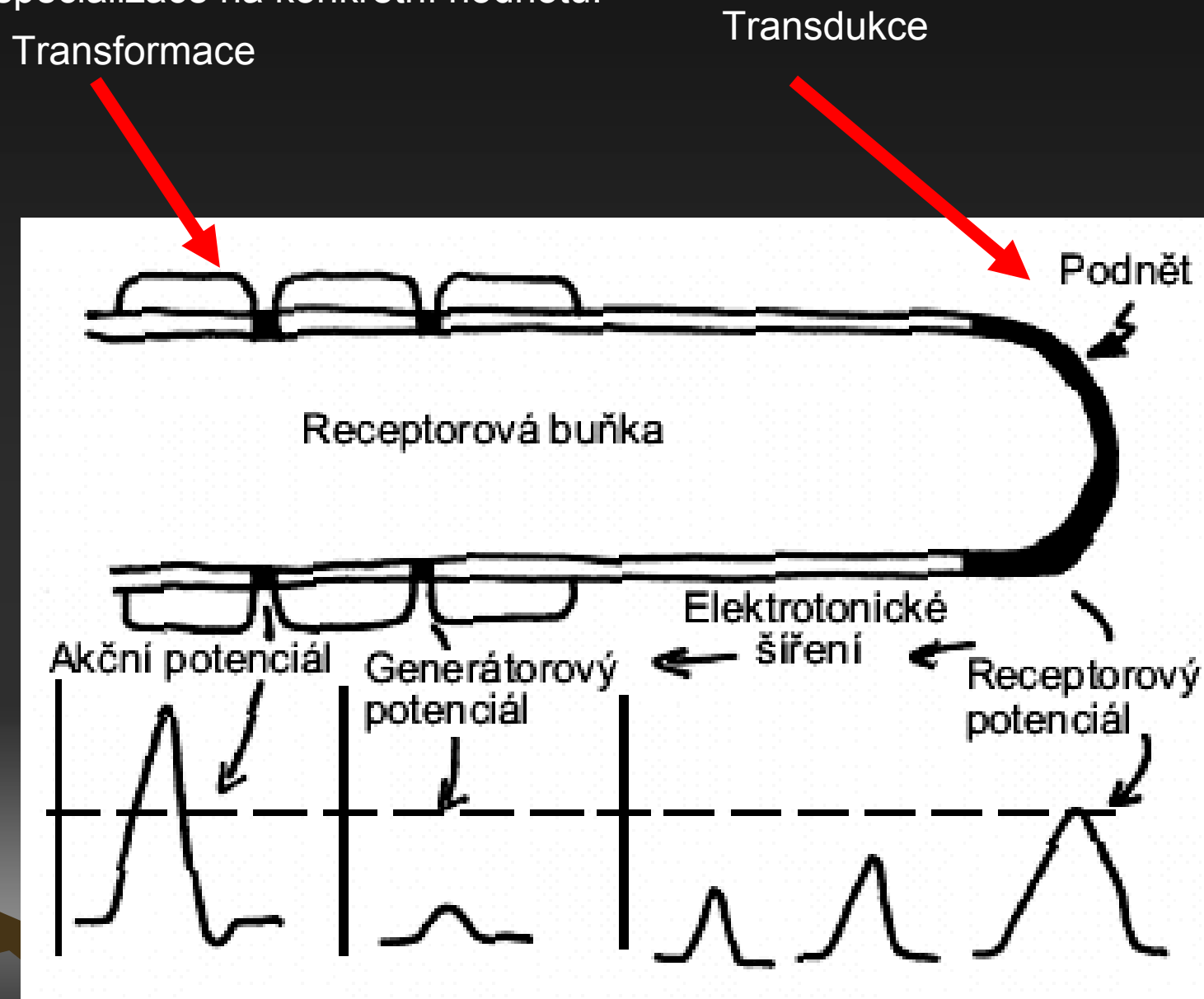
Co se děje na membránách.



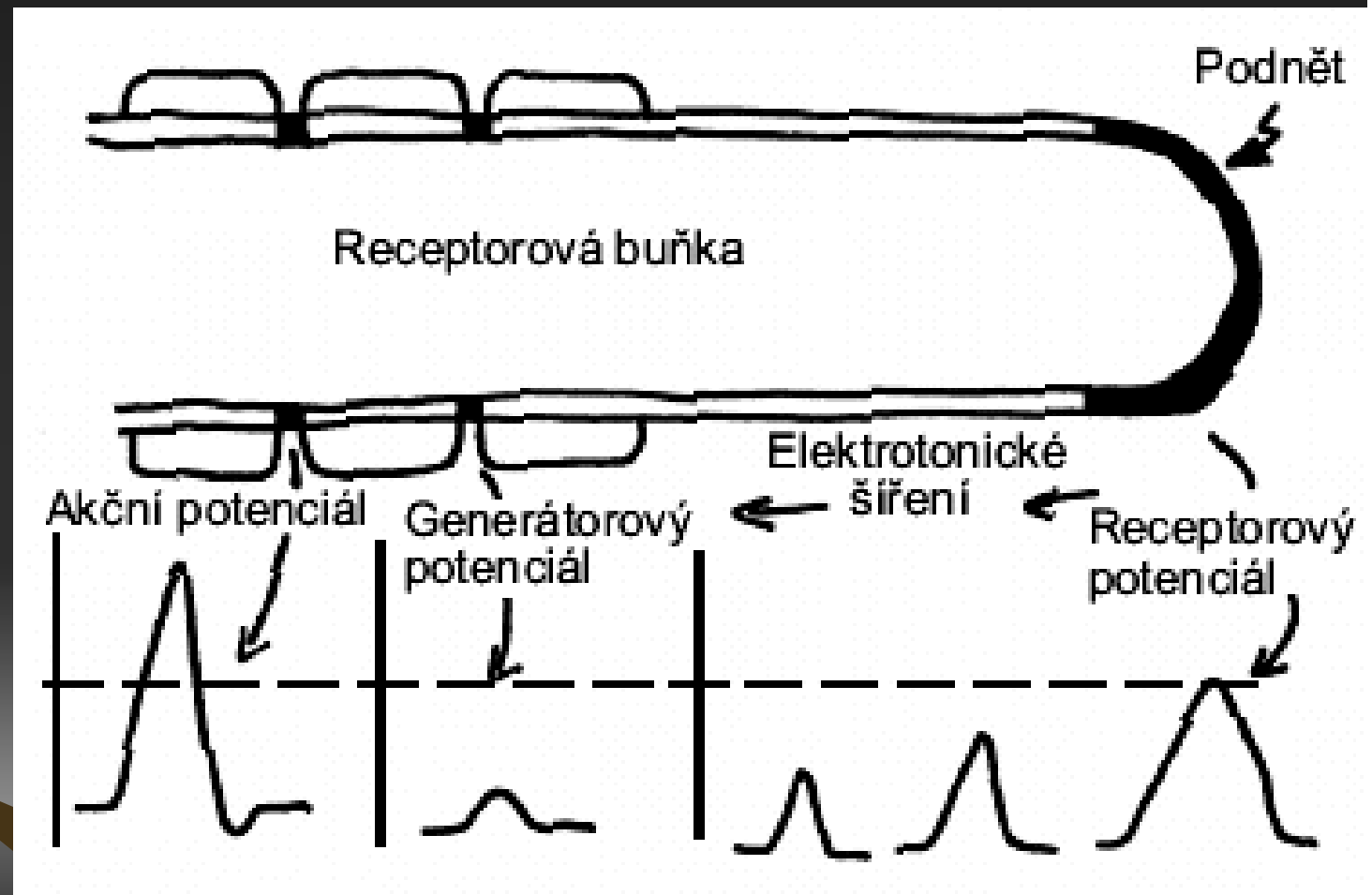
Svět smyslů – úloha mozku.

Paralelní dráhy specializované na určitou vlastnost (kvalitu).

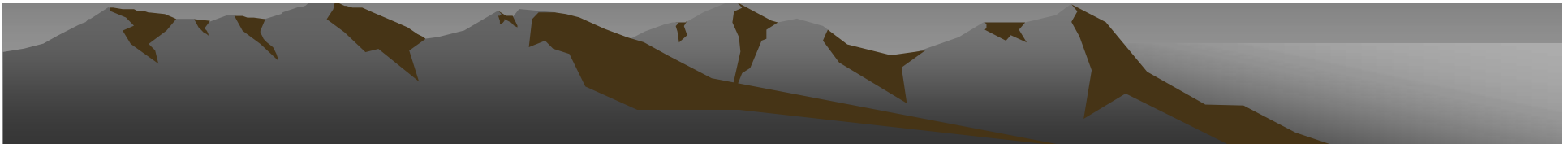
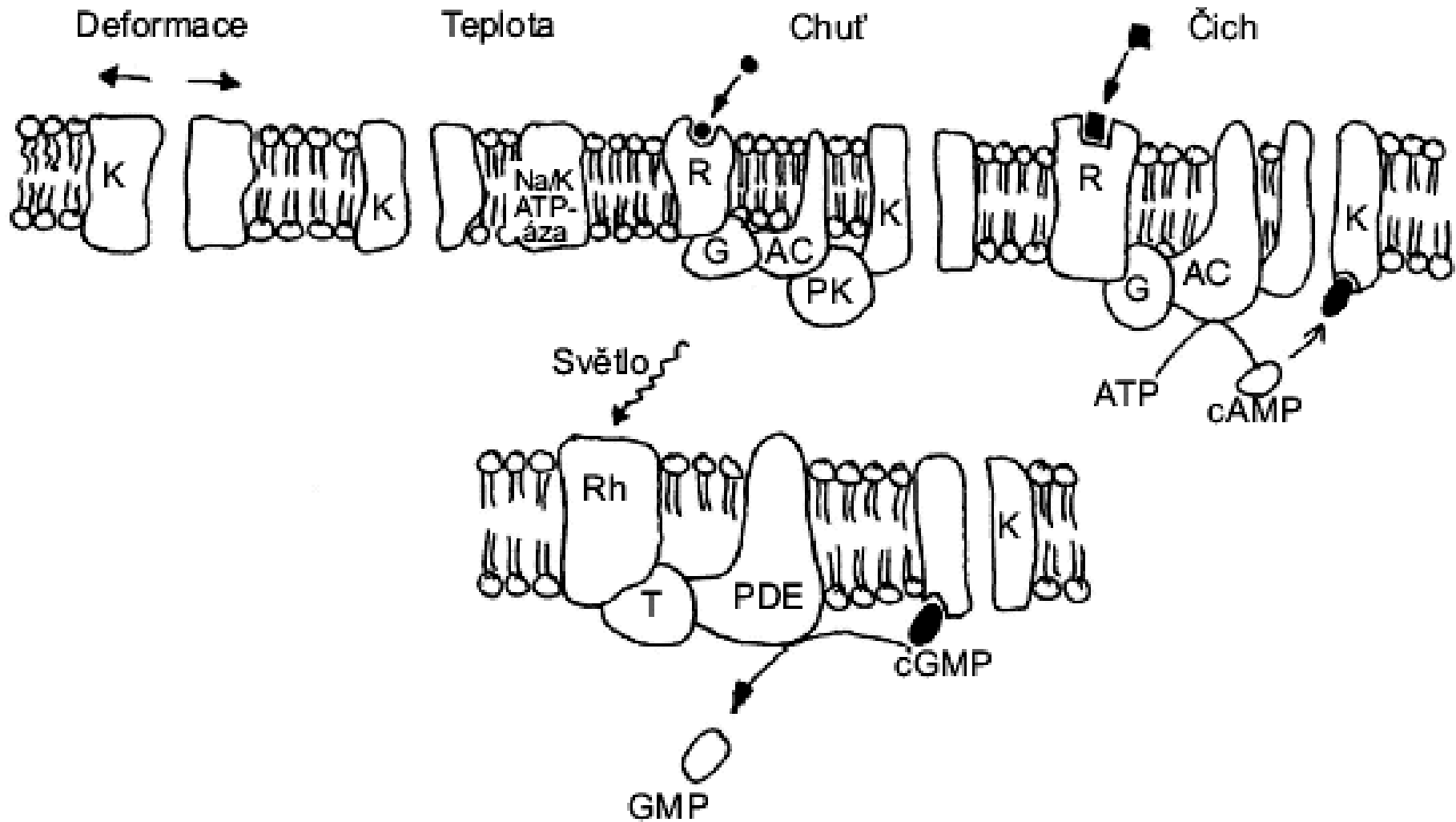
V rámci dráhy ještě specializace na konkrétní hodnotu.



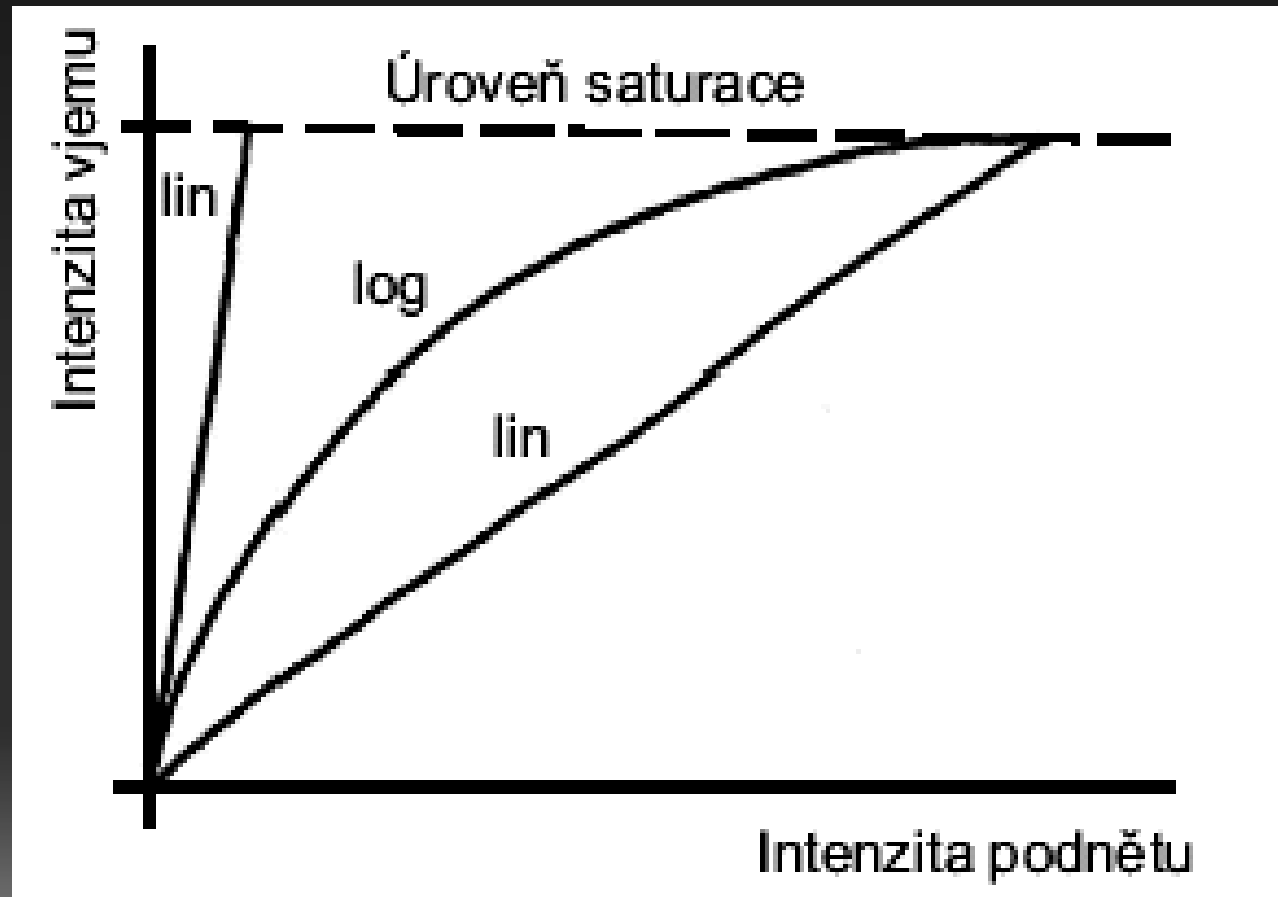
Receptorová buňka převádí energii podnětu na změnu iontové propustnosti.



Vlastnosti membrány jsou klíčem pro transdukcí.



Intenzita podnětu a intenzita odpovědi.

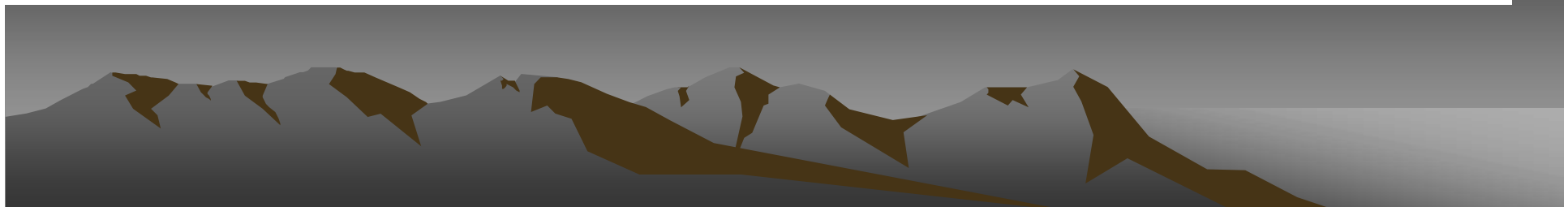
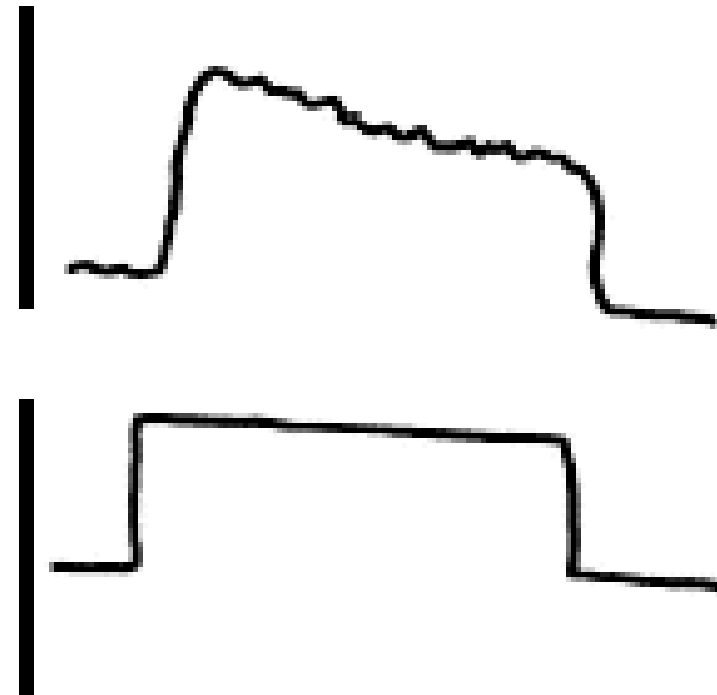
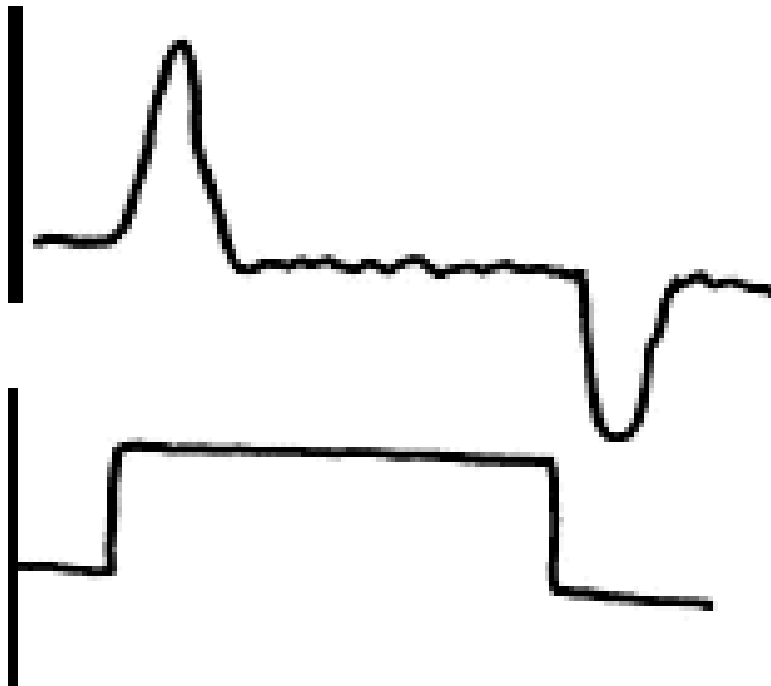


Trvání podnětu a trvání odpovědi.

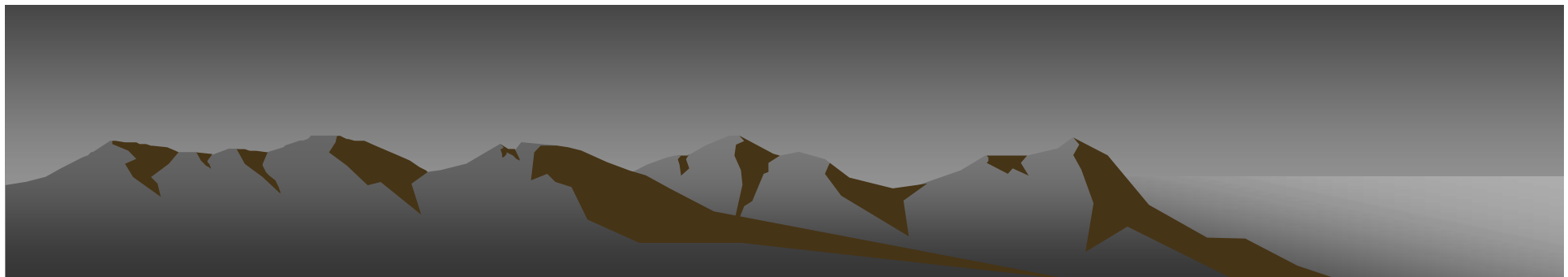
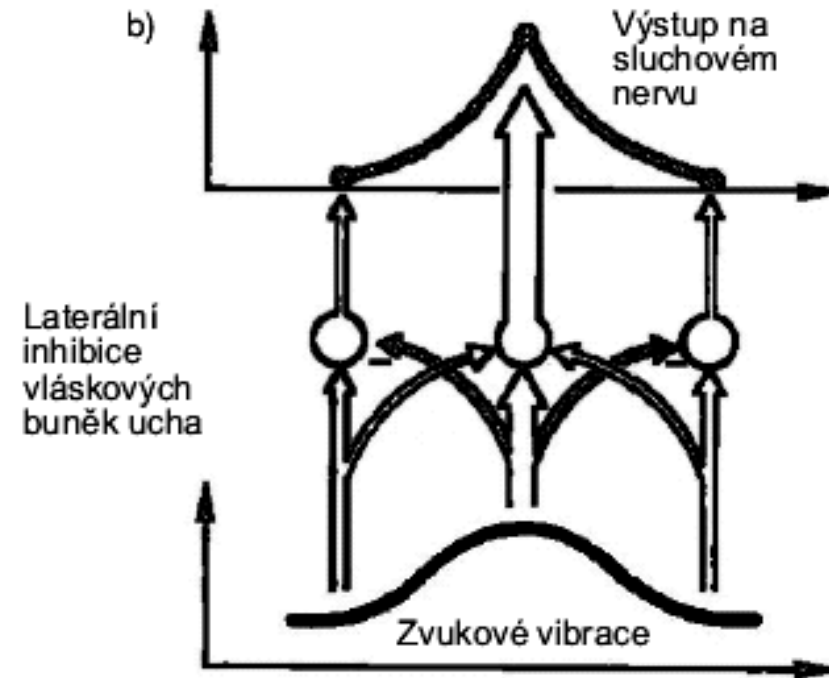
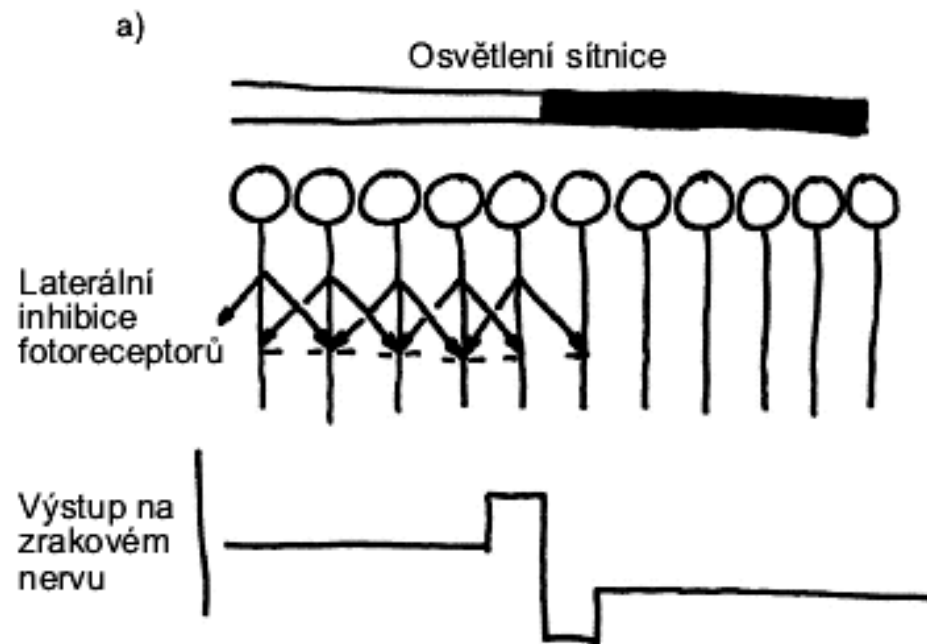
Diferenční receptor

Proporcionální receptor

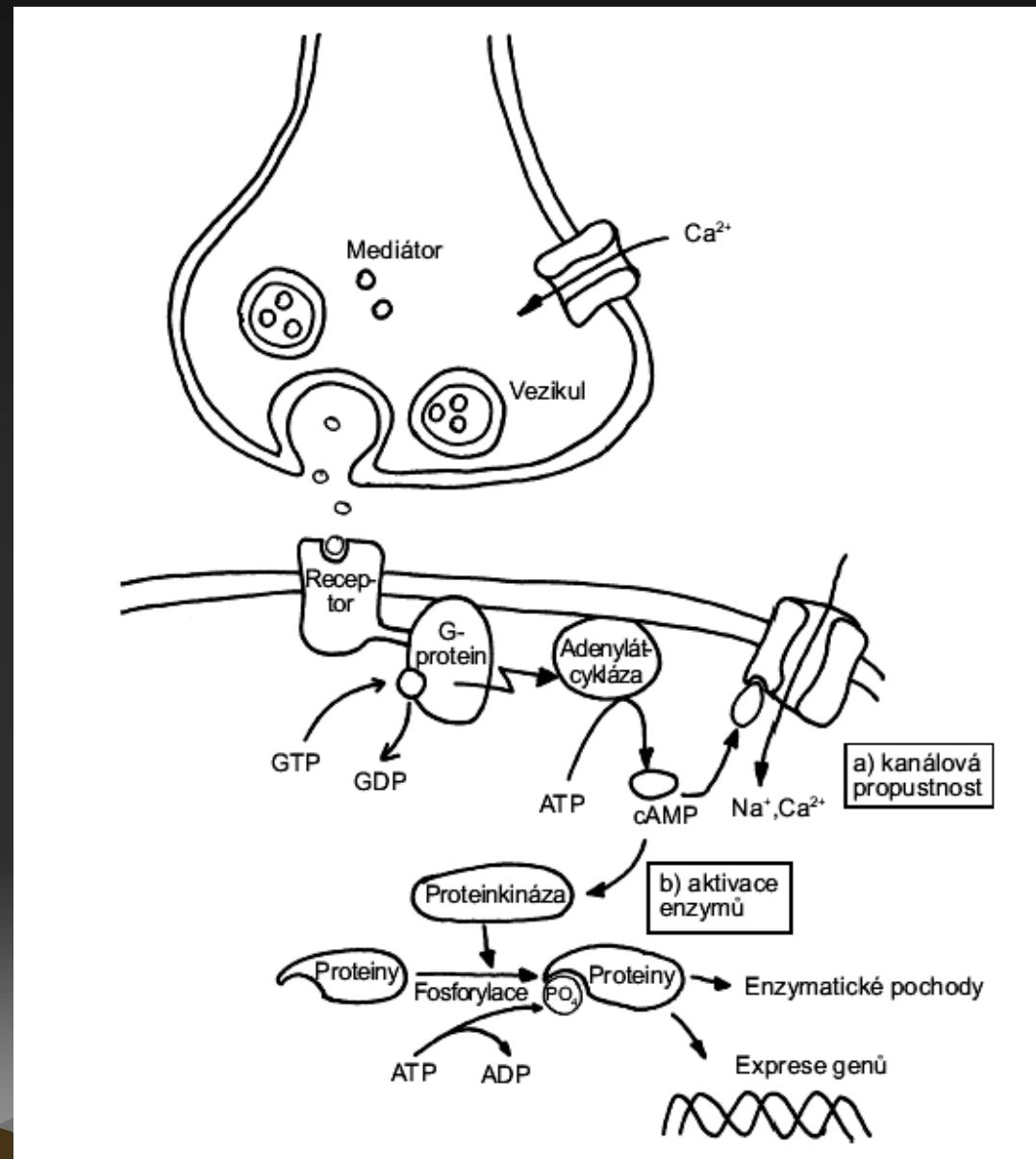
Podnět



# Laterální inhibice: vyšší rozlišovací schopnost zesílení kontrastů

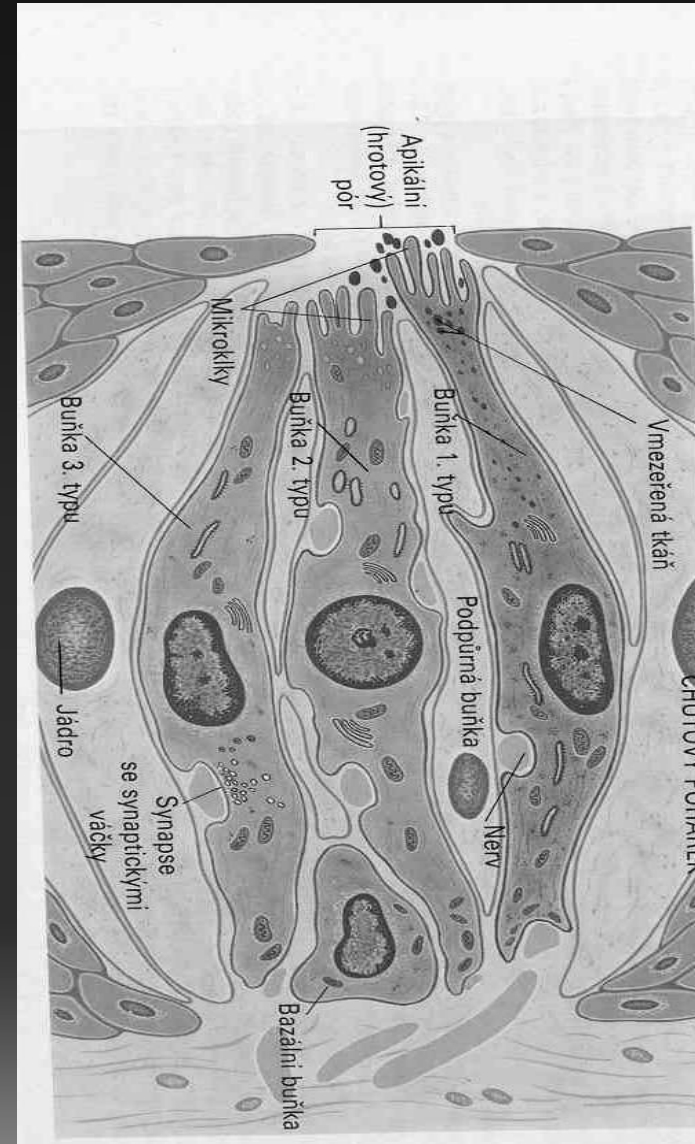
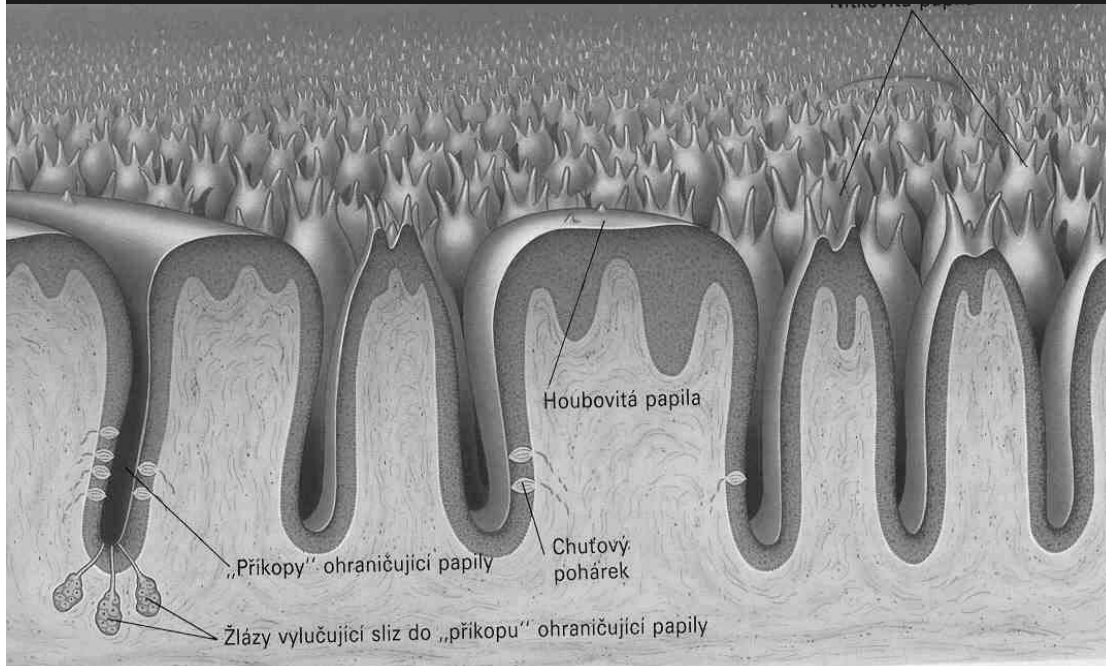


# Chemorecepce

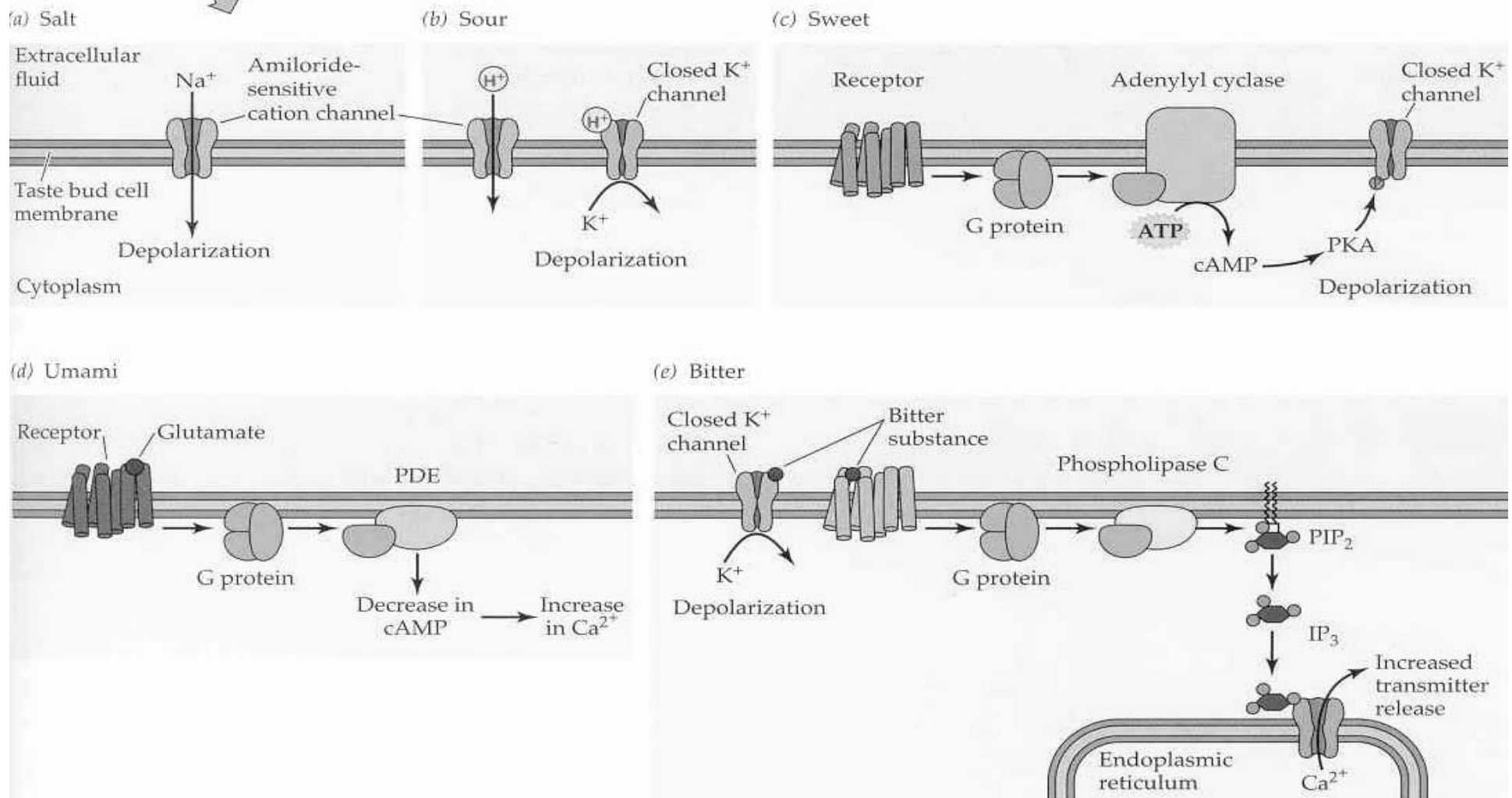




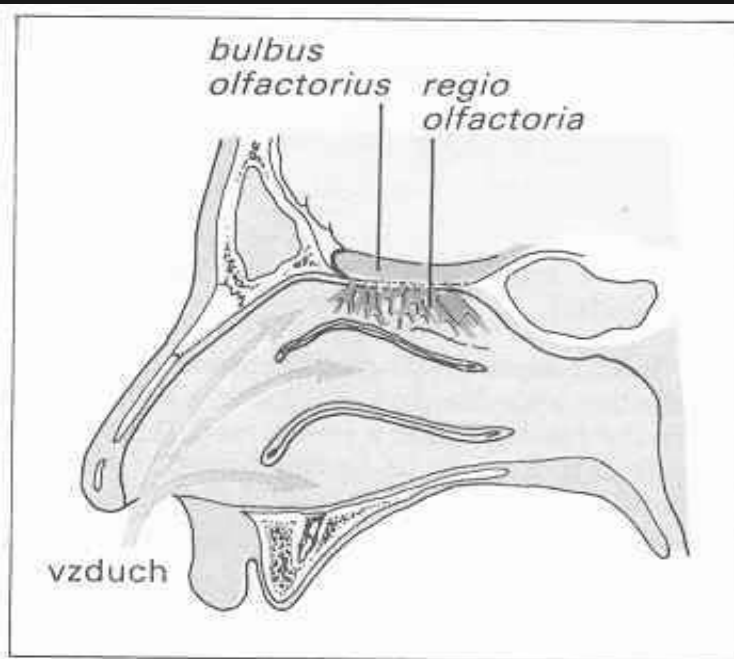
# Chuť



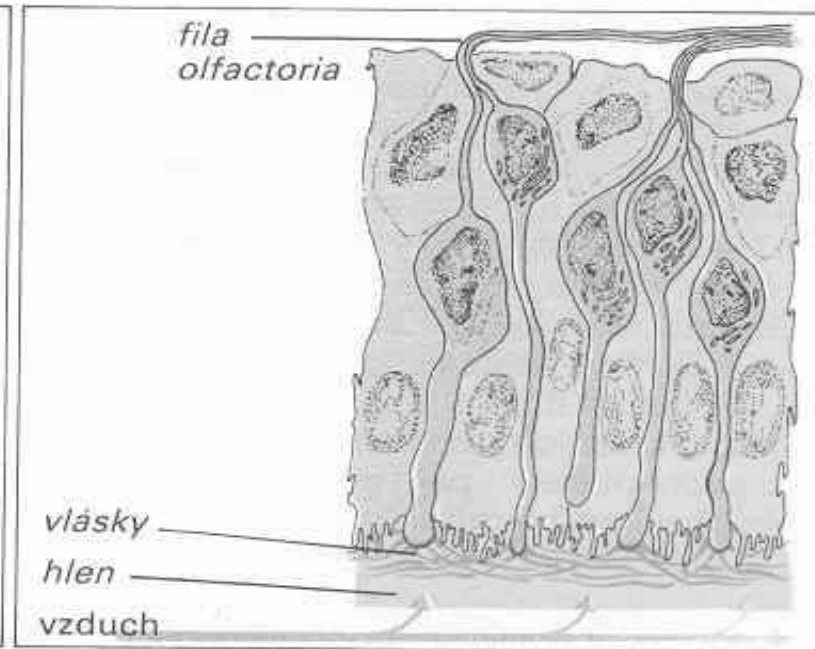
# Různě složité transdukční cesty 5 základních chutí.



# Čich

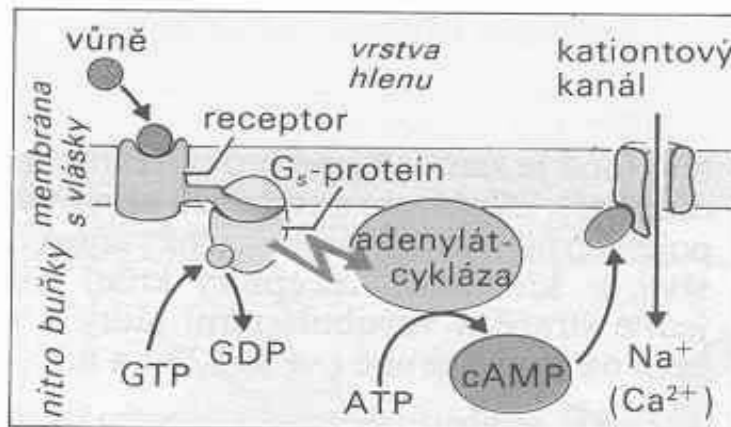


A. Nosní dutina a čichový orgán

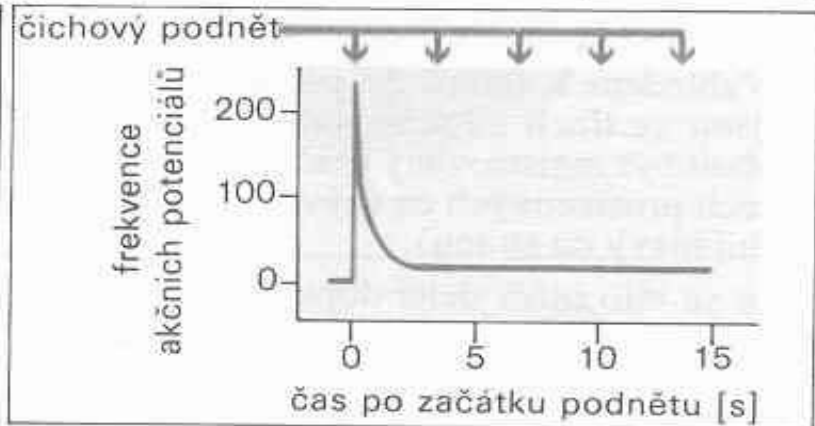


B. Čichový epitel

(podle Andrese)

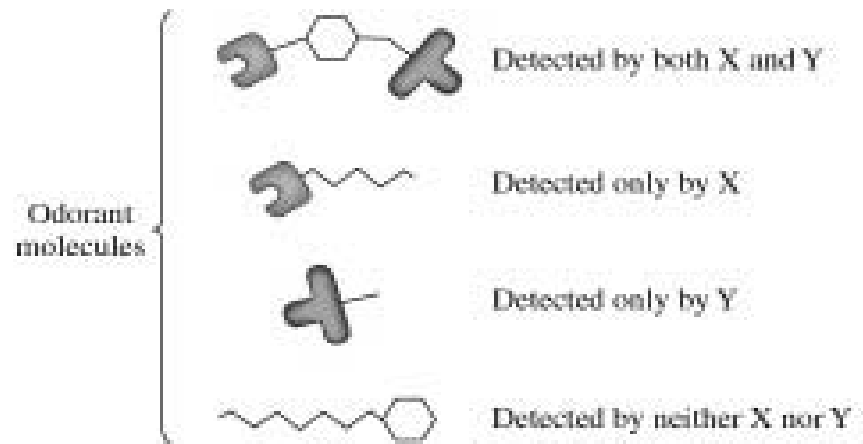
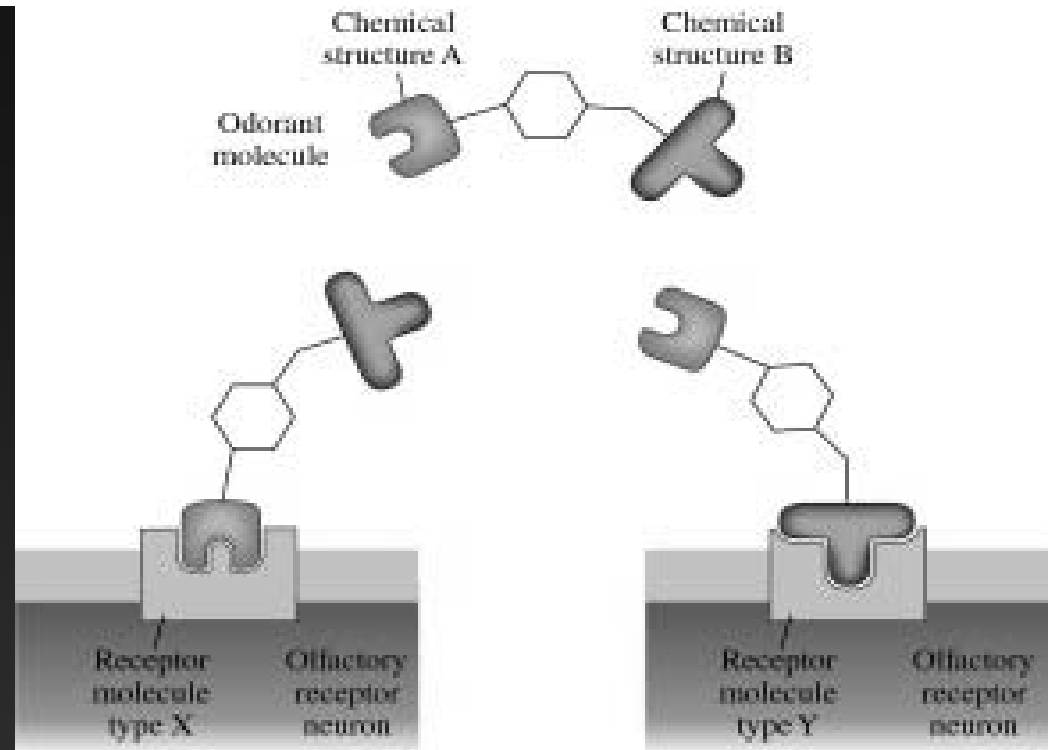


C. Transdukce čichového podnětu



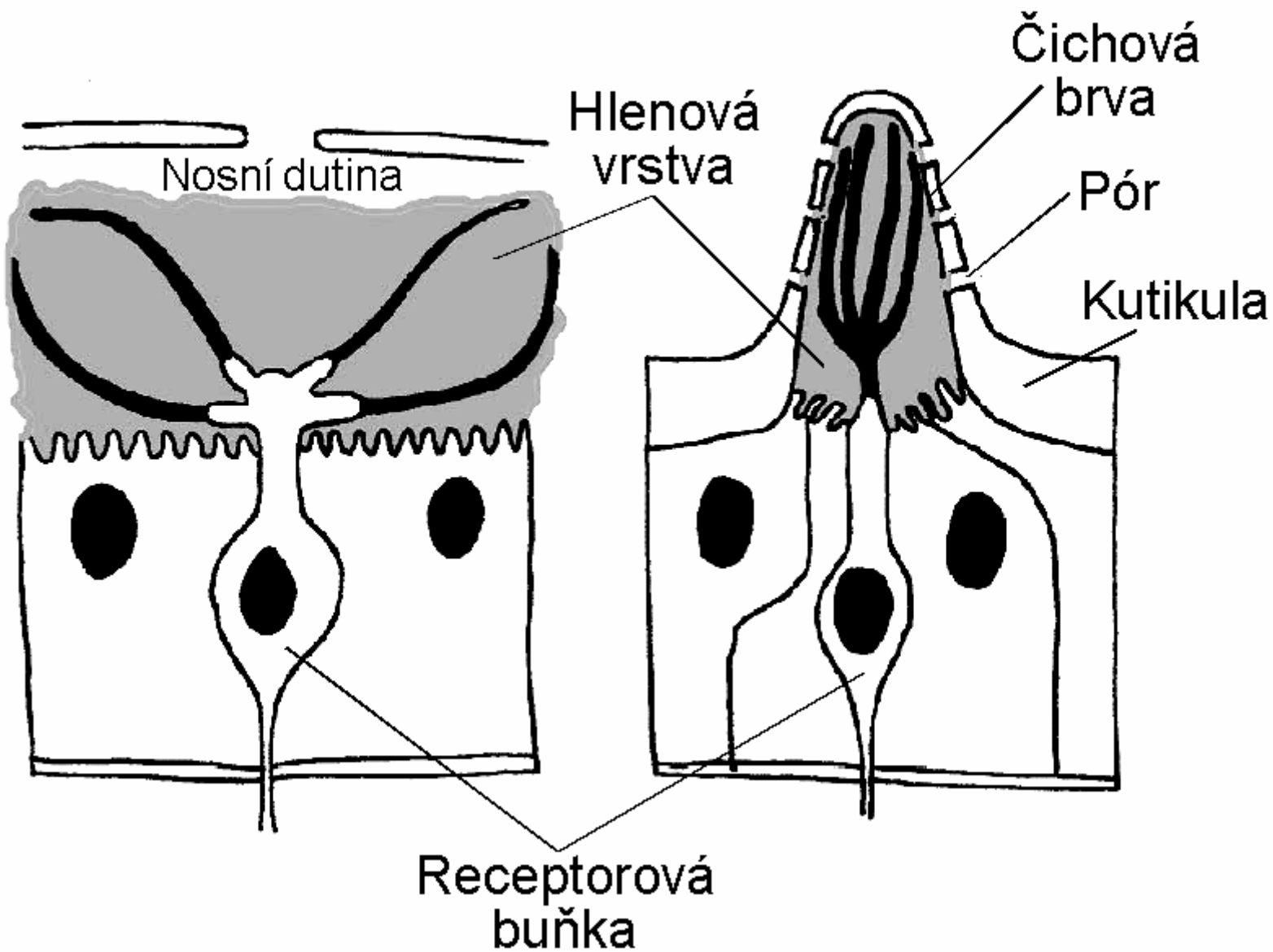
D. Adaptace čichu

# Specifita srovnatelná s imunitní Cis/trans rozlišení



a) Savci

b) Hmyz



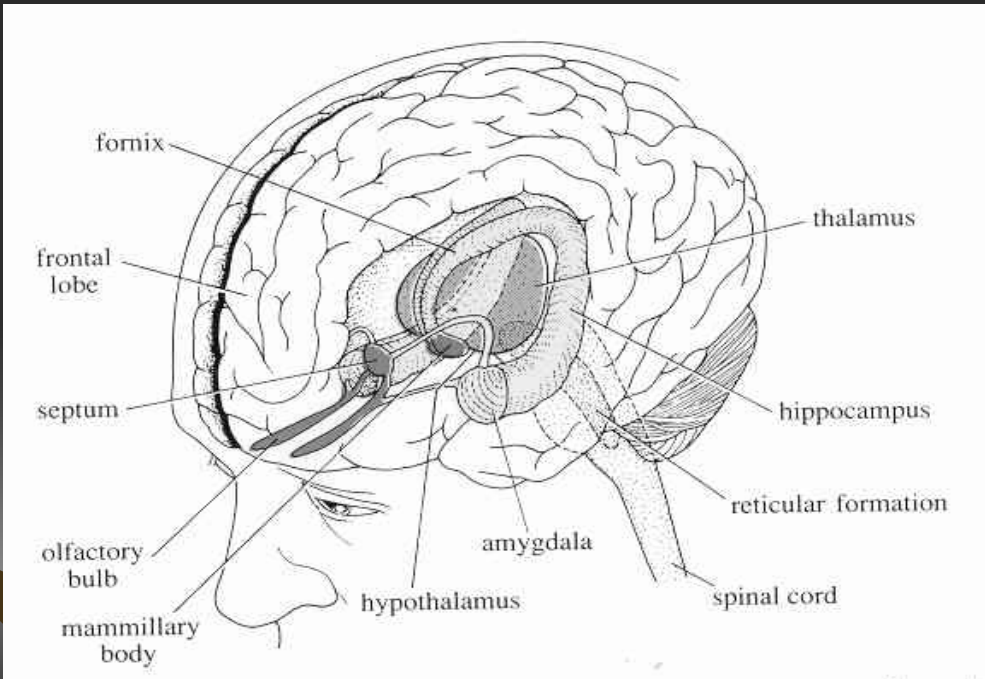
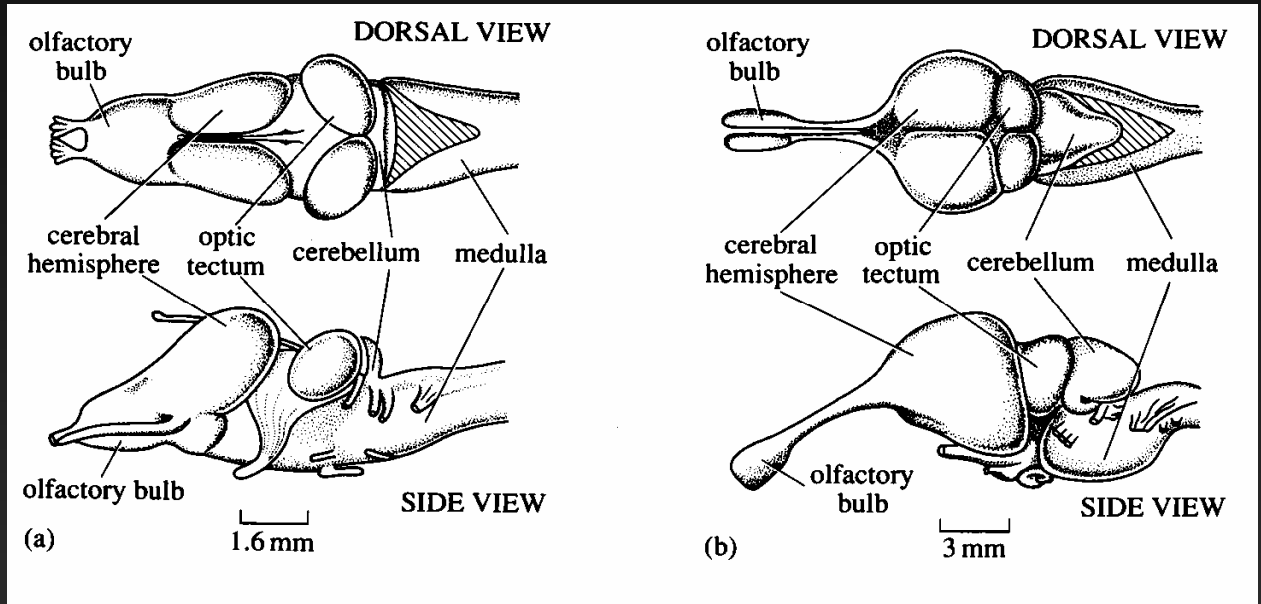
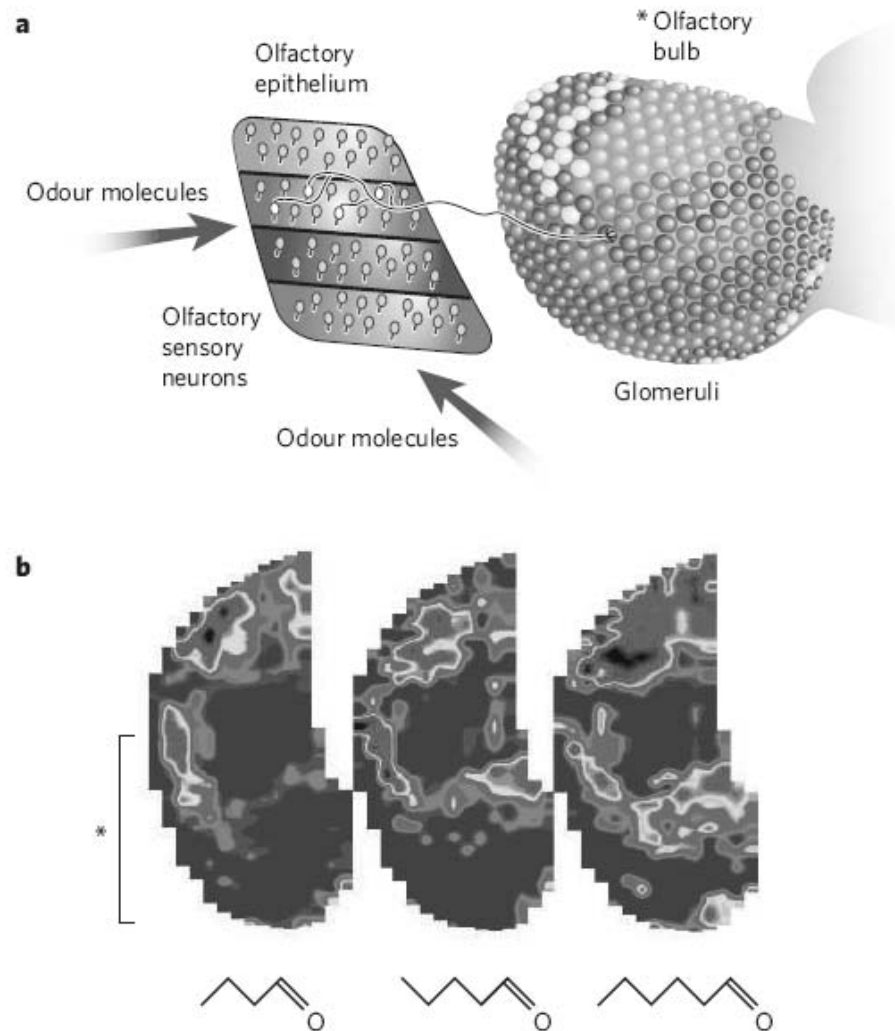
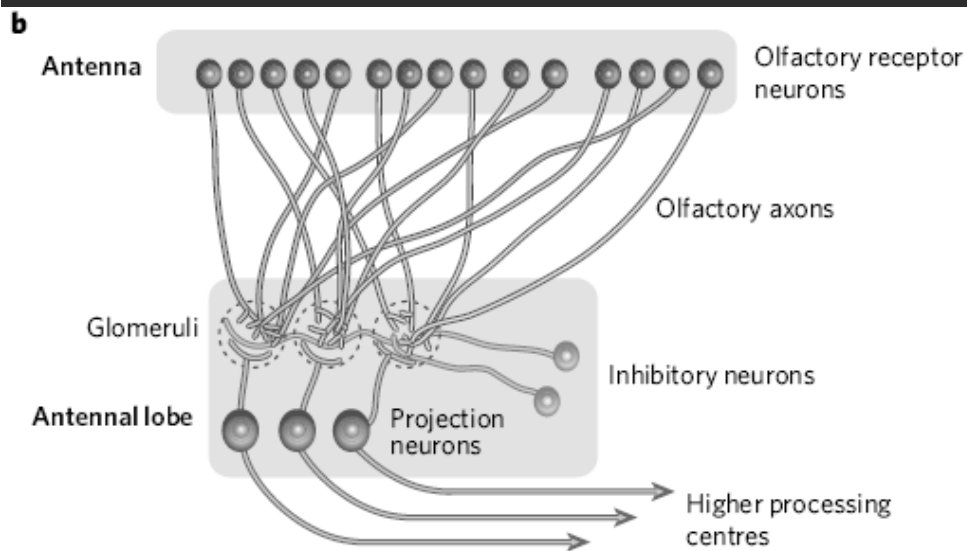


Figure 10.1 The limbic system (the main limbic system structures are shown in

Mapa vůní – vzorec aktivovaných  
Glomerulů  
Konvergence neprostorového parametru  
na prostorový

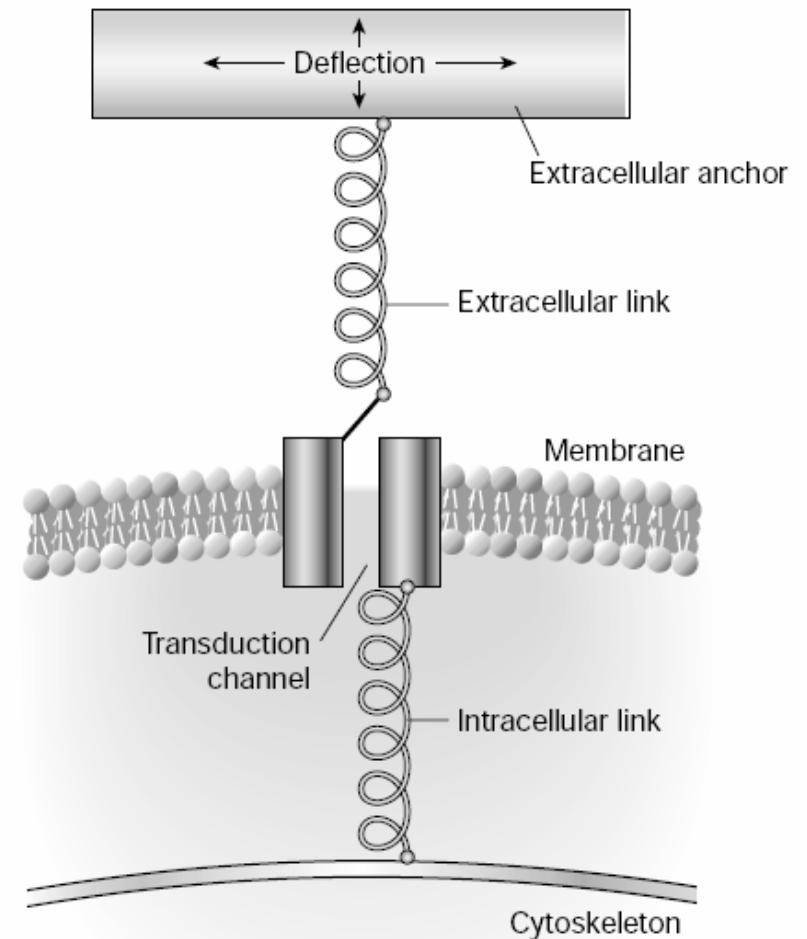


**Figure 1 | Odour images in the olfactory glomerular layer.** **a**, Diagram showing the relationship between the olfactory receptor cell sheet in the nose and the glomeruli of the olfactory bulb<sup>53</sup>. **b**, fMRI images of the different but overlapping activity patterns seen in the glomerular layer of the olfactory bulb of a mouse exposed to members of the straight-chain aldehyde series, varying from four to six carbon atoms. The lower part of the image in the left panel corresponds to the image on the medial side of the olfactory glomerular layer as shown in **a** (see asterisk). (Image in **a** adapted, with permission, from ref. 53; image in **b** adapted, with permission, from ref. 10.)

## Mechanorecepce

Bolest, dotek,  
Propriorecepce,  
Zvuk, gravitace,  
Pohyb,  
Vlhkost ?  
Magnetické pole?

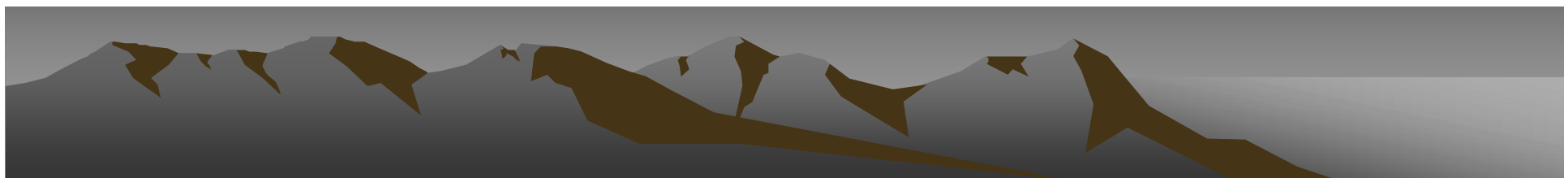
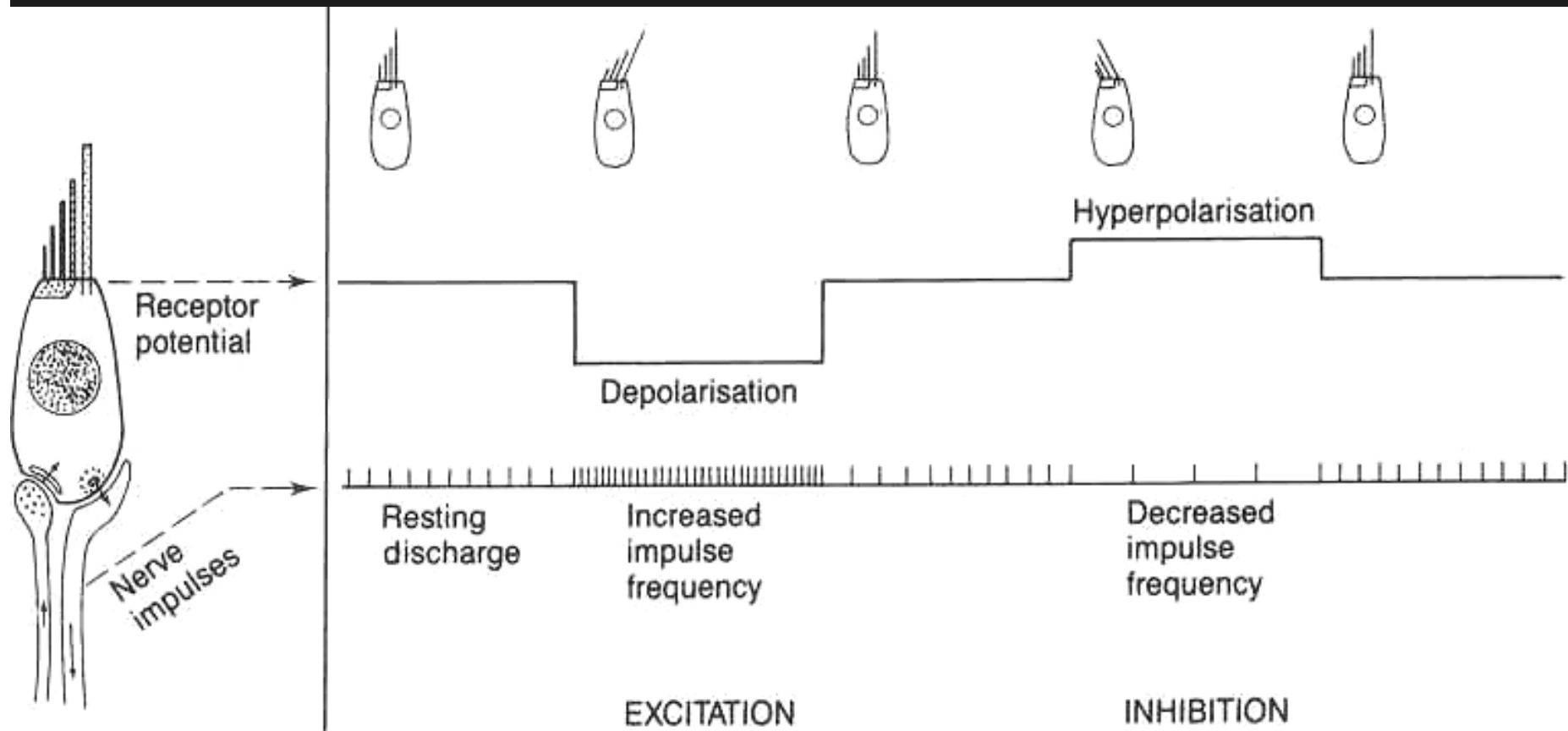
Jednotné molekulární schéma



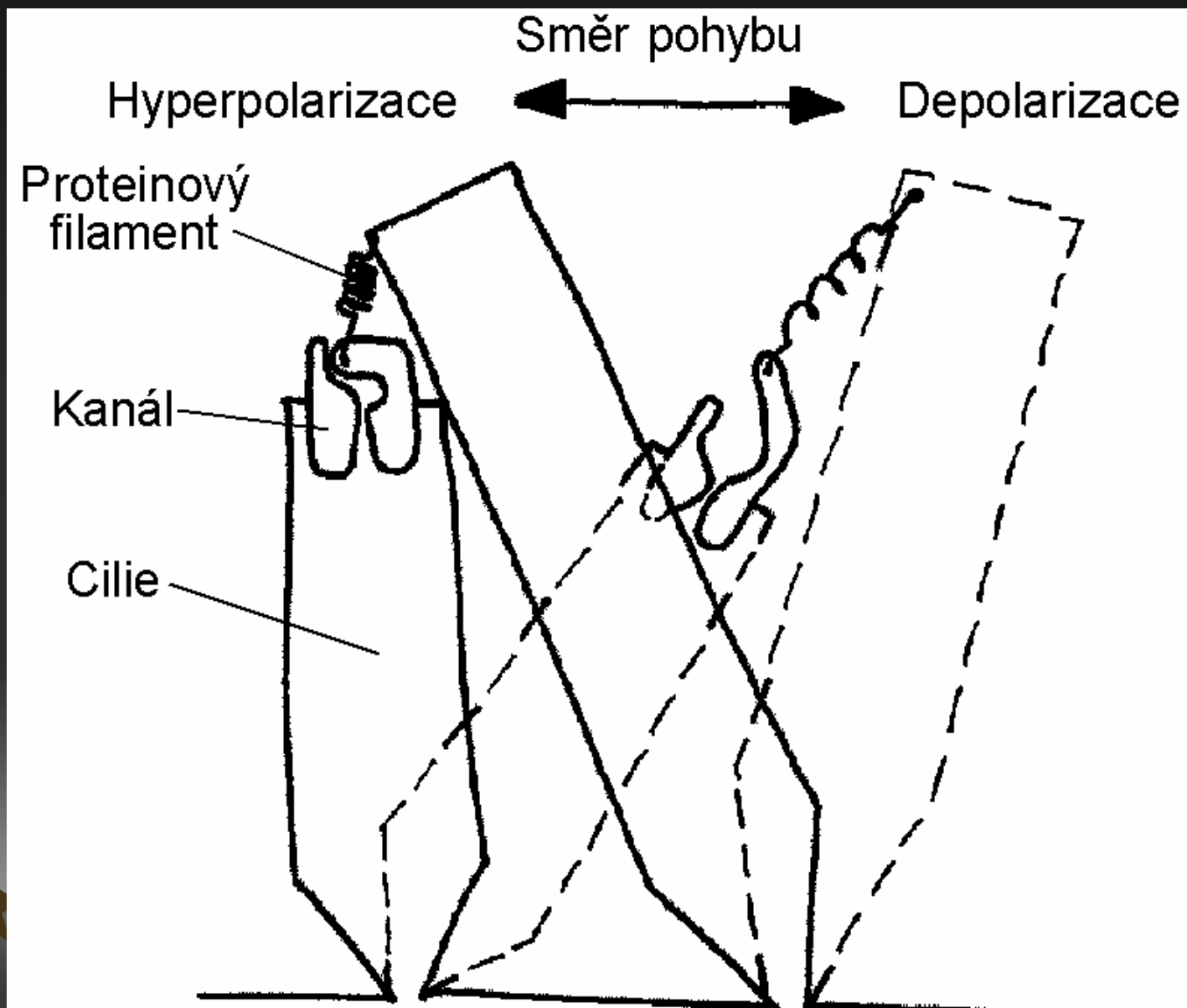
**Figure 1** General features of mechanosensory transduction. A transduction channel is anchored by intracellular and extracellular anchors to the cytoskeleton and to an extracellular structure to which forces are applied. The transduction channel responds to tension in the system, which is increased by net displacements between intracellular and extracellular structures.



# Vlásoková buňka – specialista na jemný pohyb



# Vlášková buňka – specialista na jemný pohyb



# Somatosensorické vnímání

## Mechanoreceptors

Pacinian corpuscle  
Touch; vibration  
Rapid adaptation  
Myelinated axon

Meissner corpuscle  
Touch; vibration  
Rapid adaptation  
Myelinated axon

Ruffini corpuscle  
Touch; pressure  
Slow adaptation  
Myelinated axon

Merkel disk  
Touch; pressure  
Slow adaptation  
Myelinated axon

Hair follicle receptor  
Hair displacement  
Rapid adaptation  
Myelinated axon

## Thermoreceptors

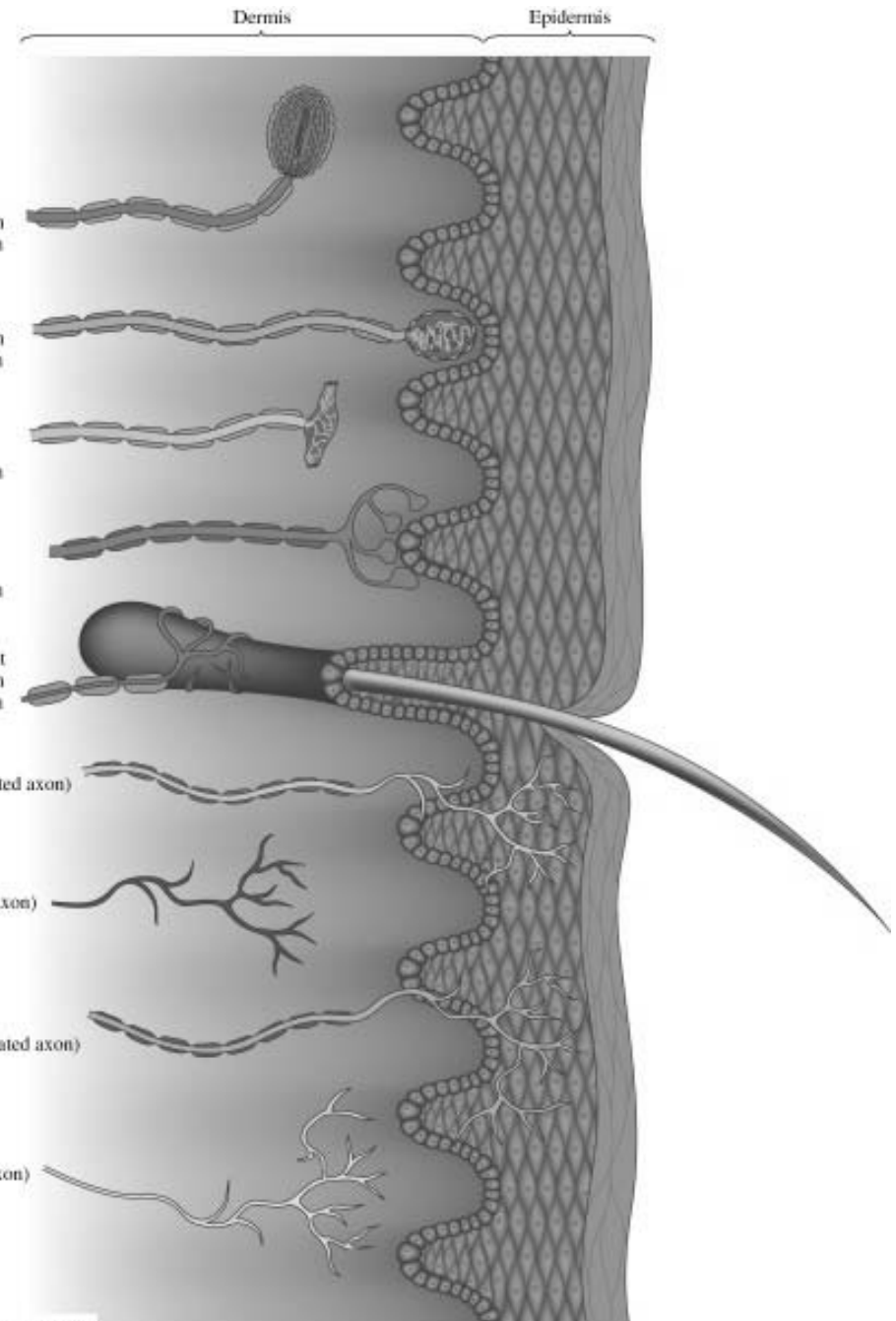
Cold (smaller myelinated axon)

Warm (unmyelinated axon)

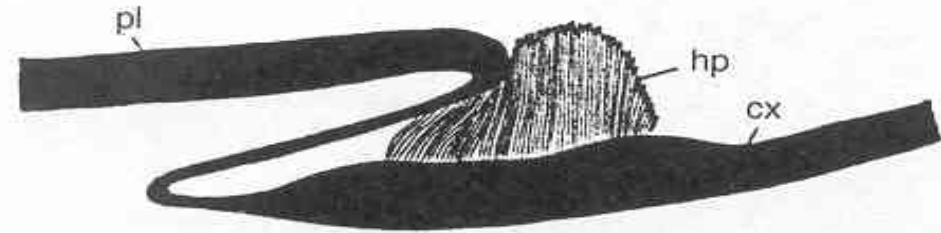
## Nociceptors

Rapid (smaller myelinated axon)

Slow (unmyelinated axon)



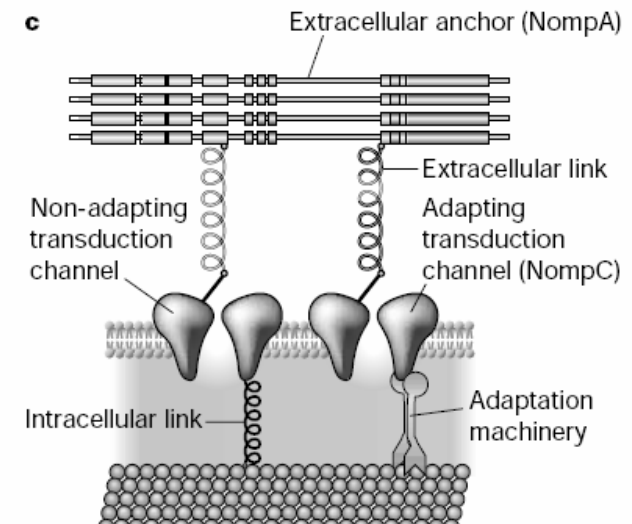
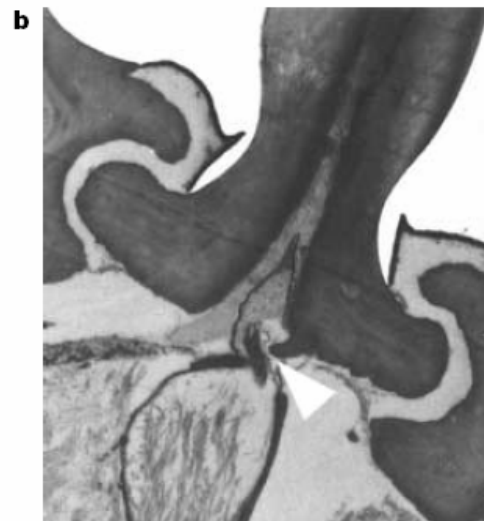
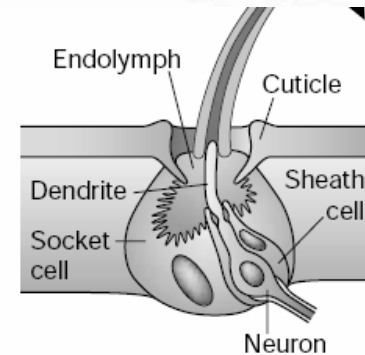
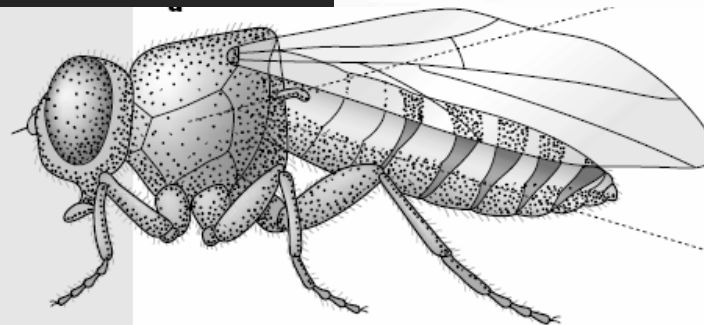
# Somatosensorické vnímání



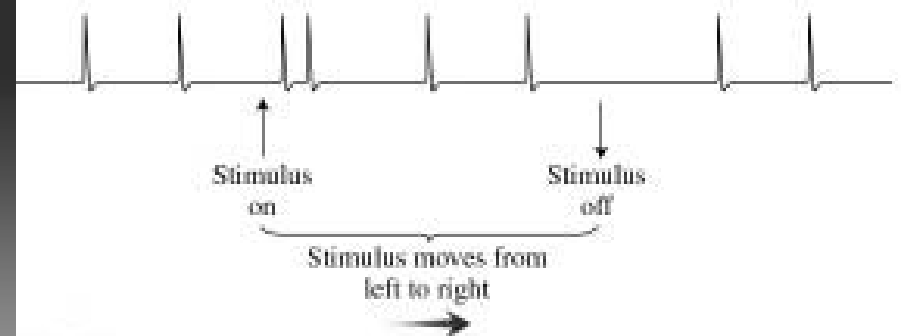
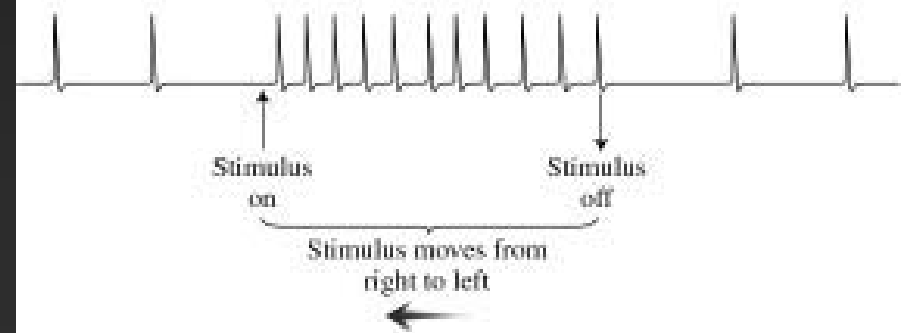
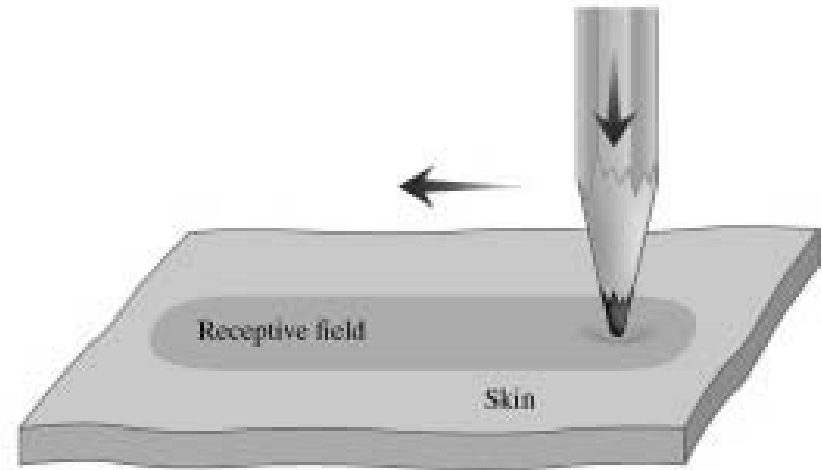
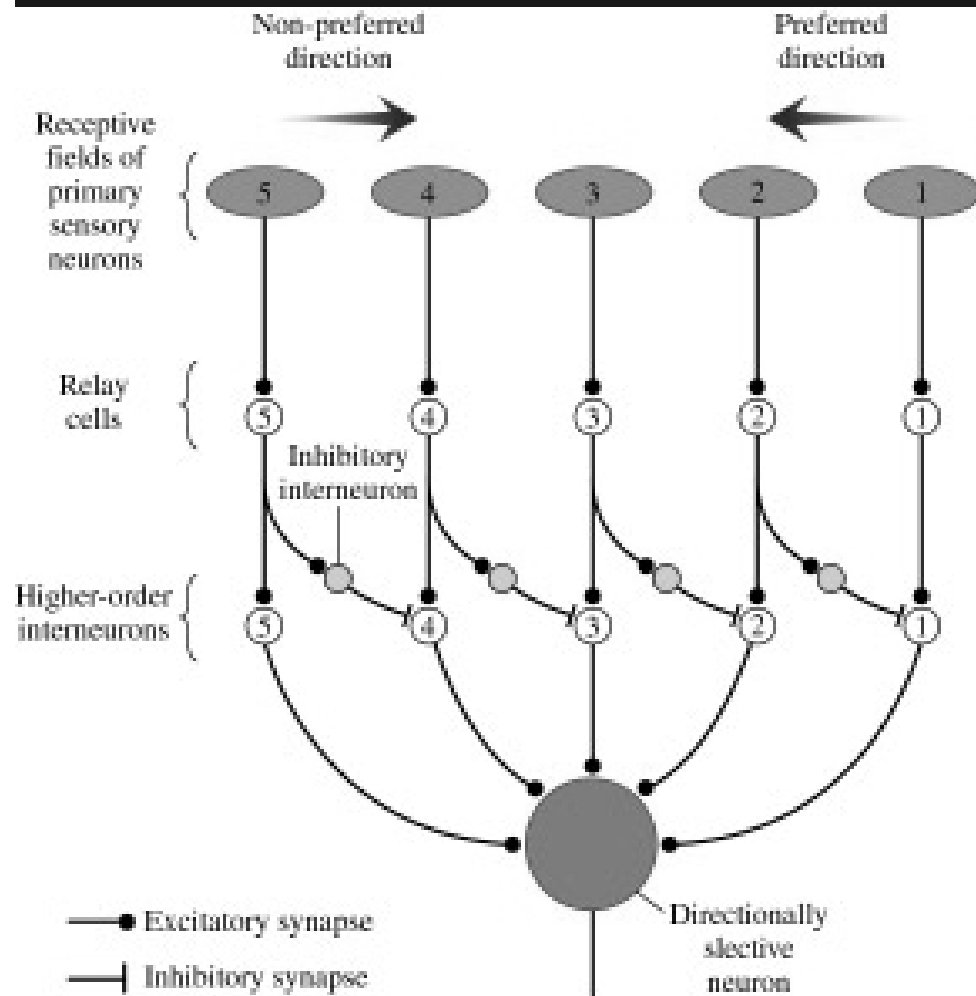
**Figure 6.3** (a) The figure shows the brushwork of sensilla at the articulation of the second leg of the cockroach, *Periplaneta americana*. The thick cuticle of the pleuron (pl) thins to a delicate articular membrane and then thickens again to form the cuticle surrounding the coxa (cx), the first segment of the leg. The brush of sensilla forms a hairplate (hp). From Pringle, 1938

**Figure 3** *Drosophila* bristle-receptor model.

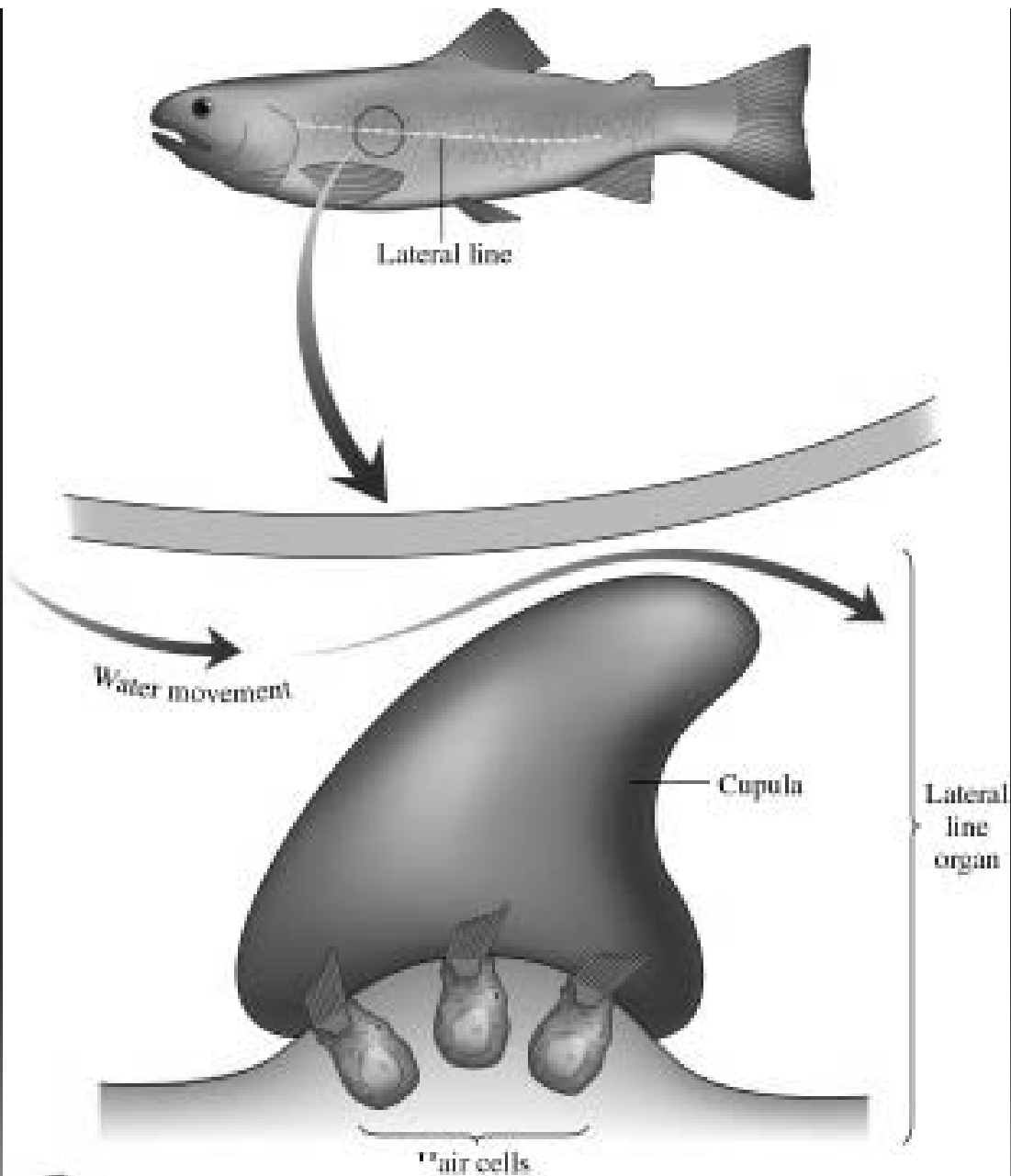
**a.** Lateral view of *D. melanogaster* showing the hundreds of bristles that cover the fly's cuticle. The expanded view of a single bristle indicates the locations of the stereotypical set of cells and structures associated with each mechanosensory organ. Movement of the bristle towards the cuticle of the fly (arrow) displaces the dendrite and elicits an excitatory response in the mechanosensory neuron. **b.** Transmission electron micrograph of an insect mechanosensory bristle showing the insertion of the dendrite at the base of the bristle. The bristle contacts the dendrite (arrowhead) so that movement of the shaft of the bristle will be detected by the neuron. **c.** Proposed molecular model of transduction for ciliated insect mechanoreceptors, with the locations of NompC and NompA indicated.



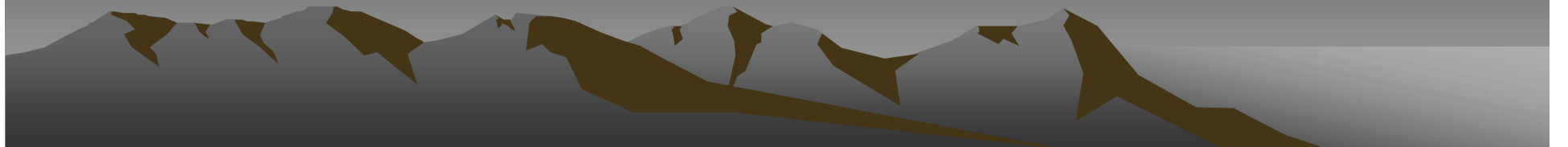
# Periferní detektor směru pohybu



# Proudový smysl

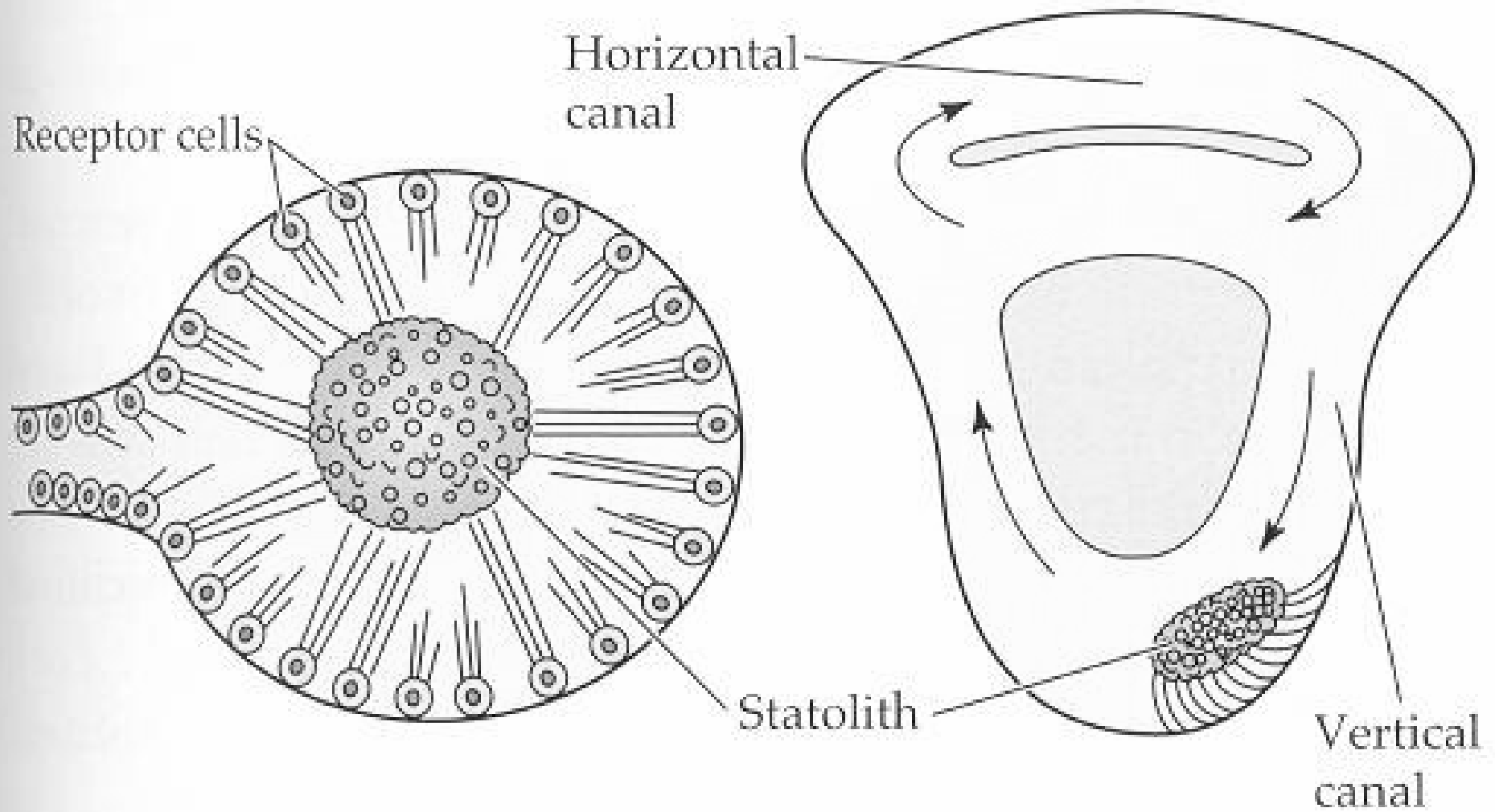


Ryba animace

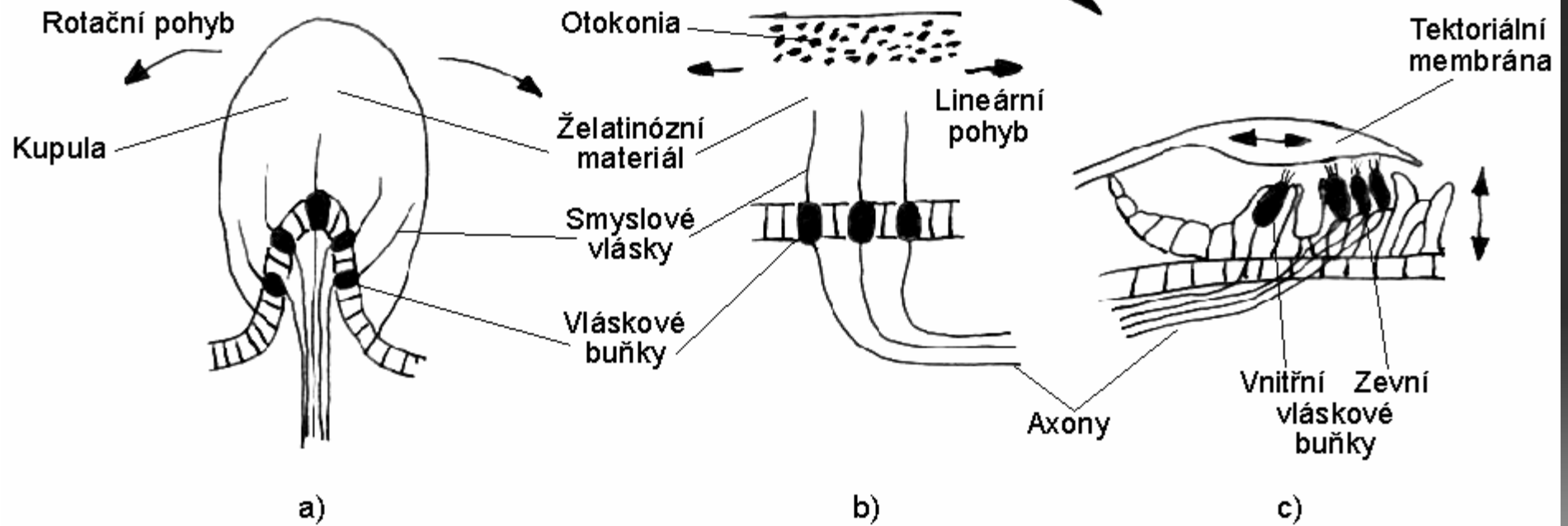
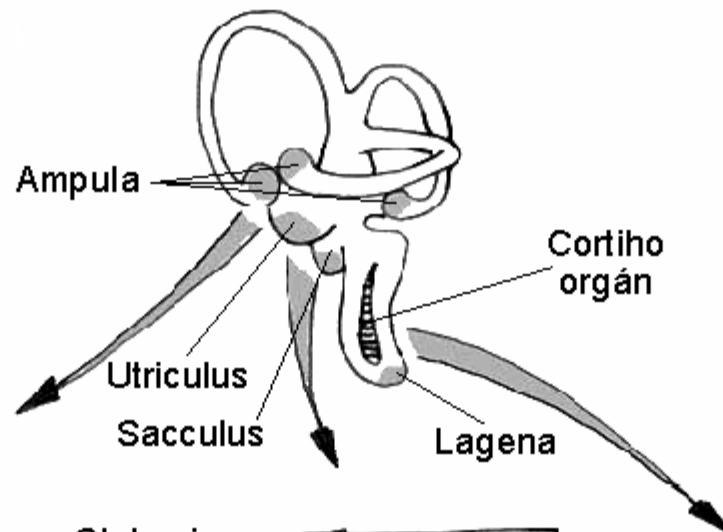


(a) Statocyst of a scallop (*Pecten*)

(b) Statocyst of a crab



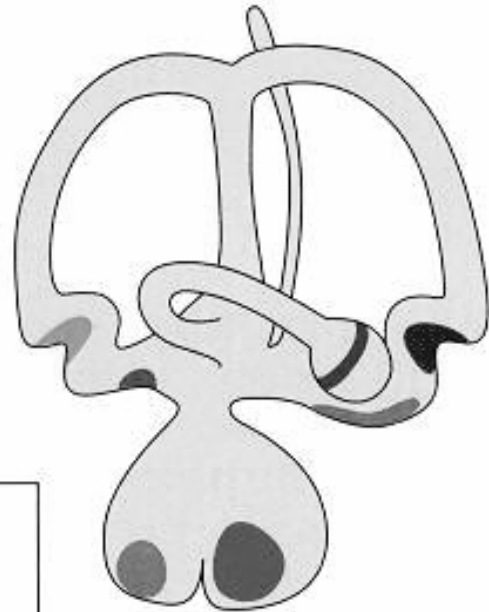




Fish (Myxine)



Frog



Bird

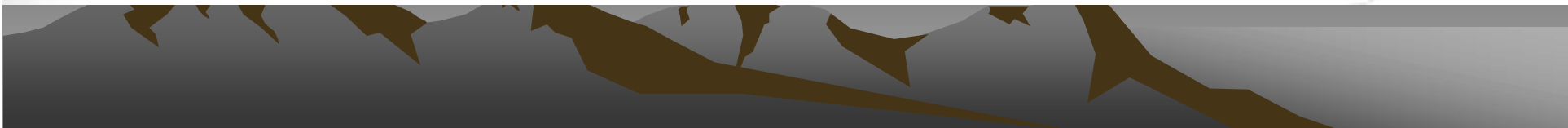


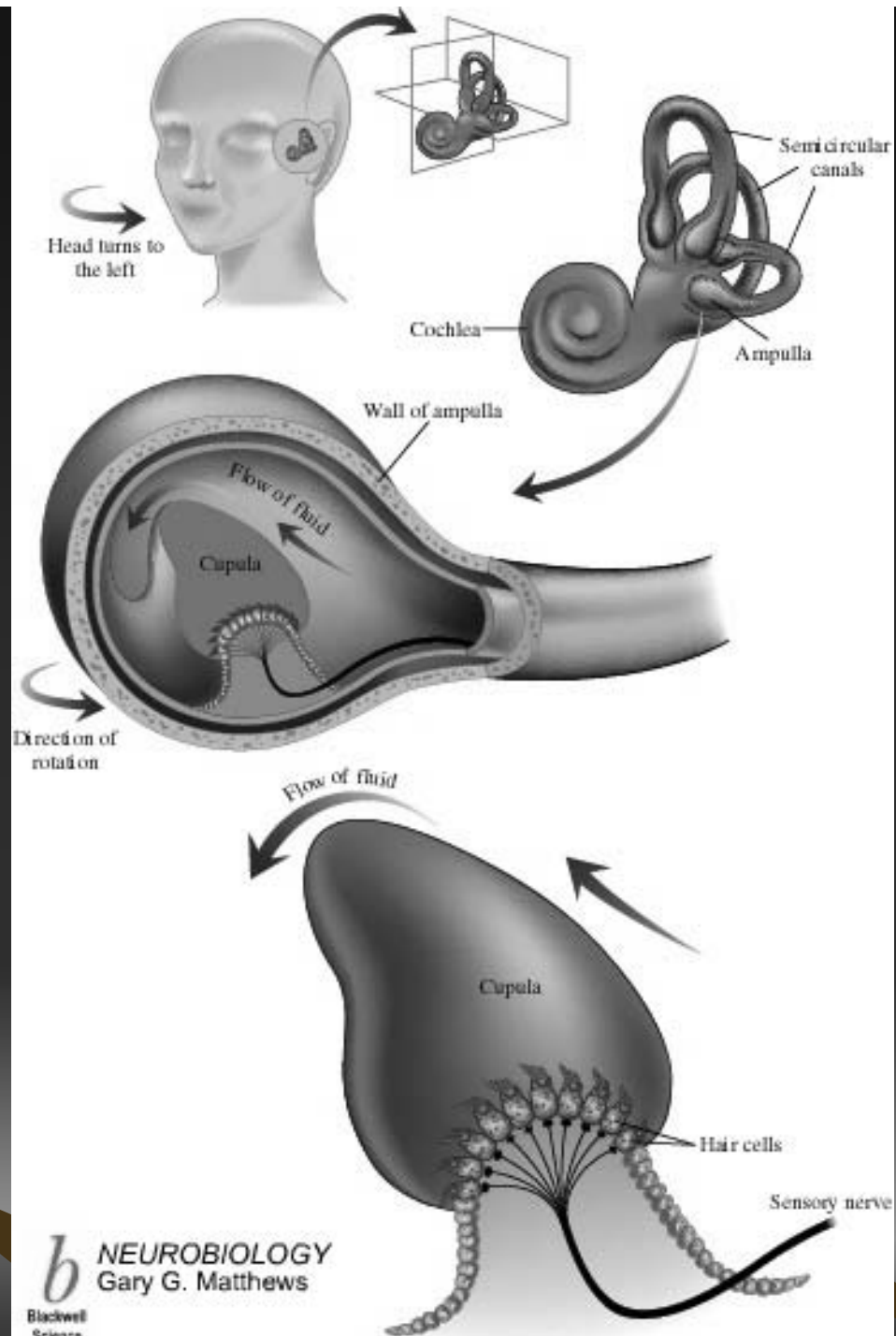
Mammal

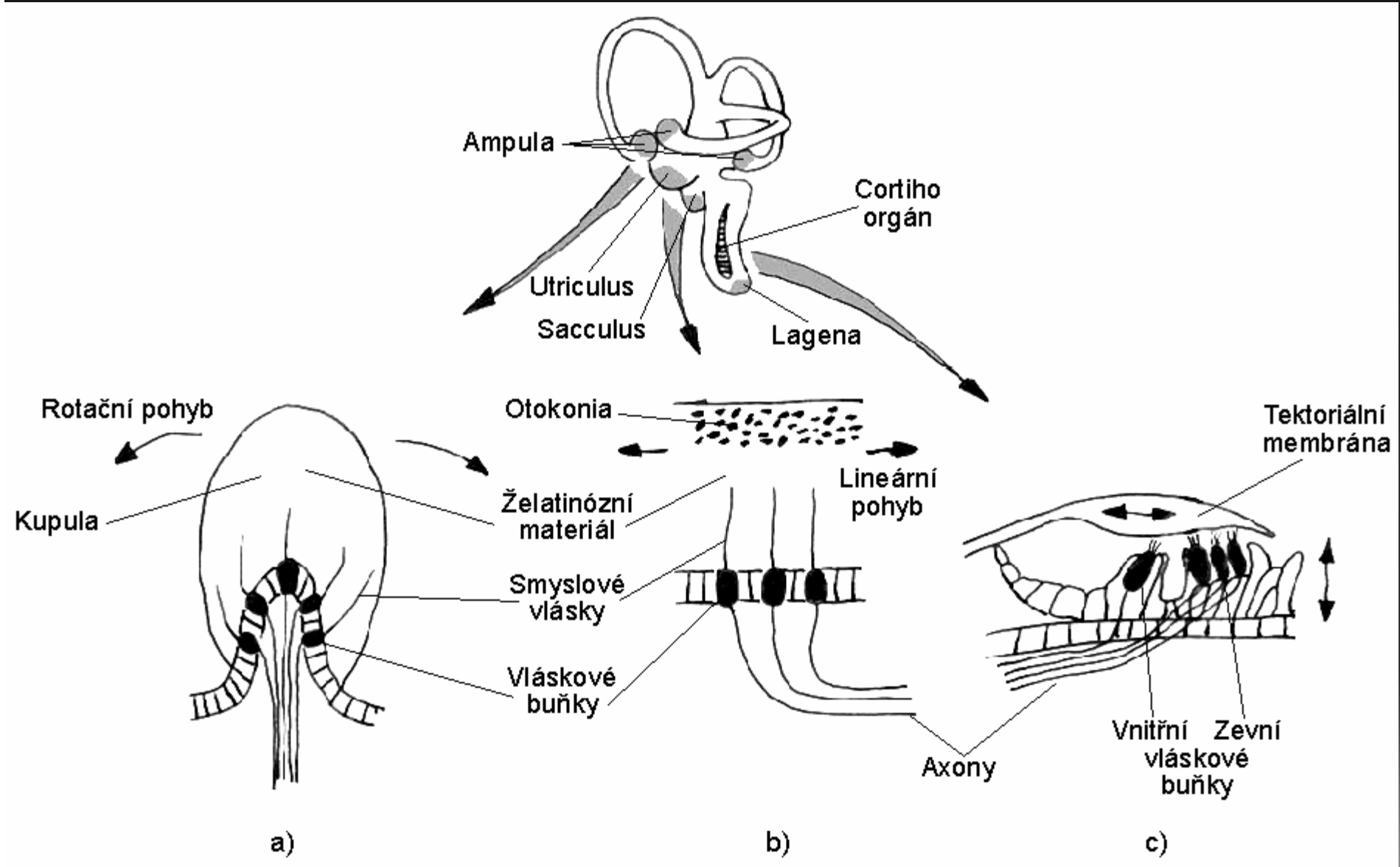


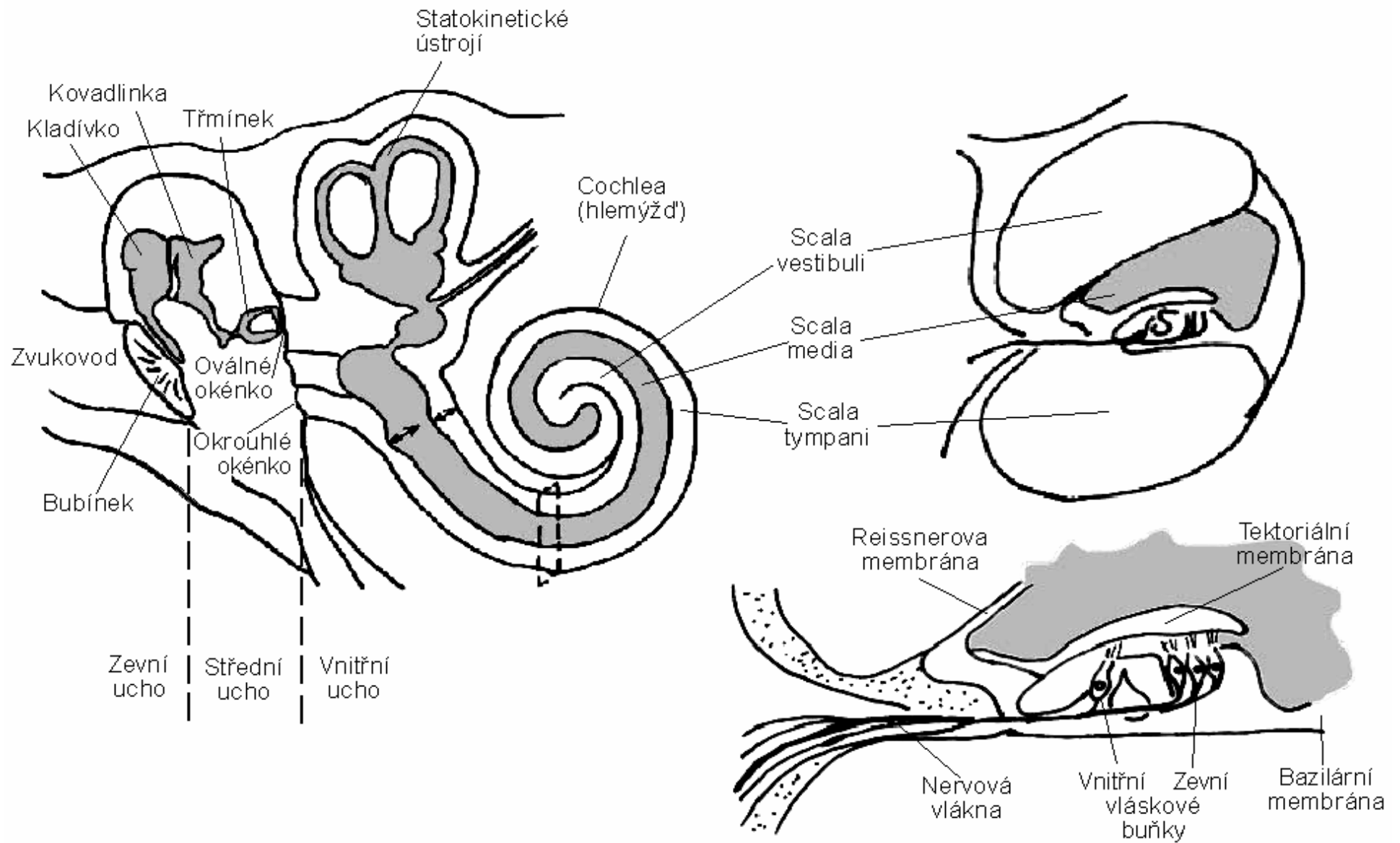
KEY

	Anterior crista
	Lateral crista
	Posterior crista
	Macula communis
	Macula lagenae
	Macula neglecta
	Macula sacculi
	Macula utricula
	Papilla basilaris

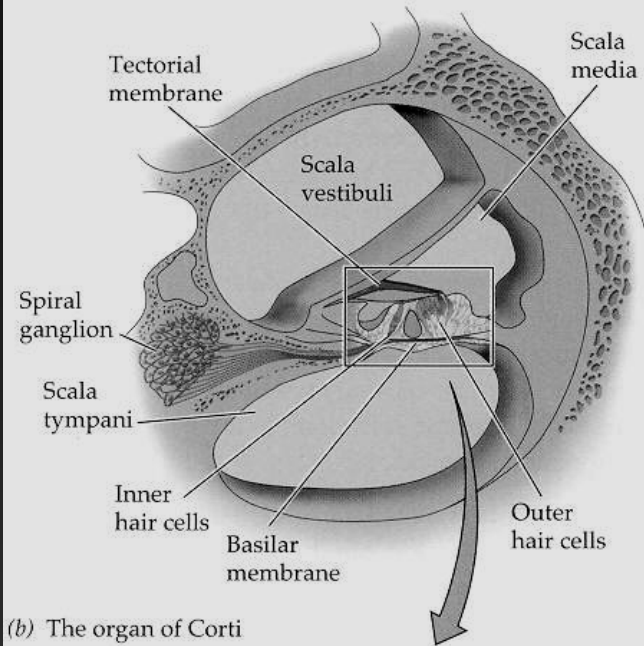




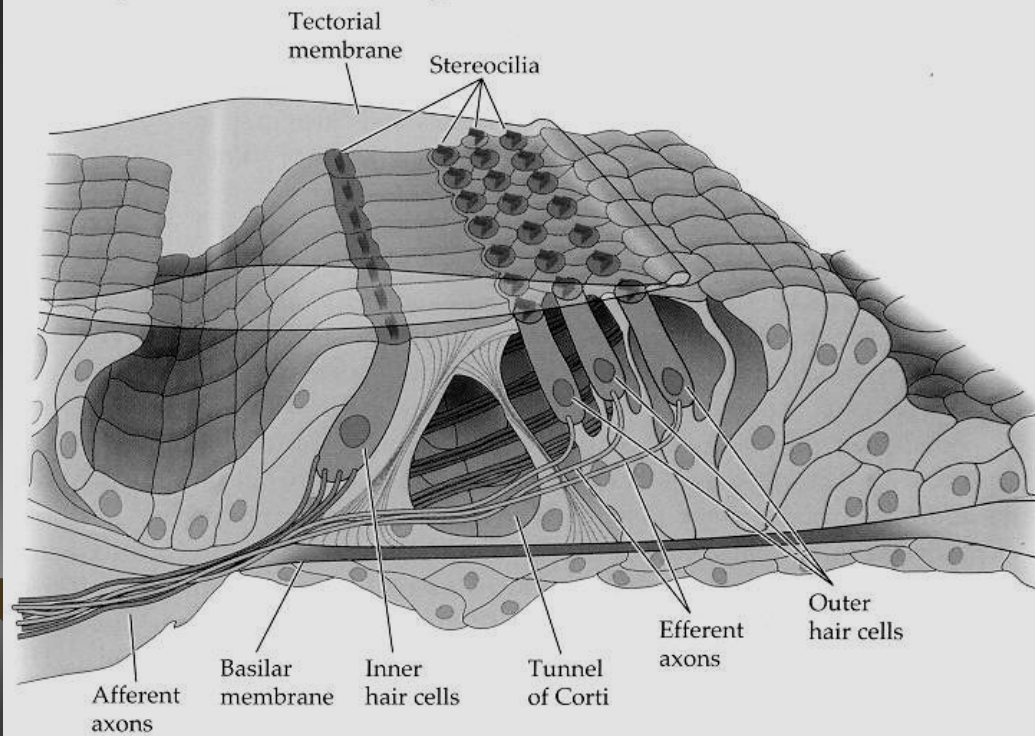




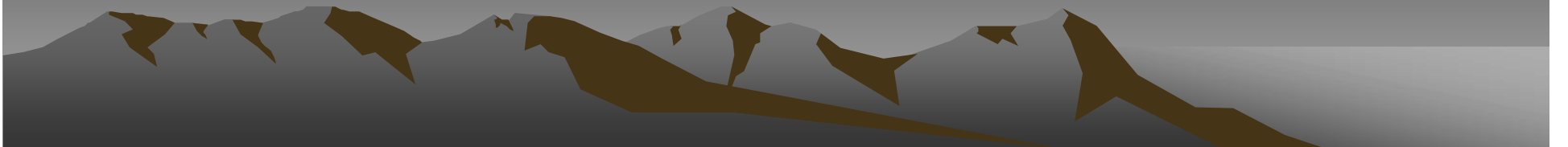
(a) A cross section through the cochlea



(b) The organ of Corti



Animace ear.

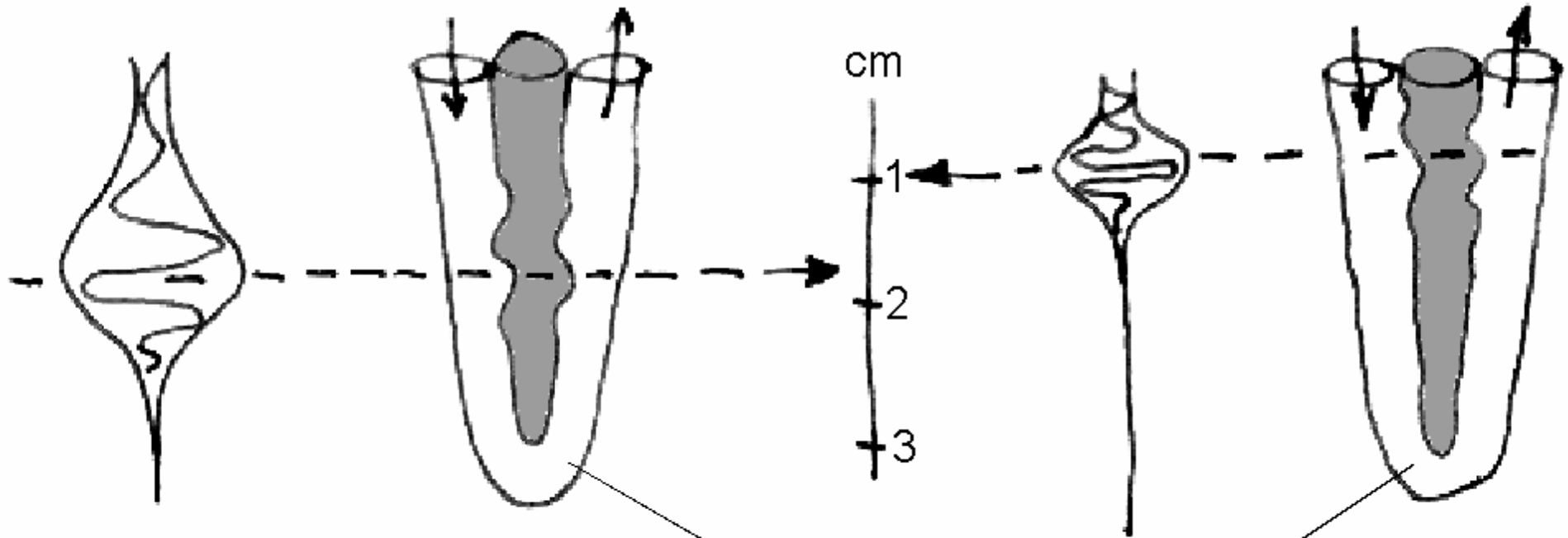


700 Hz

3000 Hz

Oválné okénko

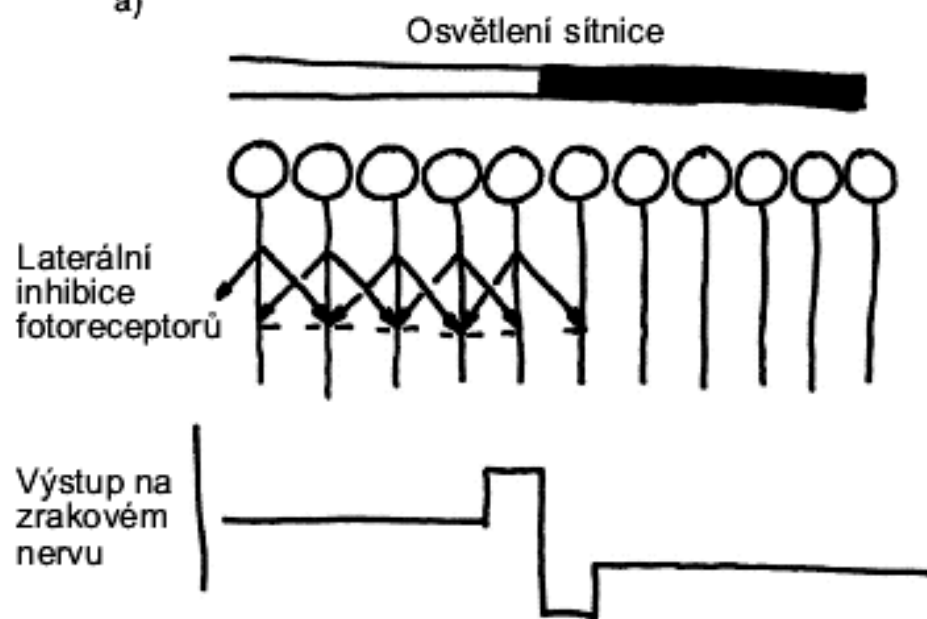
Okrouhlé okénko



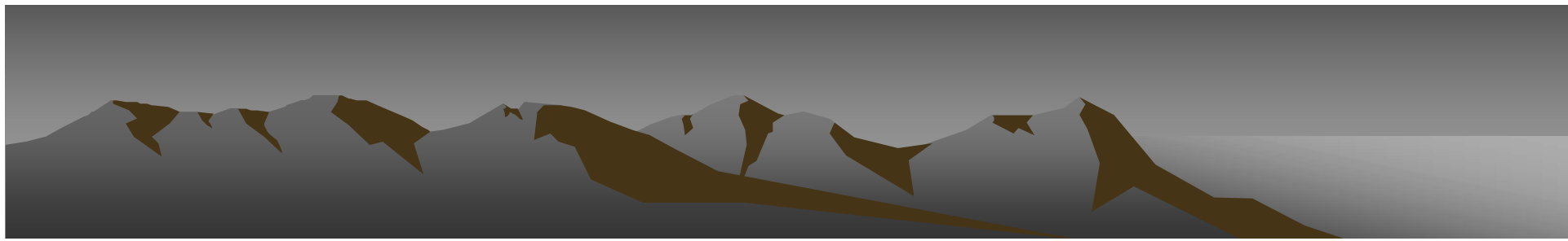
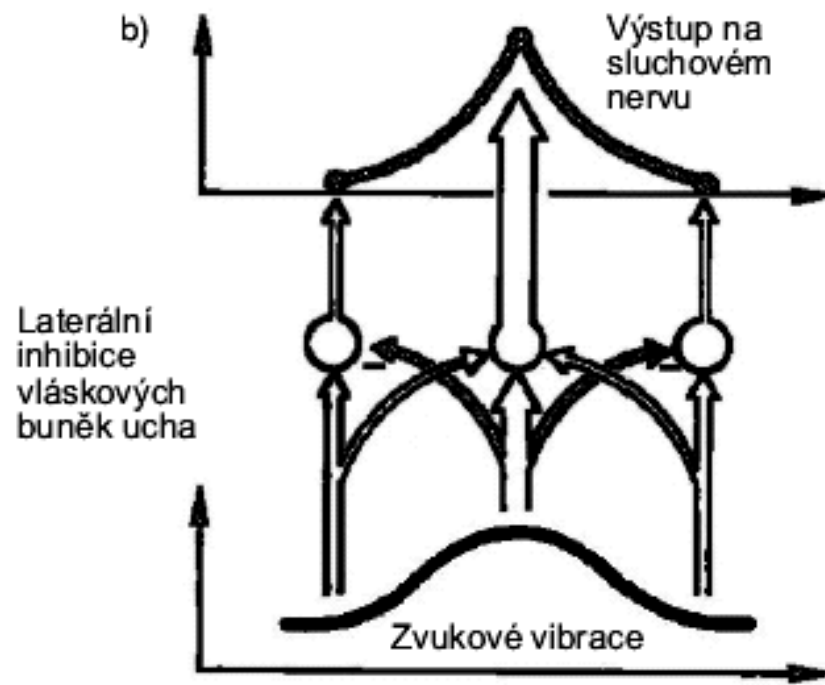
Rozvinutý hlemýžď



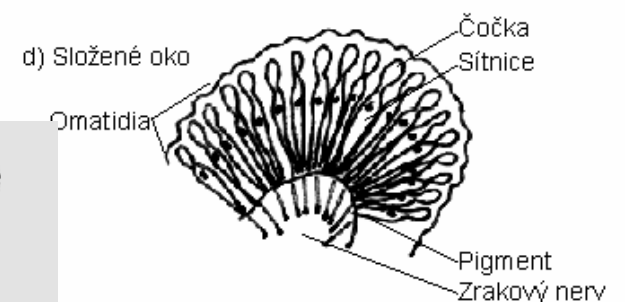
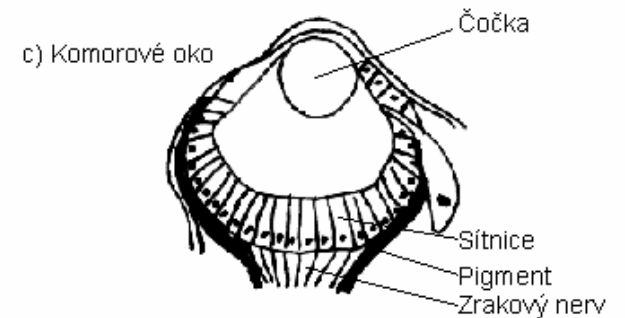
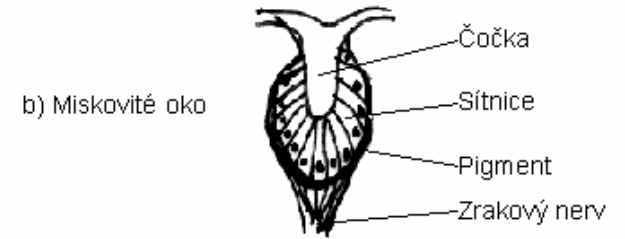
a)



b)



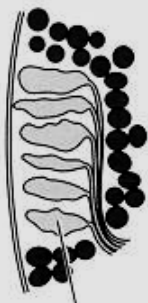
# Fotorecepce



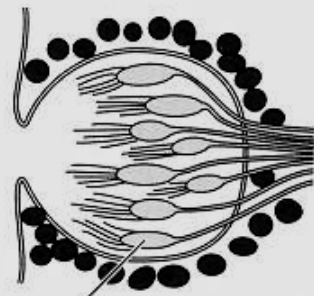
(a) Retinal plate (b) Eyecup

(c) Camera eye

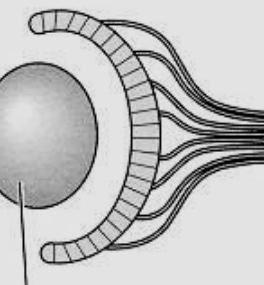
(d) Compound eye



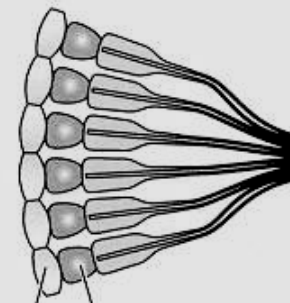
Photoreceptors



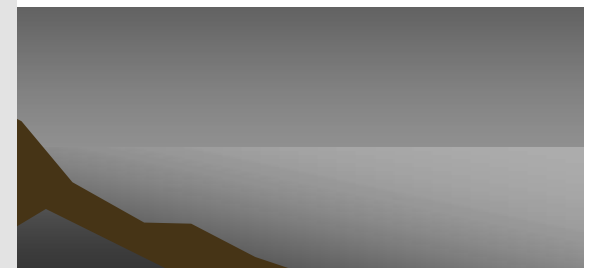
Cornea

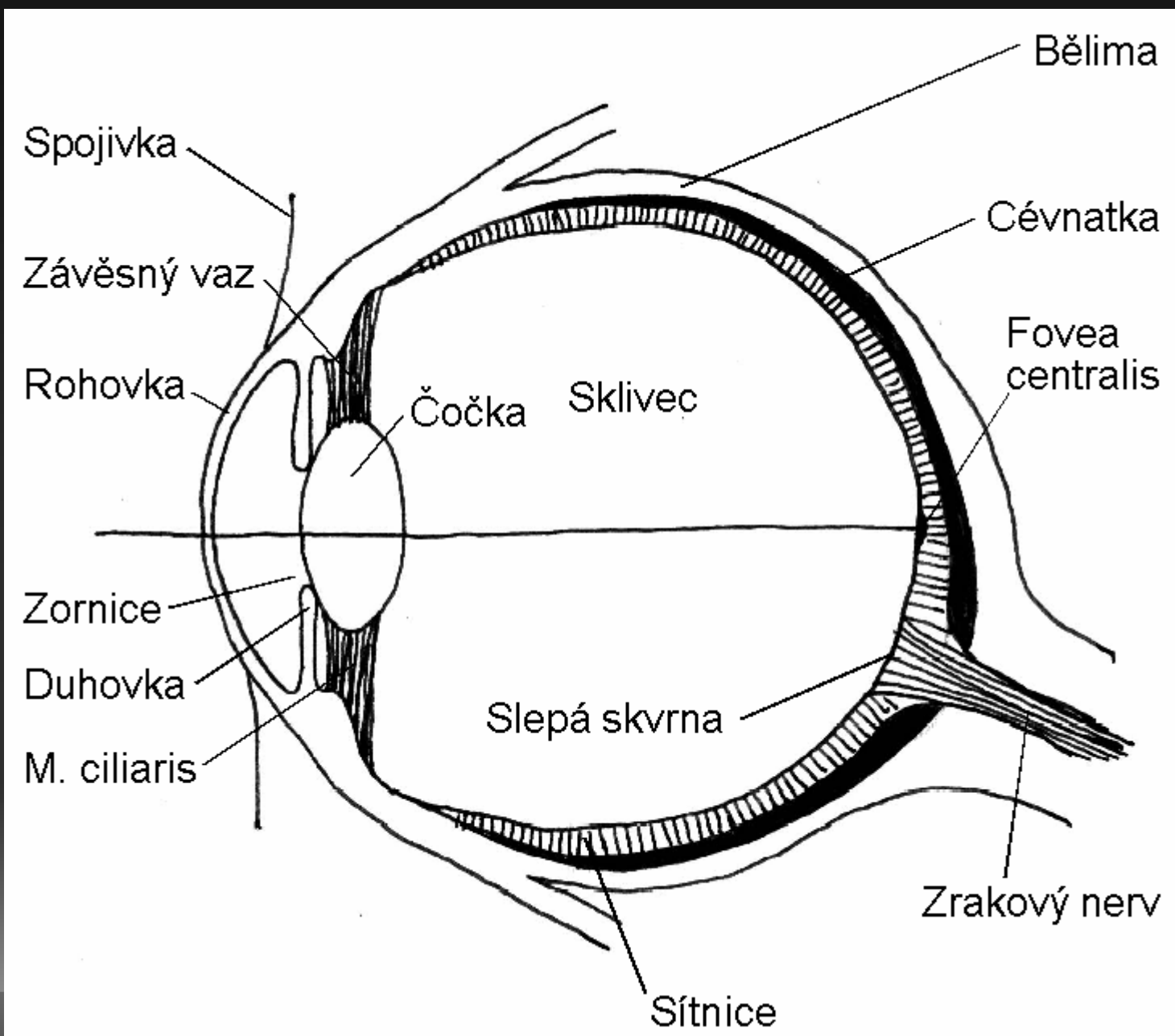


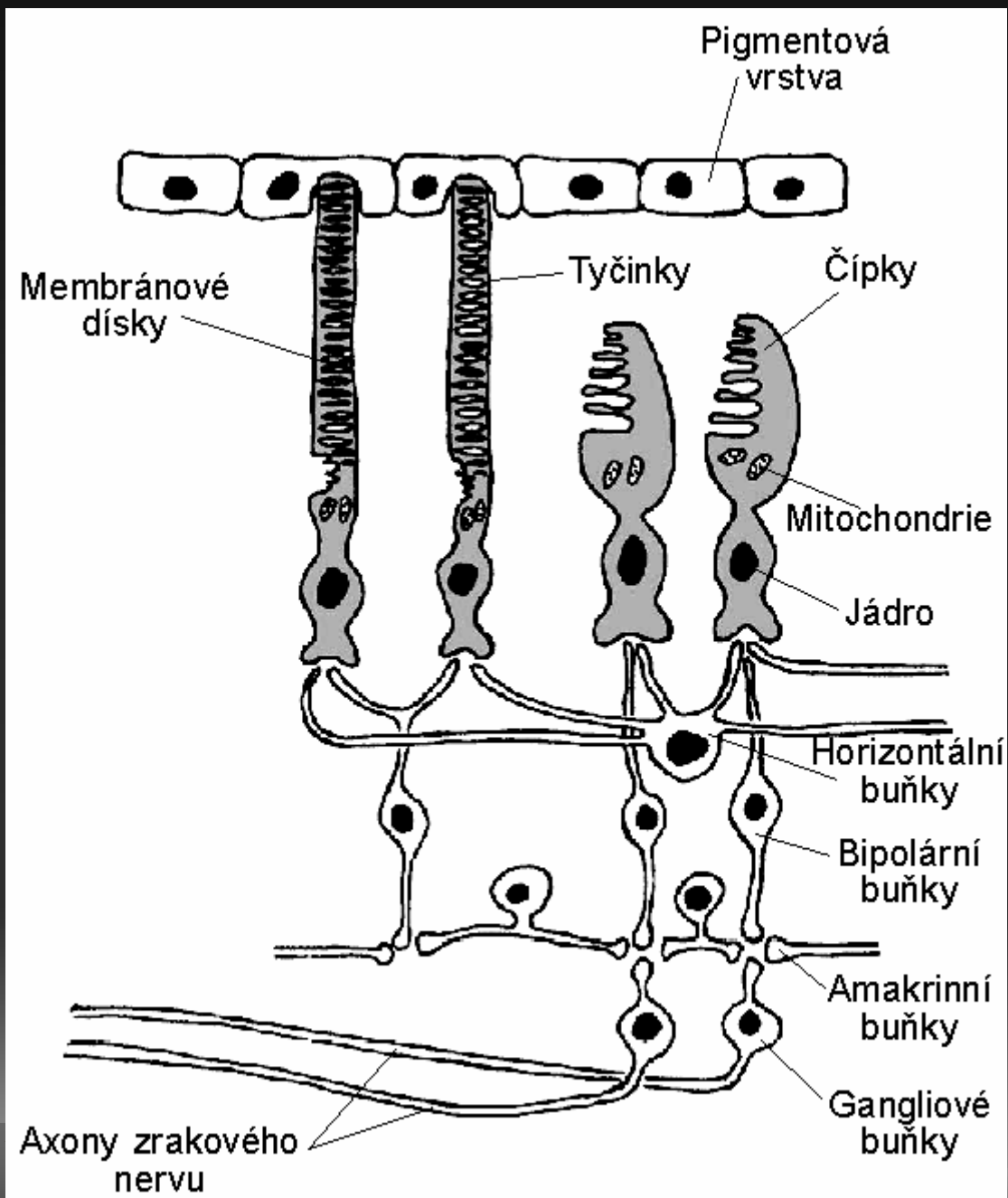
Lens

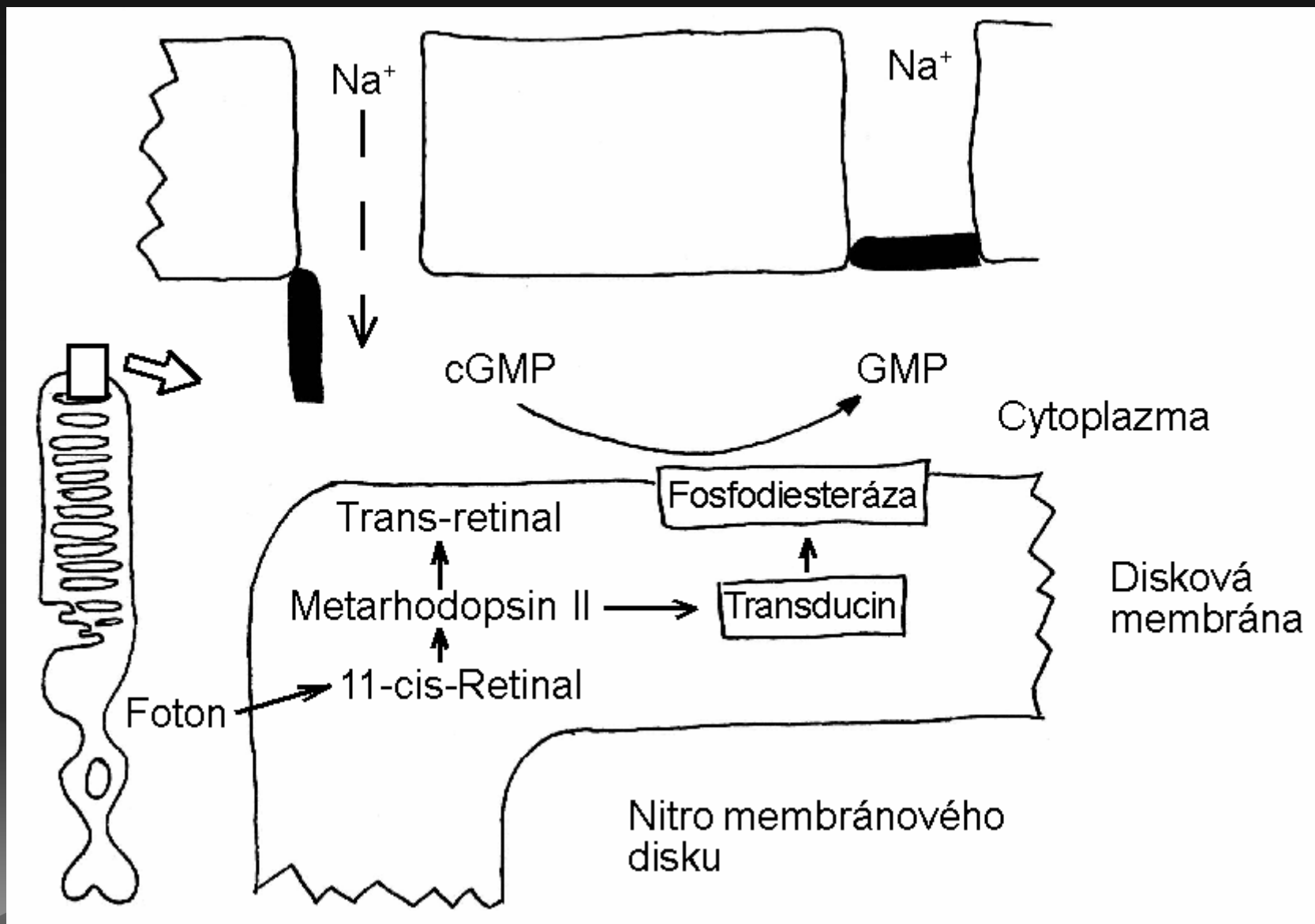


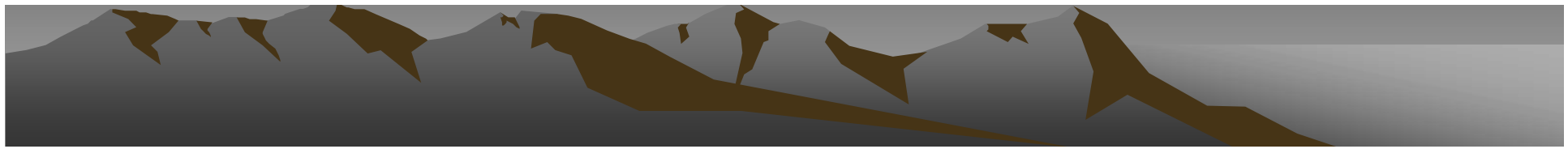
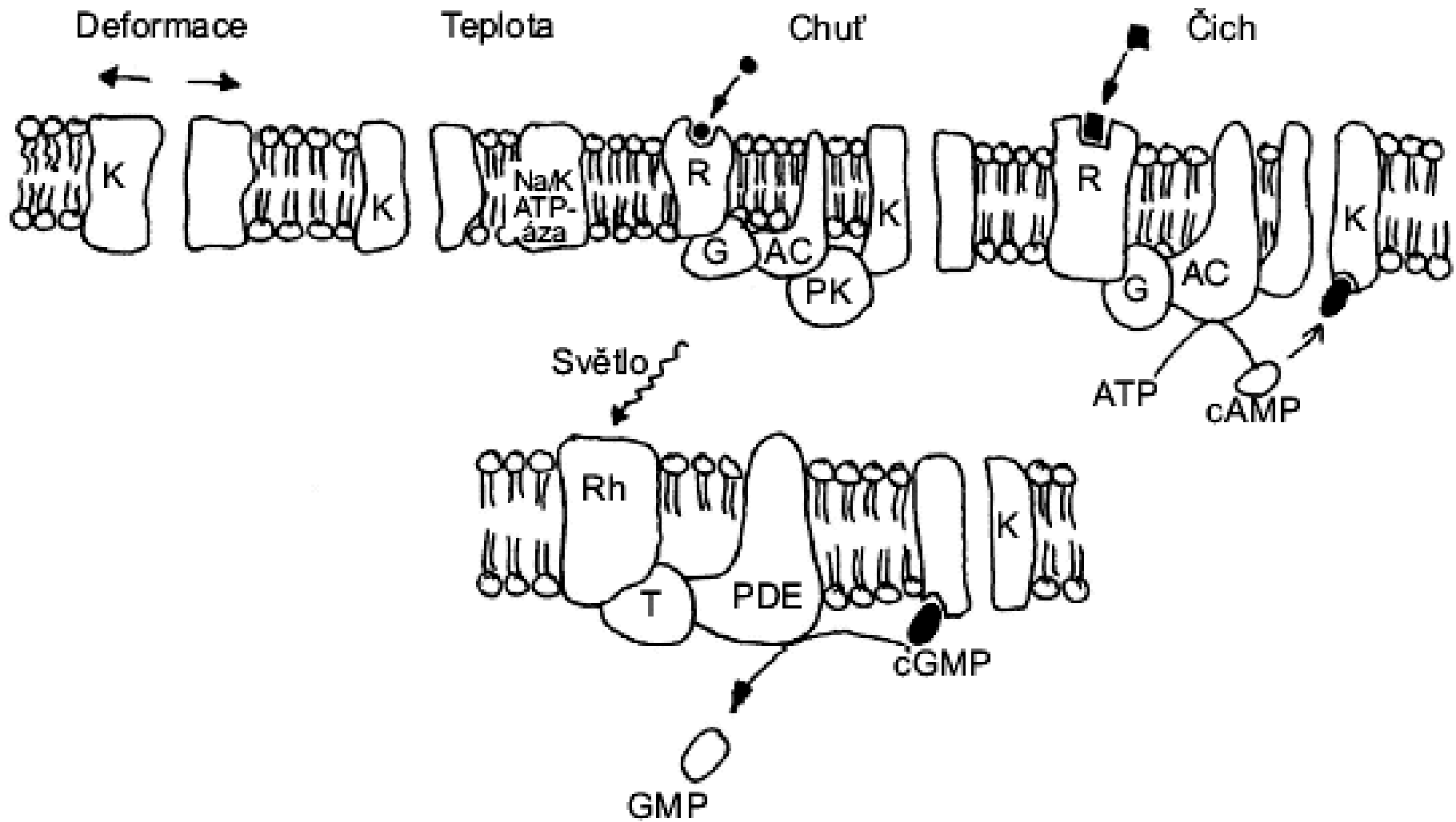
Cornea Lens



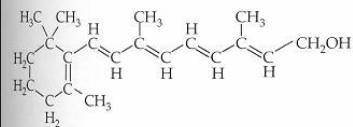




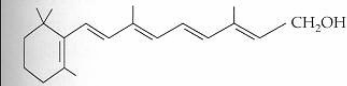




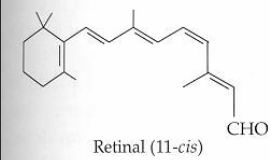
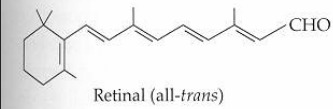
(a) Retinal and vitamin A



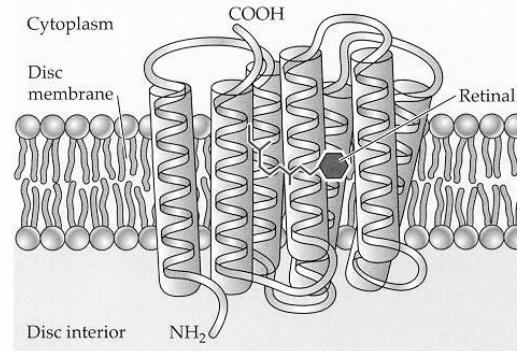
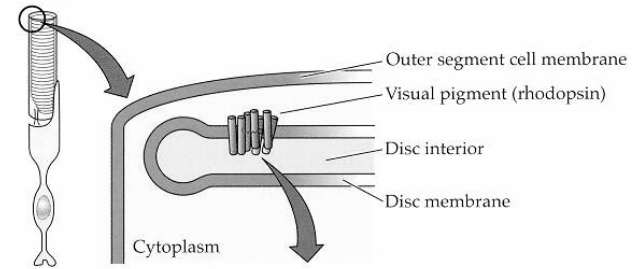
Complete structure of vitamin A (all-trans)



Condensed structure of vitamin A (all-trans)



(b) Opsin

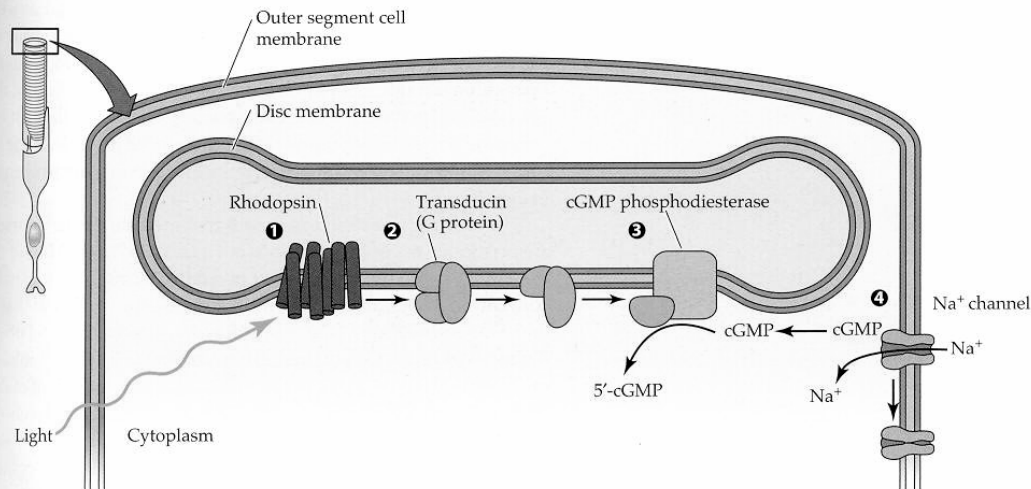


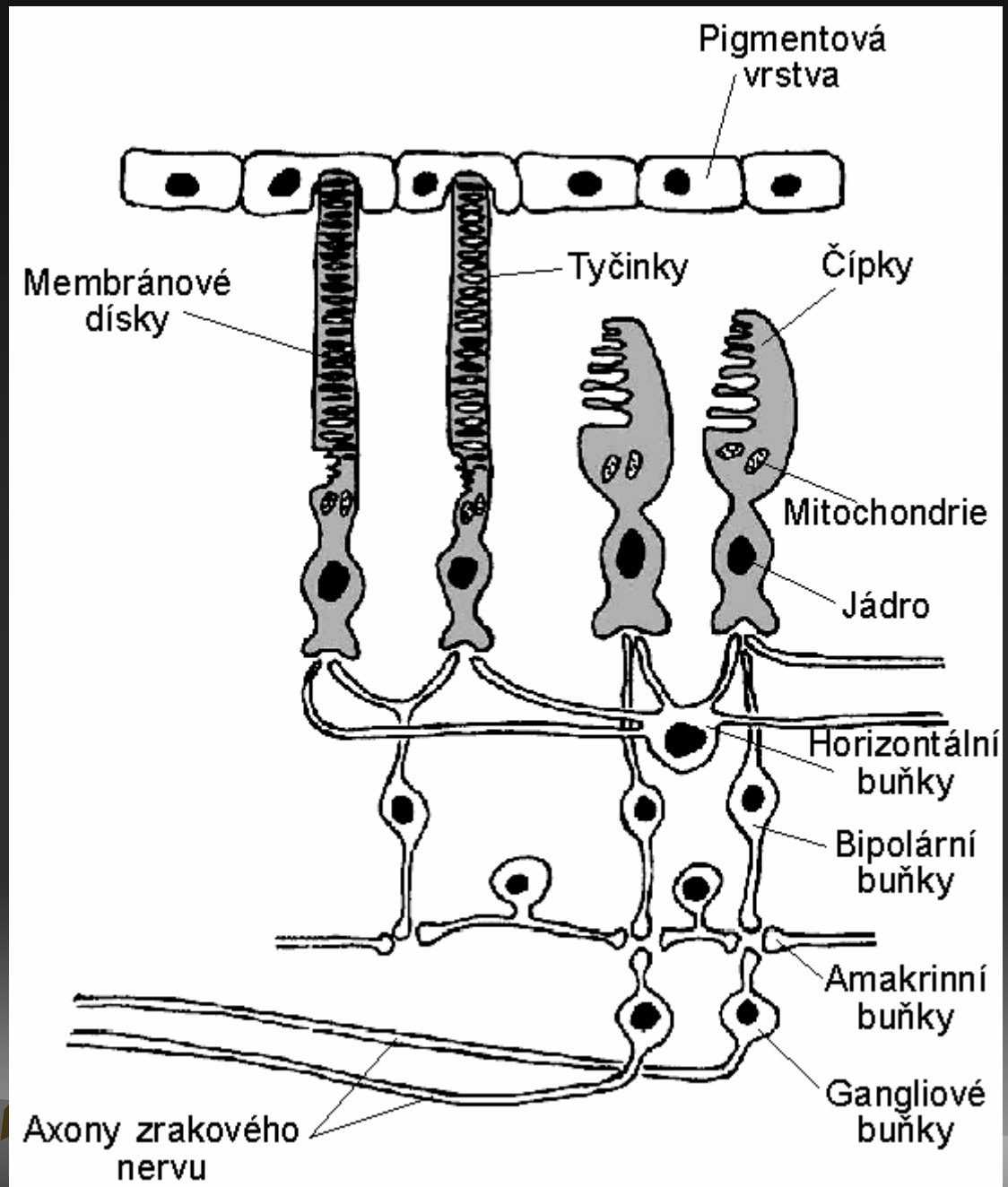
SENSORY PROCES

# Animace rhodopsin.

**Figure 13.13 Rhodopsin is a photopigment composed of two parts: retinal and opsin**

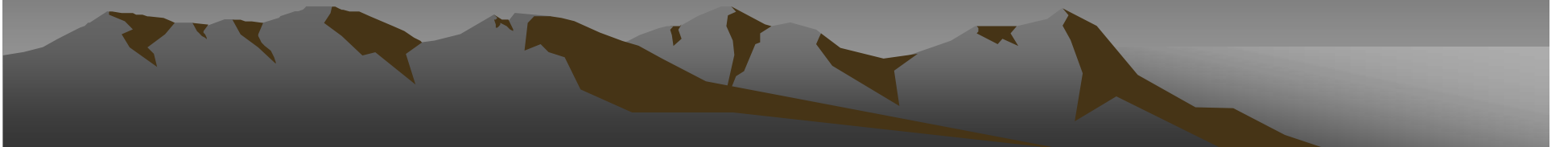
(a) Chemical structures of vitamin A and of retinal. Vitamin A is shown both as a complete structure (top) and as a skeleton structure (middle). Vitamin A is converted to retinal, which has two isomers (11-cis and all-trans). (b) Three-dimensional structure of the protein (opsin) portion of vertebrate rhodopsin. Seven  $\alpha$ -helical regions of the protein span the membrane; retinal is attached to an amino acid residue within the seventh membrane-spanning region.





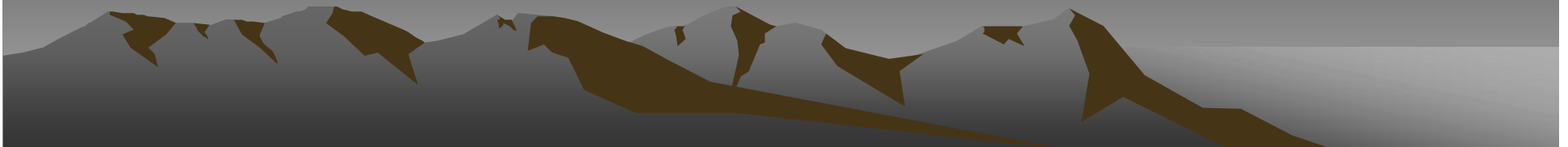


# Biologické rytmy



Rytmické děje jsou přirozenou součástí funkce organismu.

Předpovídají pravidelné změny bez ohledu na přechodné výkyvy.



Rytmické děje jsou přirozenou součástí funkce organismu.

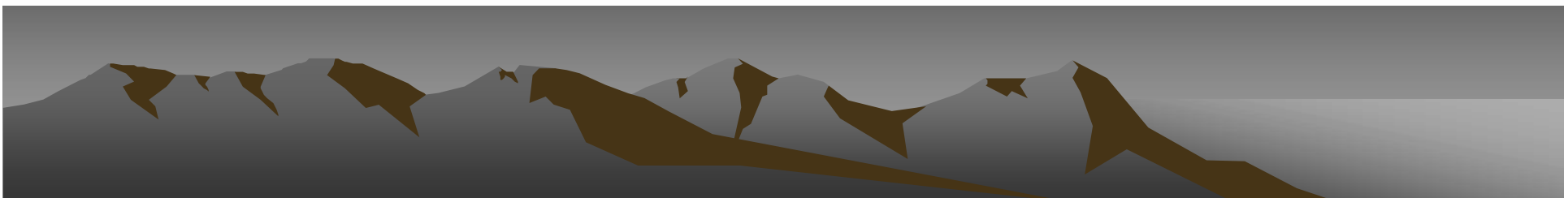
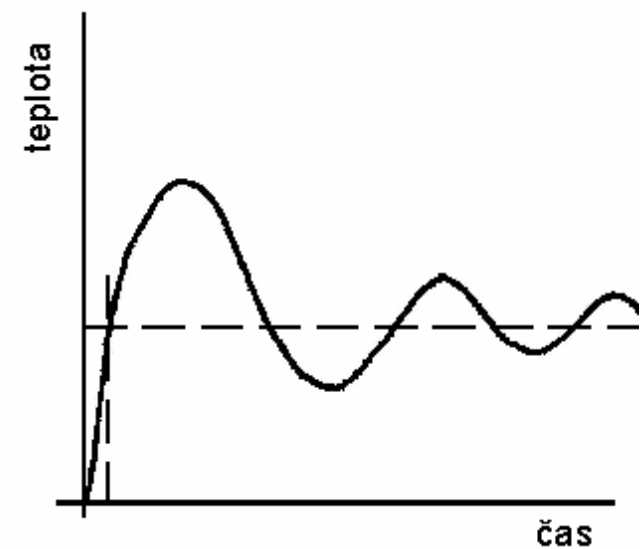
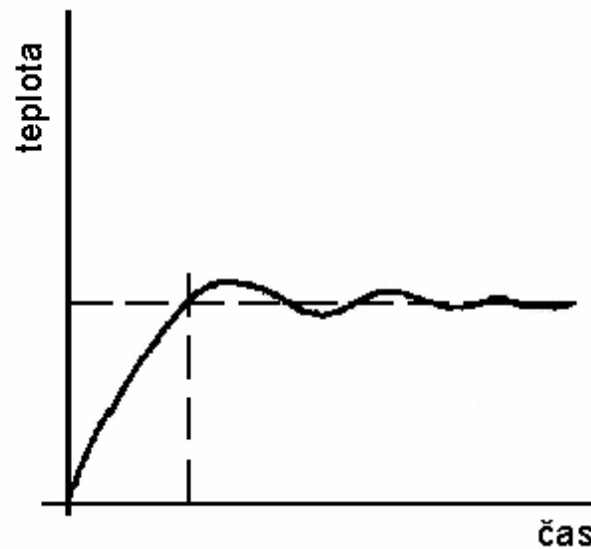
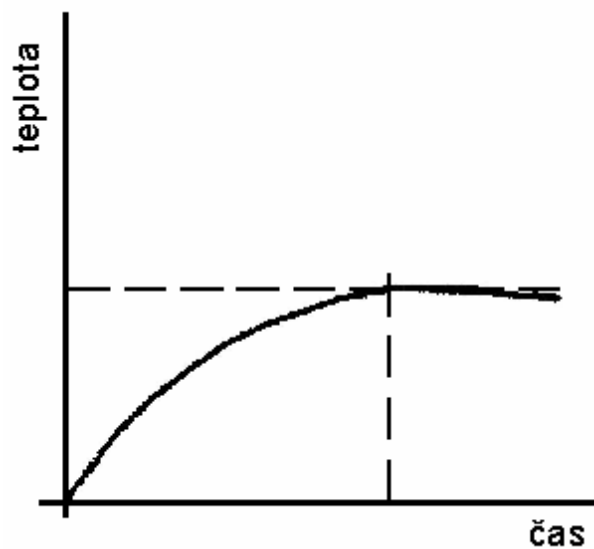
Bez vnějších korelátů: nervové vzruchy, srdeční rytmus, dechový rytmus...



Rytmické děje jsou přirozenou součástí funkce organismu.

Bez vnějších korelátů: nervové vzruchy, srdeční rytmus, dechový rytmus...

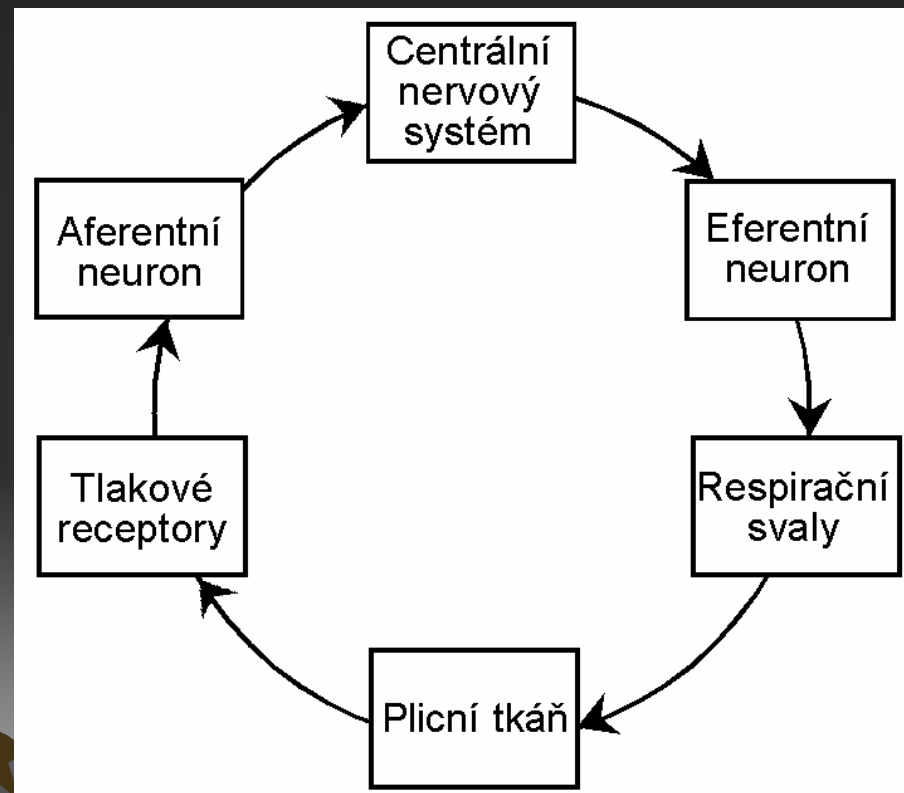
Negativní zpětná vazba je zdrojem kmitů – regulace homeostázy.



Rytmické děje jsou přirozenou součástí funkce organismu.

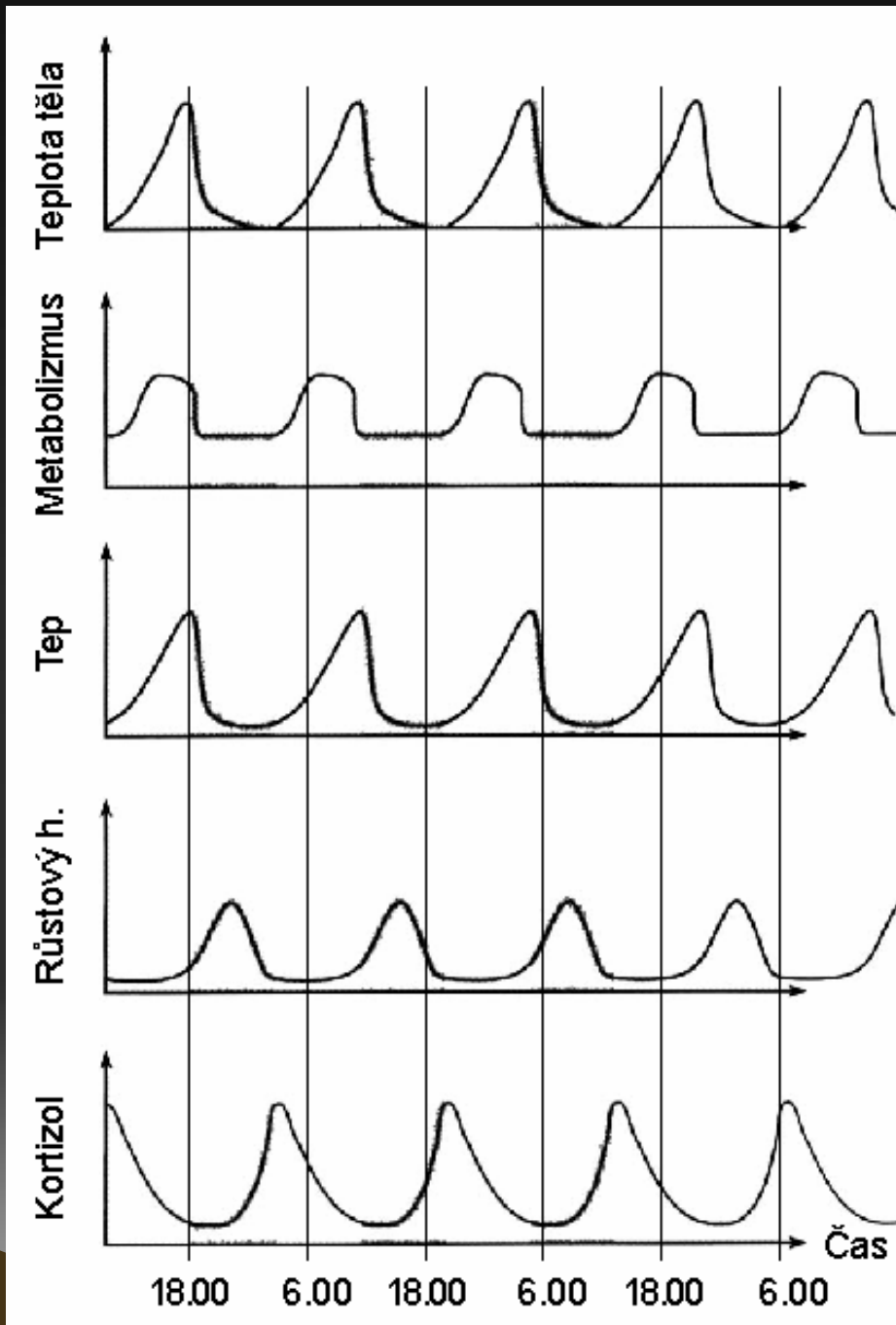
Bez vnějších korelátů: nervové vzruchy, srdeční rytmus, dechový rytmus...

Negativní zpětná vazba je zdrojem kmitů – regulace homeostázy.



Rytmicita s vazbou na prostředí

Cirkadiánní = asi 24 hod perioda

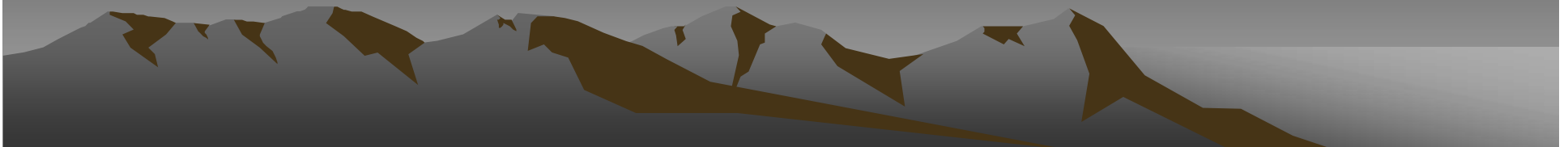


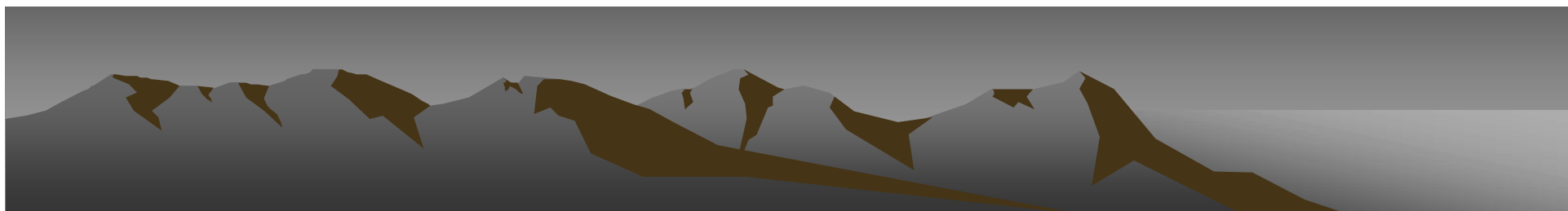
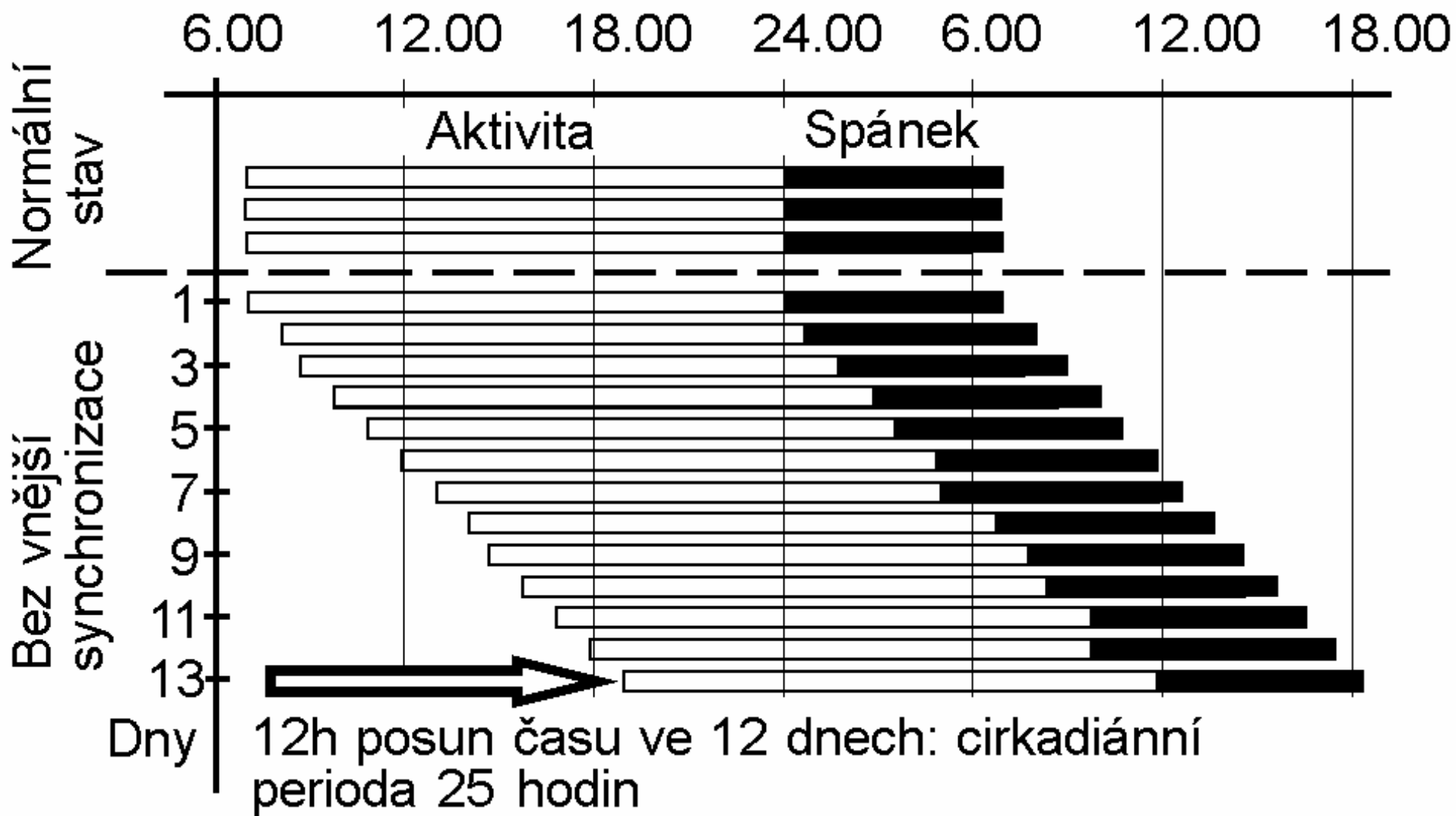
S vnějšími korelátý:

Synchronizátory:

Silné, slabé

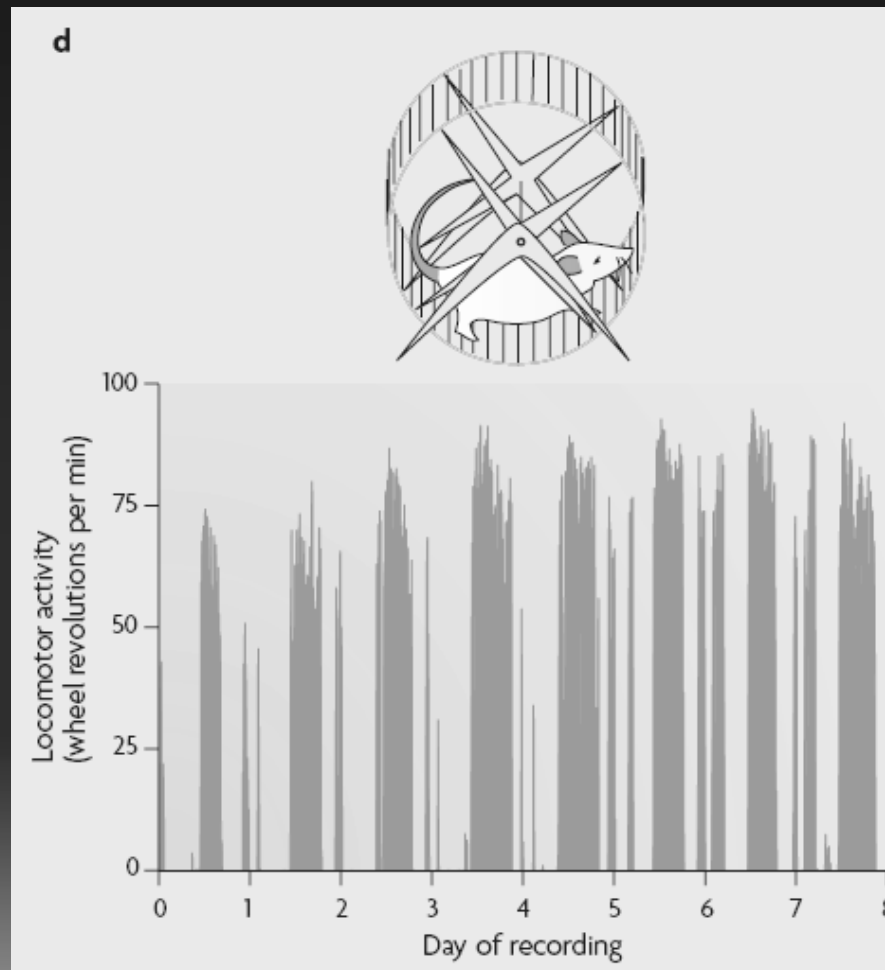
24 hodinové, lunární, anuální





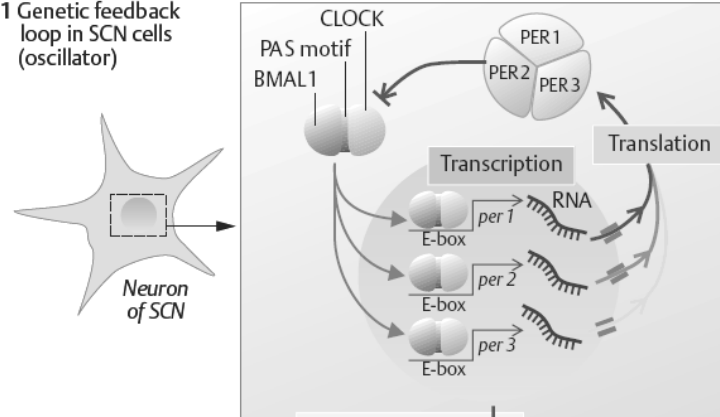


Jak se měří?  
Běhací kolo (mlýnek)

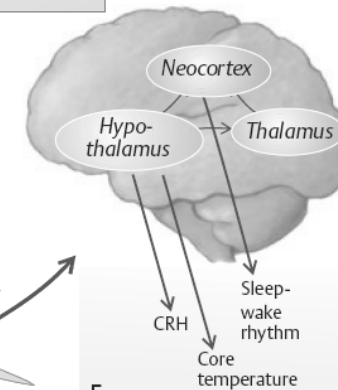


**A. Circadian rhythm generator in suprachiasmatic nucleus (SCN)**

**1 Genetic feedback loop in SCN cells (oscillator)**



**4 Effectorsystems in CNS**



**5 Circadian rhythms of:**  
 - CRH secretion  
 - Core temperature,  
 - Sleep-wake cycle (see B),  
 etc.

**2 Zeitgeber**



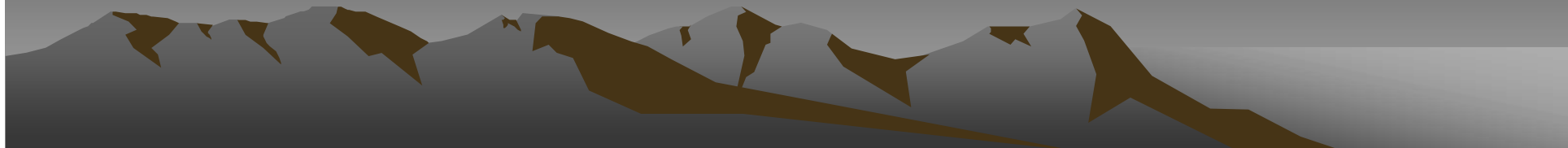
Retina, etc.

Melatonin secretion

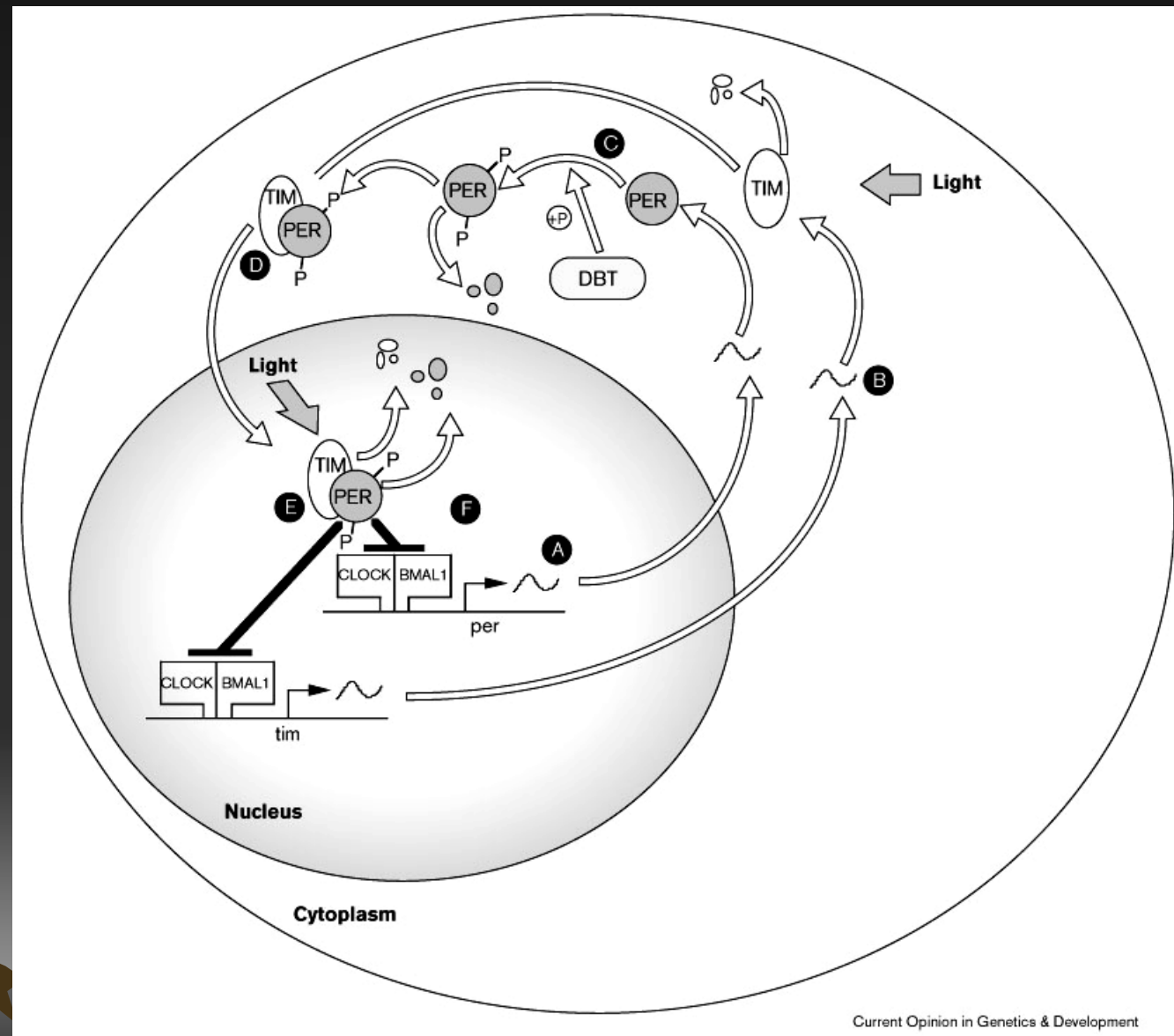
**3 Coupled oscillators in SCN**

Membrane potential

Intracellular Cl<sup>-</sup> concentration ?

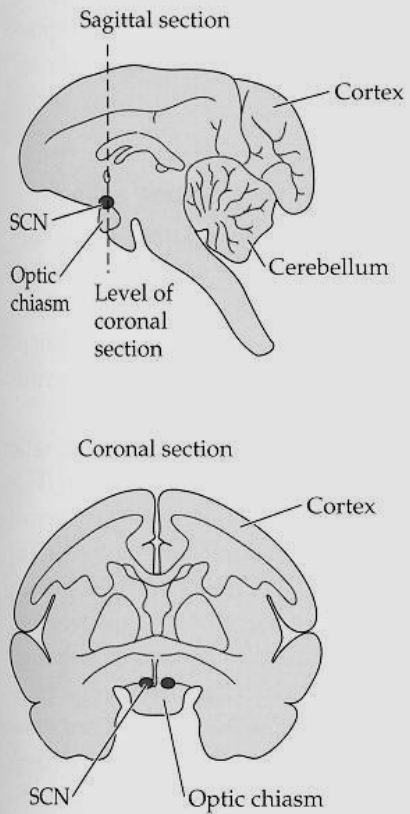


# Molekulární hodiny a zpětnovazebná smyčka synchronizovaná světlem.

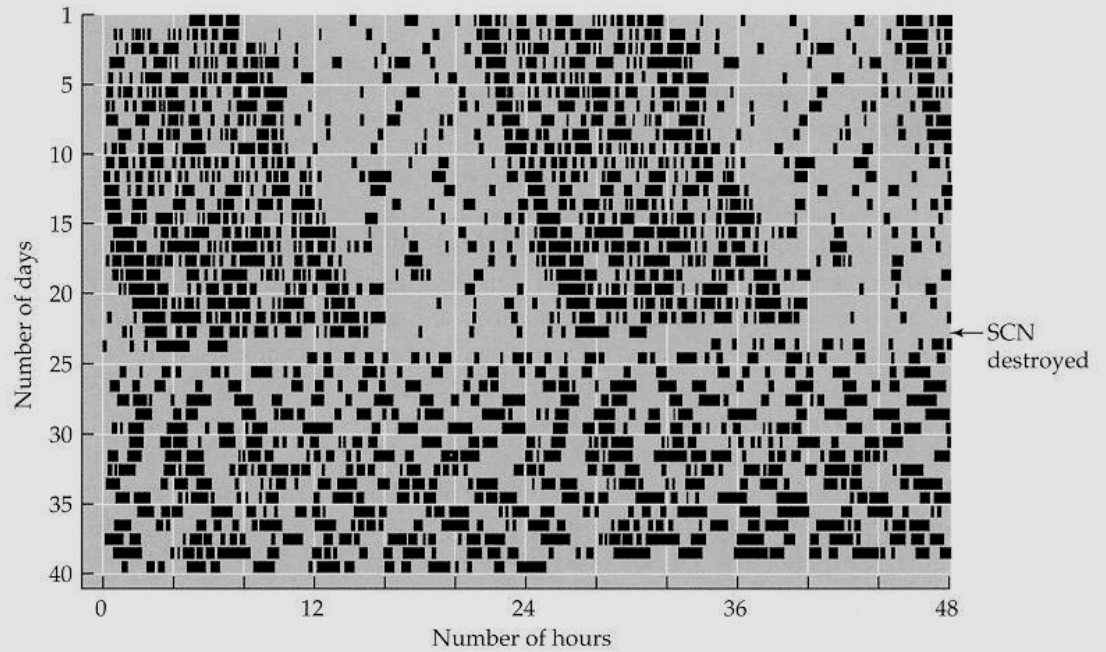


# Suprachiasmatické jádro

(a) Location of the SCN

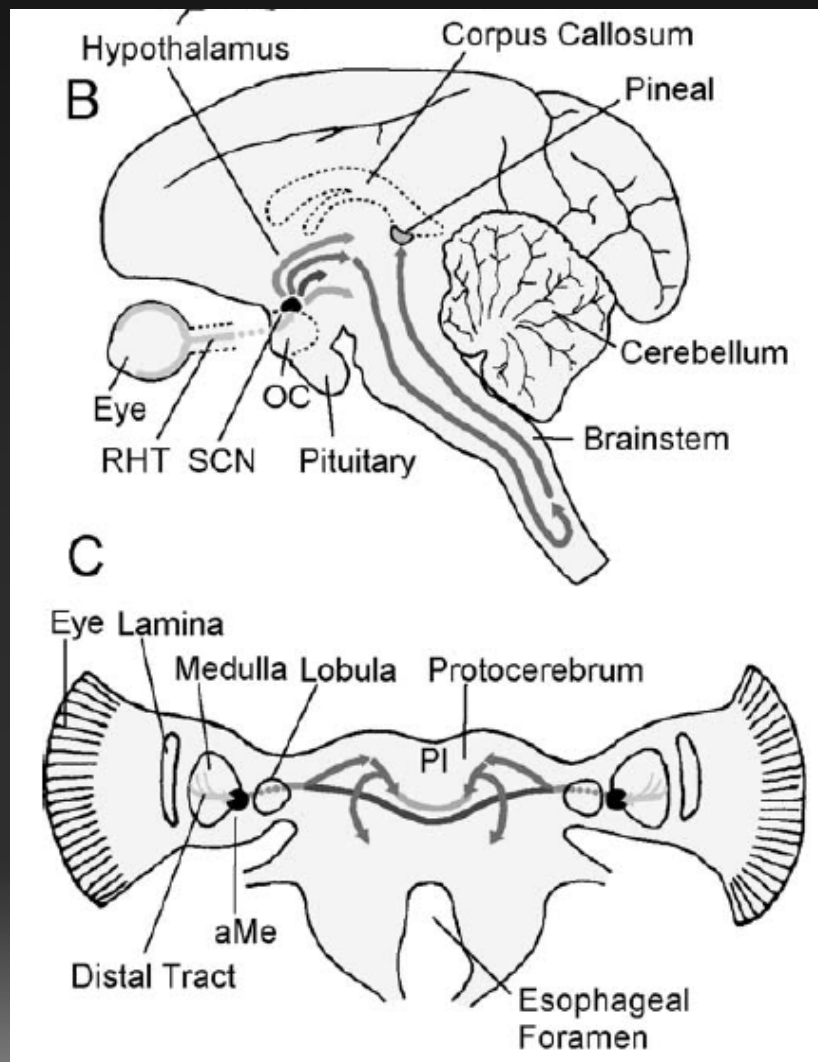


(b) Loss of free-running rhythms upon destruction of the SCN

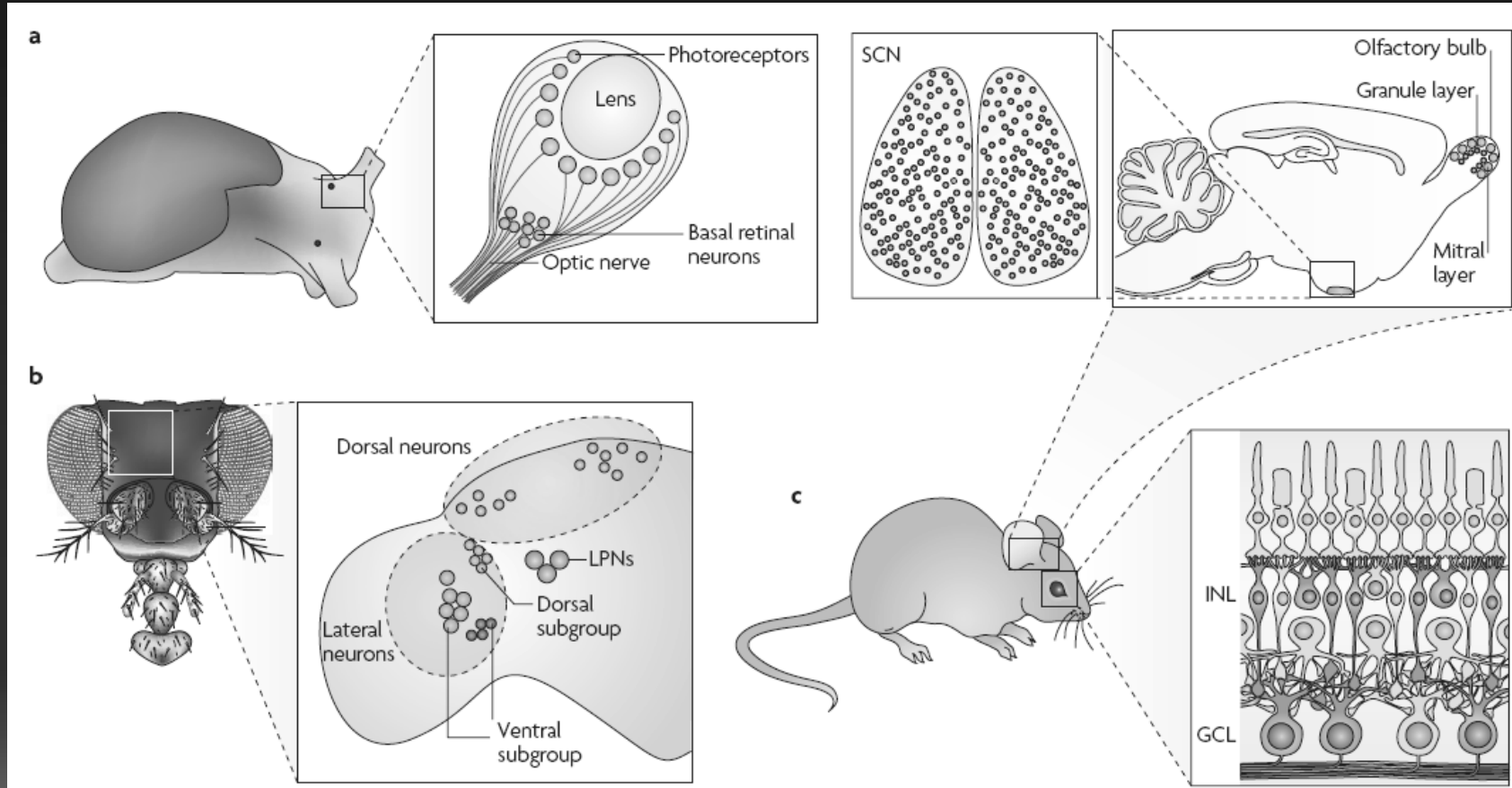


**Figure 10.17** The suprachiasmatic nucleus in the hypothalamus of the brain is the major circadian clock of mammals (a) The location of the SCN in the ventral hypothalamus, above the optic chiasm (the crossing of the optic nerves). The sagittal section shows a side view near the midline (anterior to the right). (b) A free-running circadian activity is lost following destruction of a mammal's SCN.

# Synchronizace světlem

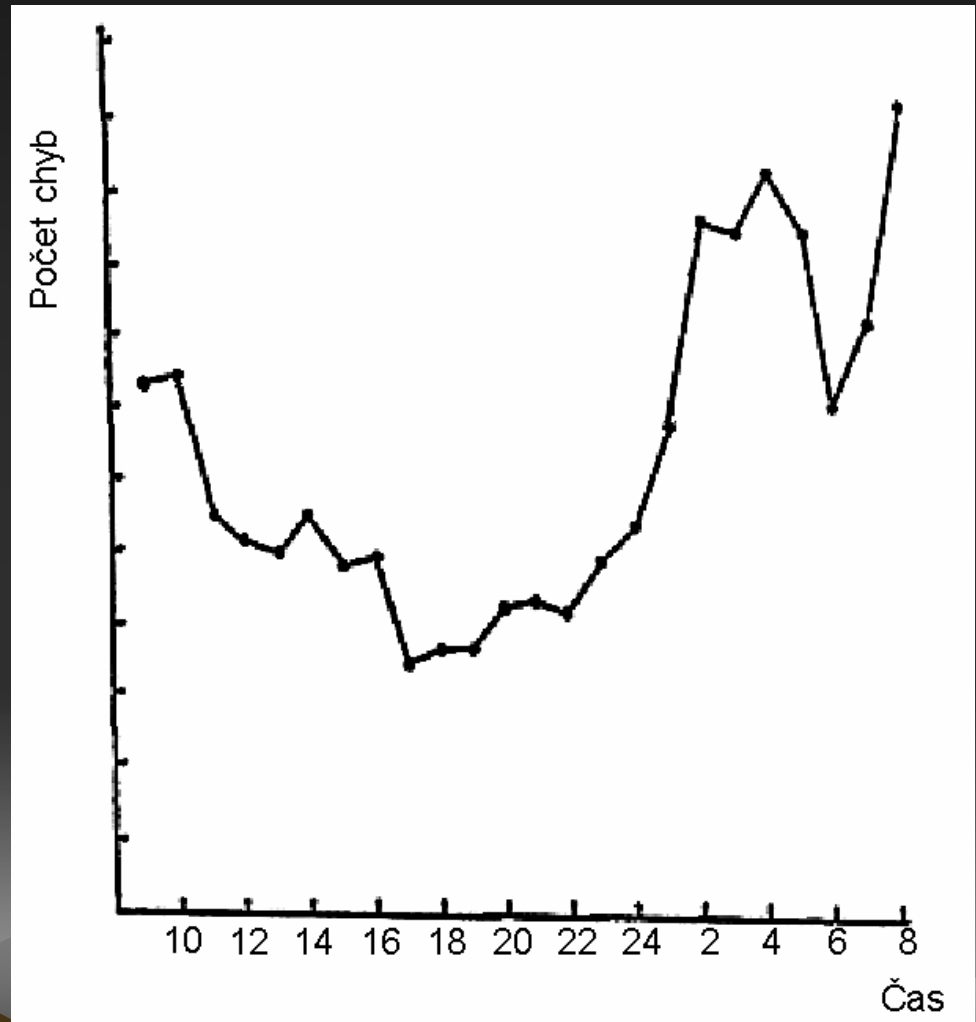


# Hlavní a periferní oscilátory



Chronobiologie

Chronopatologie



Příklady testovacích otázek ke zkoušce z Fyziologie živočichů

<http://www.sci.muni.cz/ksfz/texty/fyztest.htm>

Základní studijní literatura: skripta Srovnávací fyziologie živočichů (Vácha, Bičík, Petrásek, Šimek, 2002)

### 1. Vysvětlete existenci klidového membránového potenciálu. Zmiňte roli $K^+$ a $Na^+$ .

Příklad správné odpovědi na plný počet bodů: Hlavní roli mají ionty  $Na^+$ ,  $K^+$ ,  $Cl^-$  a intracelulární fixní anionty bílkovin. Klidový potenciál je asi  $-90mV$ . Příčiny vzniku: A) Elektrogenní Na/K pumpa čerpá 2  $K^+$  dovnitř buňky a 3  $Na^+$  ven. B) Propustnost membrány – Sodíková propustnost je nízká, zavřené kanály nedovolují  $Na^+$  vracet se do buňky. Elektrická i koncentrační síla působí vysokou hnací sílu sodíku. Draslíková propustnost je vysoká, jeho elektrická a protichůdná koncentrační síla se vyrovnávají – je blízko svému rovnovážnému potenciálu.

### 2. Popište děje při přenosu vzruchu mezi dvěma neurony přes synaptické spojení.

Příklad správné odpovědi na plný počet bodů: AP dorazí na synaptický knoflík. Depolarizace způsobí otevření napětově vrátkovaných Ca kanálů. Nárůst intracelulárního  $Ca^{2+}$  vyvolá přesun a exocytózu vezikul s mediátorem do štěrbin synapse. Mediátor se naváže na receptory postsynaptické membrány. Zde se otevrou kationtové kanály (přímo nebo přes kaskádu G-protein – adenylát cykláza – cAMP). Vzniklá depolarizace zvyšuje pravděpodobnost vzniku nového AP na iniciálním segmentu. Mediátor je ze štěrbin odstraněn enzymaticky nebo endocytózou.

### 3. Jaké jsou možné adaptační strategie živočichů na změnu vnějších podmínek? Charakterizujte je.

Příklad správné odpovědi na plný počet bodů: A) Uteč. Např. migrace, diapauza, encystace. Zejména malé organizmy (relativně velký povrch) s měkkým tělem nemající izolační nebo regulační mechanismy nemohou aktivně žít v nevhodném prostředí. B) Akceptuj. Zejména středně velcí s exoskeletem nemohou příliš regulovat vnitřní prostředí, ale mohou přežívat mimo optimum. C) Vyreguluj. Velcí živočichové mohou udržet konstantní optimální vnitřní prostředí.

### 4. Které hormony mohou ovlivňovat energetický metabolismus. Jmenujte hlavní z nich, zmiňte místo sekrece a způsob působení.

Příklad správné odpovědi na plný počet bodů: A) Trijodtyronin a Tyroxin ze štítné žlázy zvyšují oxidační děje v mitochondriích a tak i metabolismus, proteosyntézu, zrání, růst. B) Somatotropin (růstový h.) z adenohipofýzy zvyšuje využívání lipidů a růst. C) Somatostatin z D buněk pankreasu snižuje využívání živin (tlumí sekreci inzulínu a glukagonu, resorpci ve střevě). D) Katecholaminy ze dřene nadledvin mobilizují energetické rezervy, zvyšují svalový výkon. Podobně E) kortizol z kůry nadledvin.

