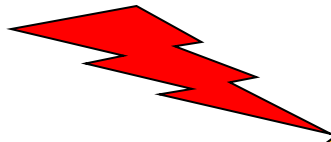


# Čulni receptori

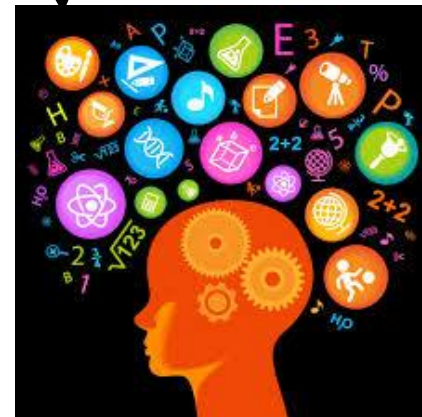
- Specijalizovane strukture specifično prilagođene za prijem različitih vidova energije
- Energiju stimulusa prevode u električne signale - akcione potencijale koji se prenose do CNS
- U CNS - analiza i integracija signala, a rezultat je opažanje (percepcija) stimulusa.

stimulus



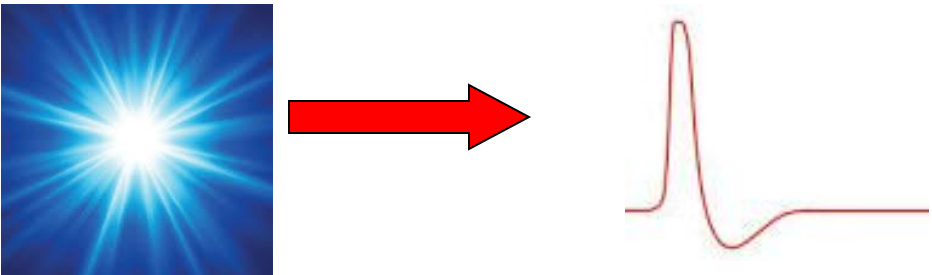
Čulni receptor

Akcioni potencijali

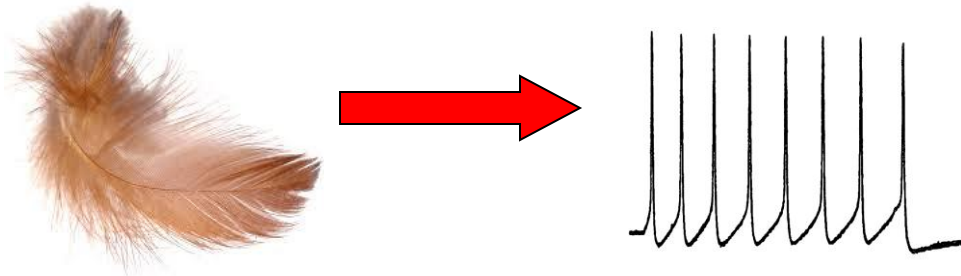


Percepcija

➤ **Pretvarači energije**

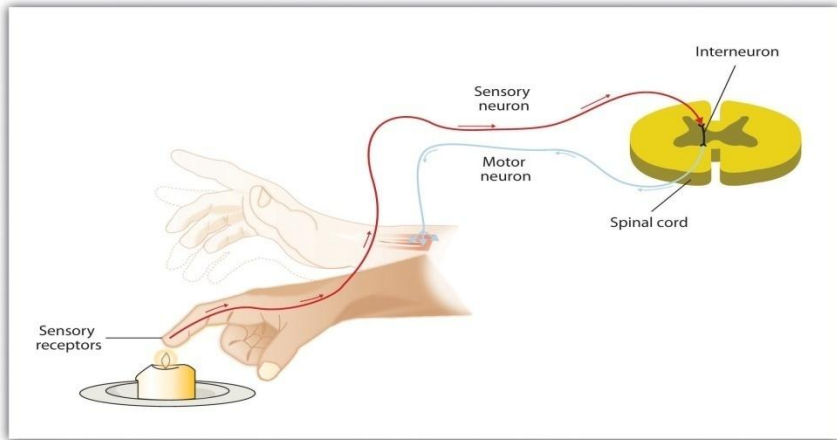


➤ **Pojačivači energije**



➤ **Adekvatan stimulus**

➤ **Efikasan stimulus**



# Kategorizacija receptora prema lokalizaciji

## ➤ Eksteroceptori



## ➤ Interoceptori

- proprioceptori
- visceroreceptori



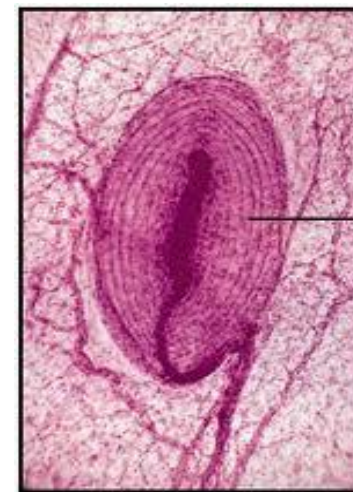
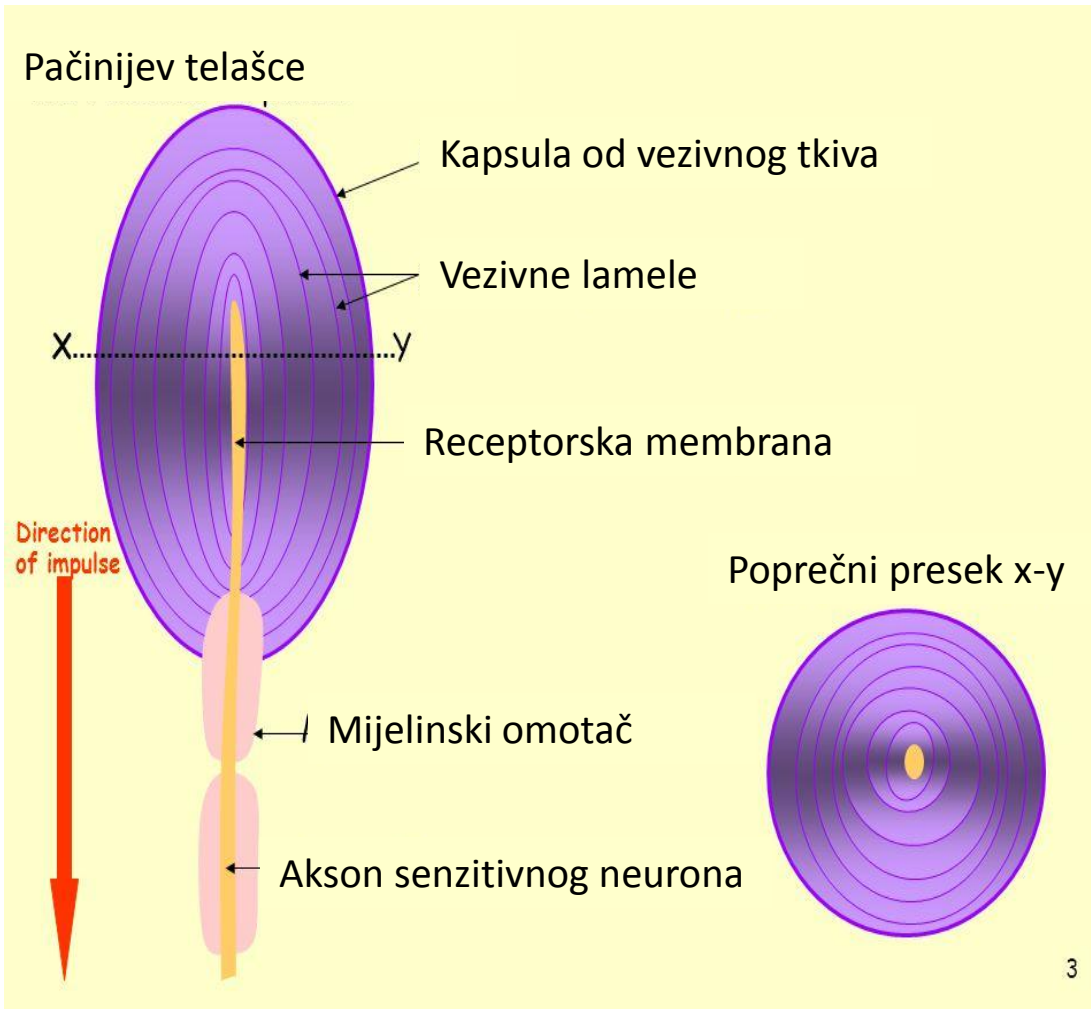
# Kategorizacija prema fiziološkoj dispoziciji



- **Mehanoreceptori** (kožni receptori za dodir, slušni receptori, proprioceptori)
- **Hemoreceptori** (receptori za ukus, miris, unutrašnji receptori za kiseonik)
- **Fotoreceptori** (štapići i čepići mrežnjače)
- **Termoreceptori** (detekcija promene temperature kože i krvi)
- **Nociceptori** (receptori za bol)
- Elektroceptori (promena električnog polja)
- Magnetoceptori (promena magnetnog polja)

# Zajedničke odlike senzorne transdukcije

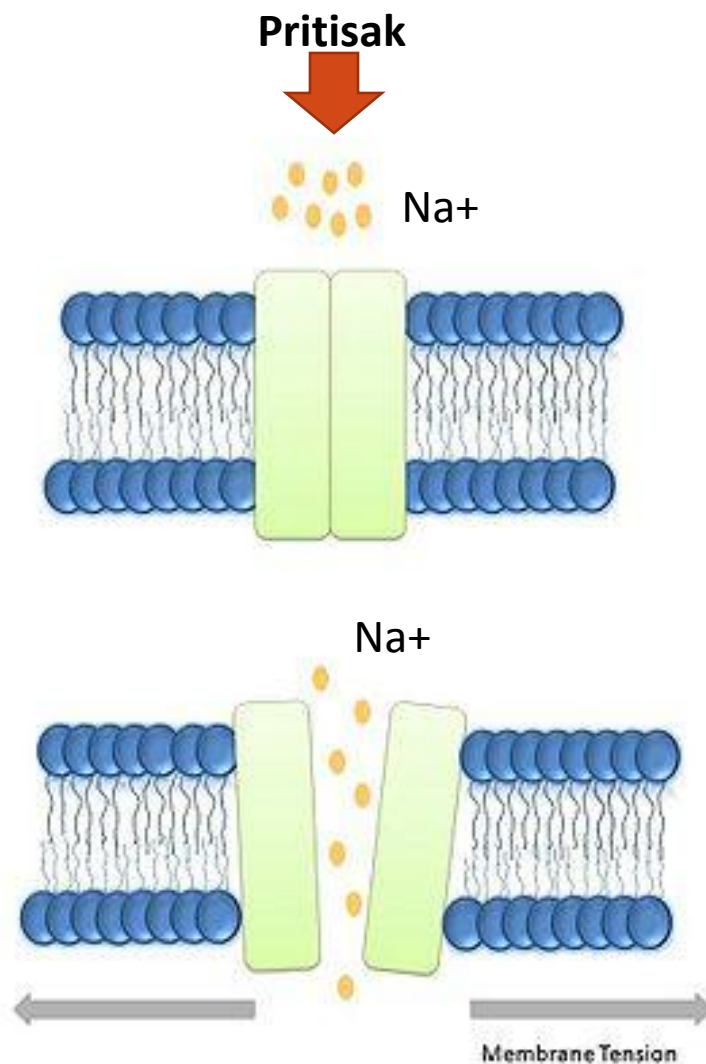
# Pačinijevo telašće



Pacianian corpuscle, responds to touch.

- Prema lokalizaciji – **eksteroceptor**
- Prema morfološkoj vrednosti - **učaureni nervni završetak**
- Prema fiziološkoj dispoziciji – **mehanoreceptor, reaguje na vibracije frekvencije do 200 Hz.**

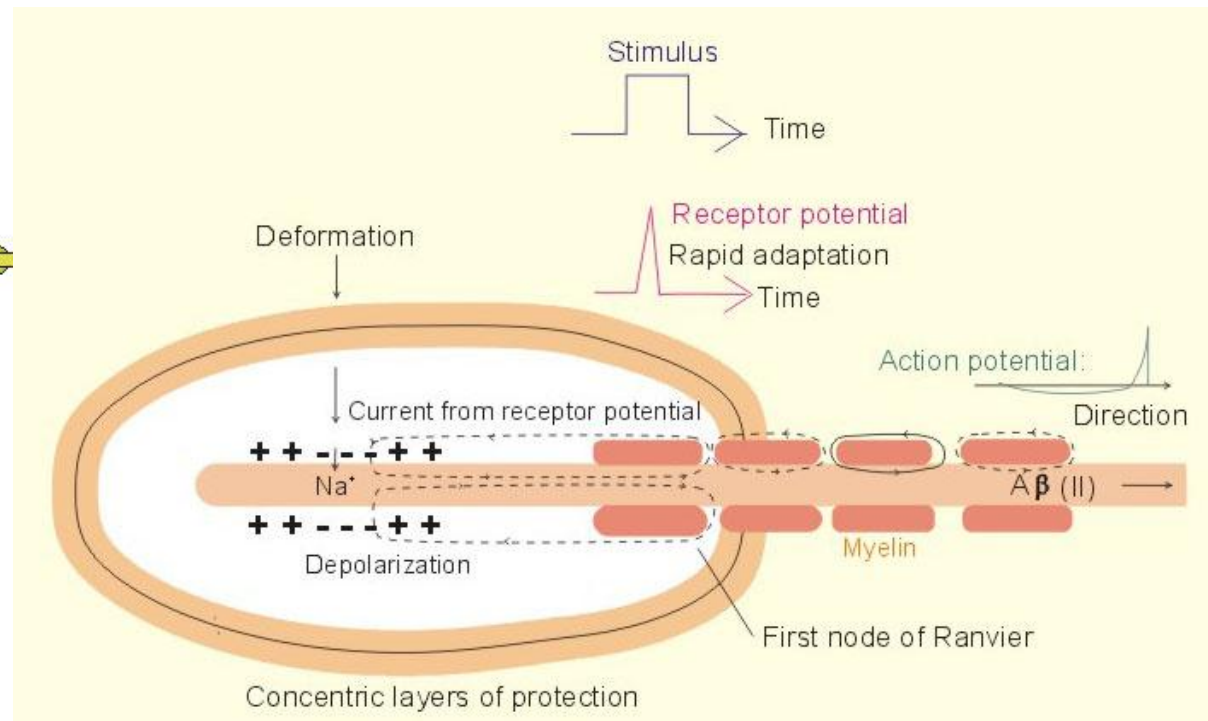
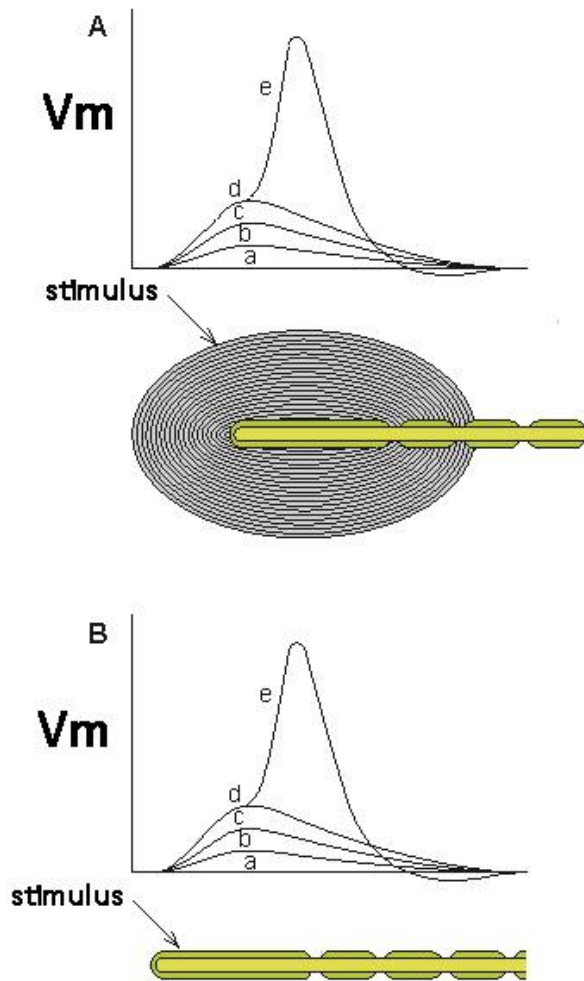
# Transdukcioni kanal Pačinijevog telašca (TRPM - mehano-osetljivi kanal)





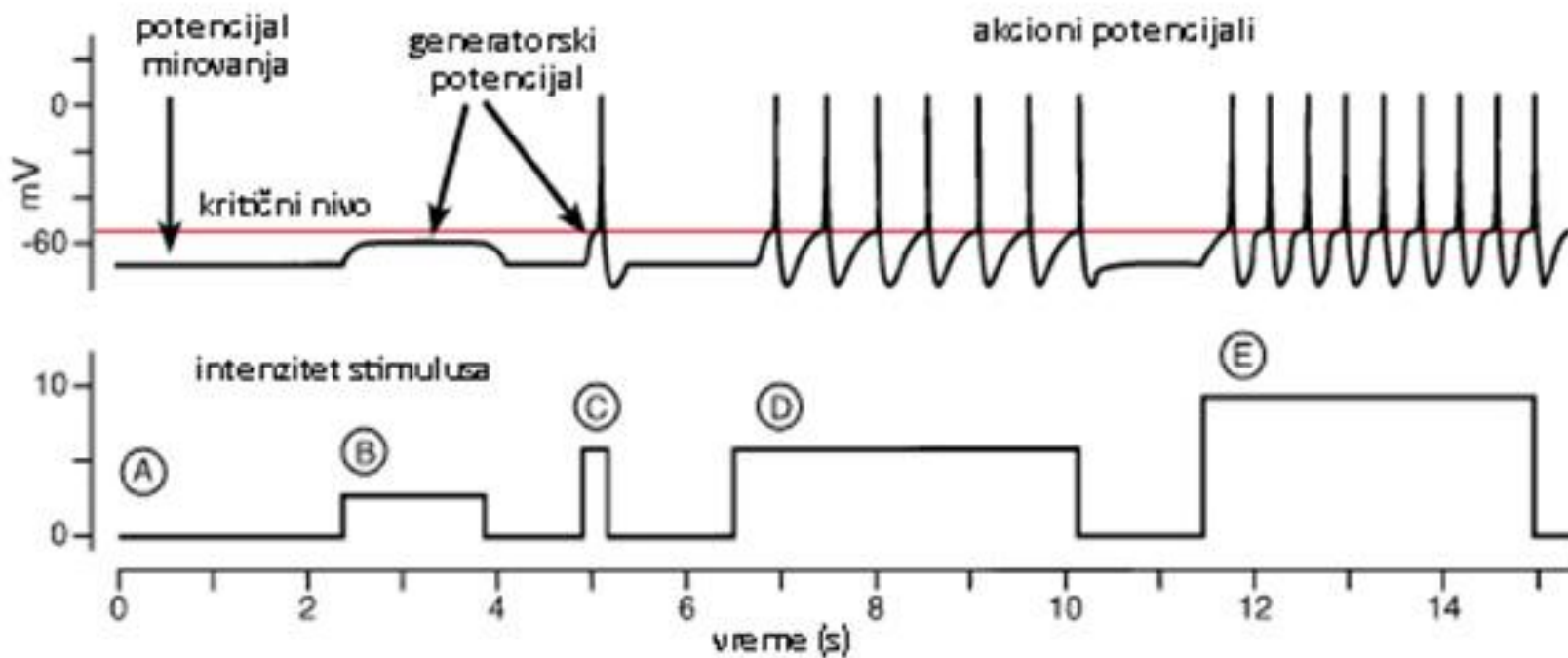
# Receptorski (generatorski) potencijal

## Receptorska i konduktilna membrana



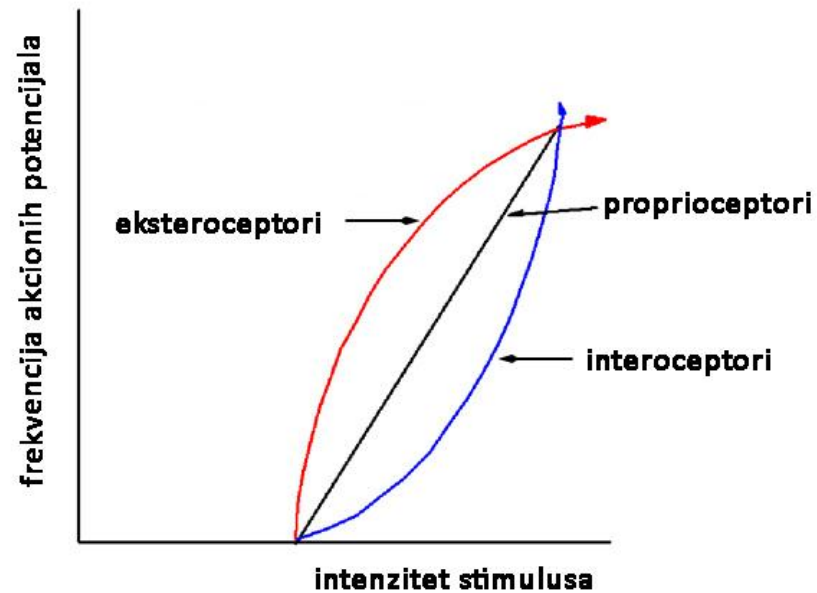
# Šifra frekvencije

## MEMBRANSKI POTENCIJAL



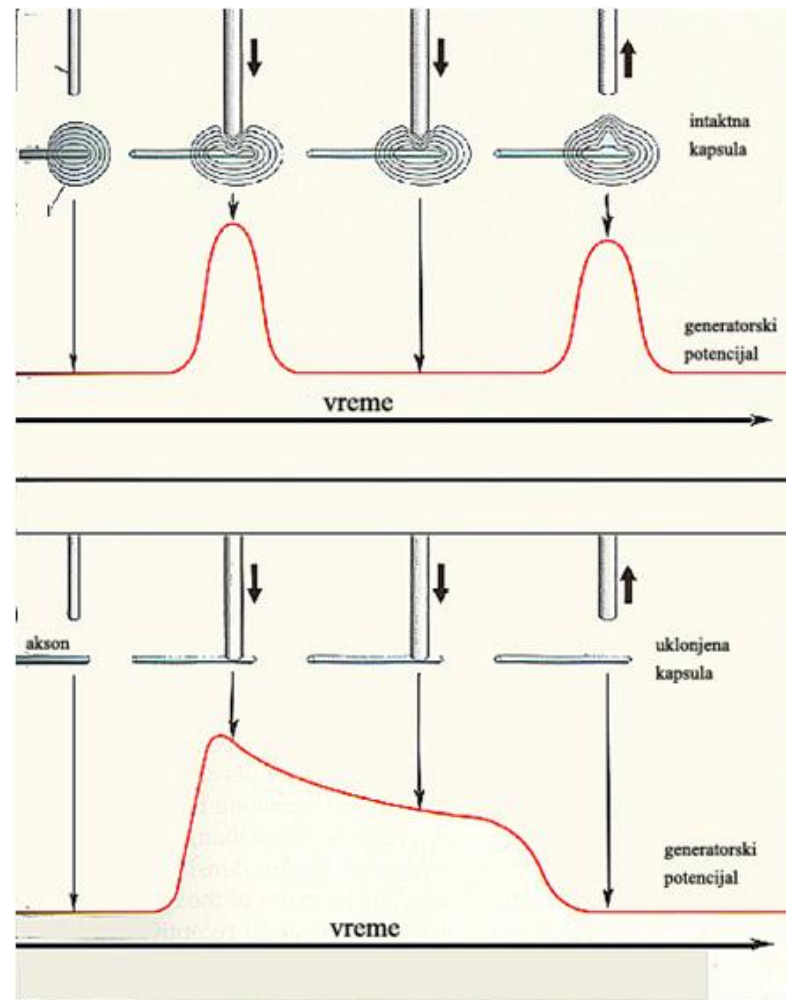
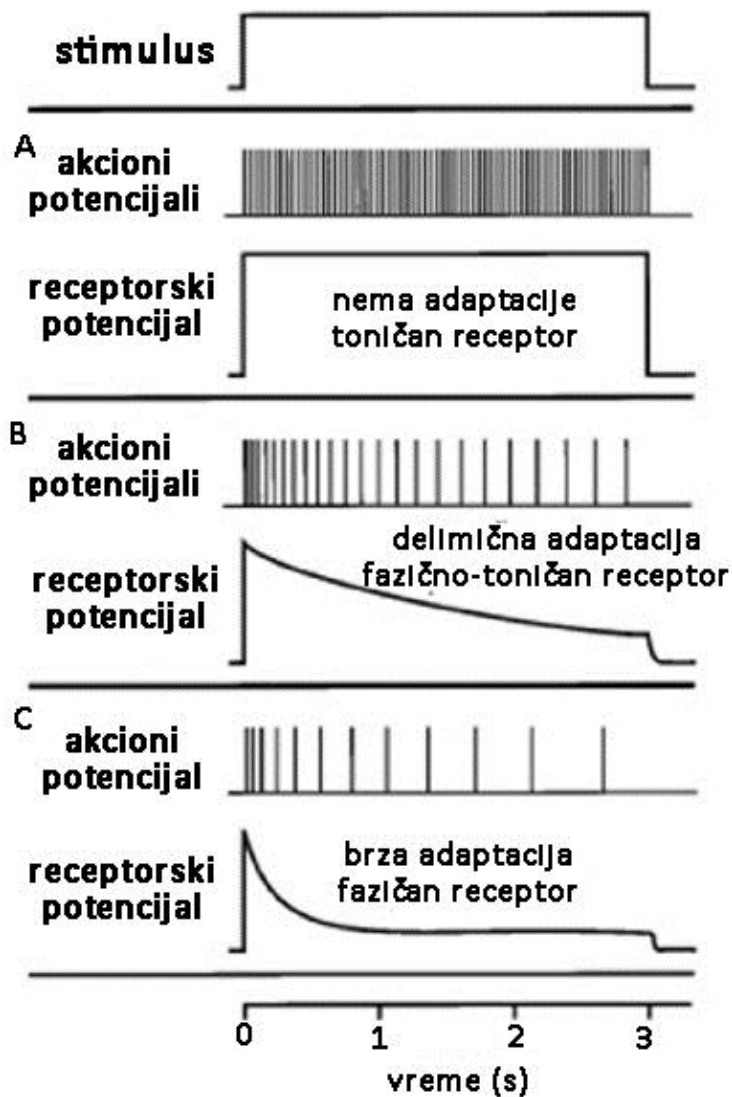
Преузето из: Н. Недељковић (2012) Општа физиологија

# Odnos intenziteta stimulusa i frekvencije akcionih potencijala



Eksteroceptori:  $F = k \log S$

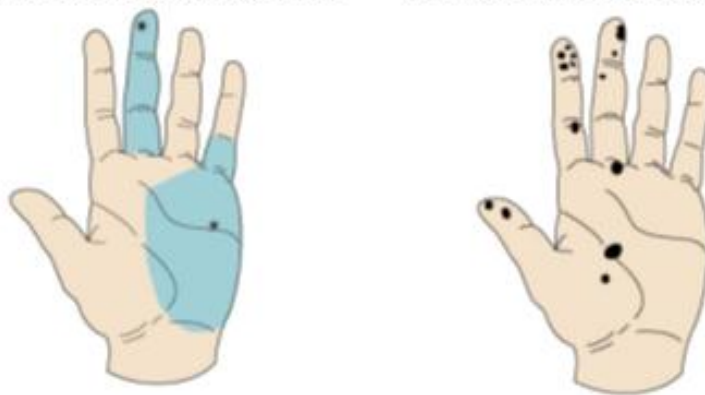
# Adaptacija receptora



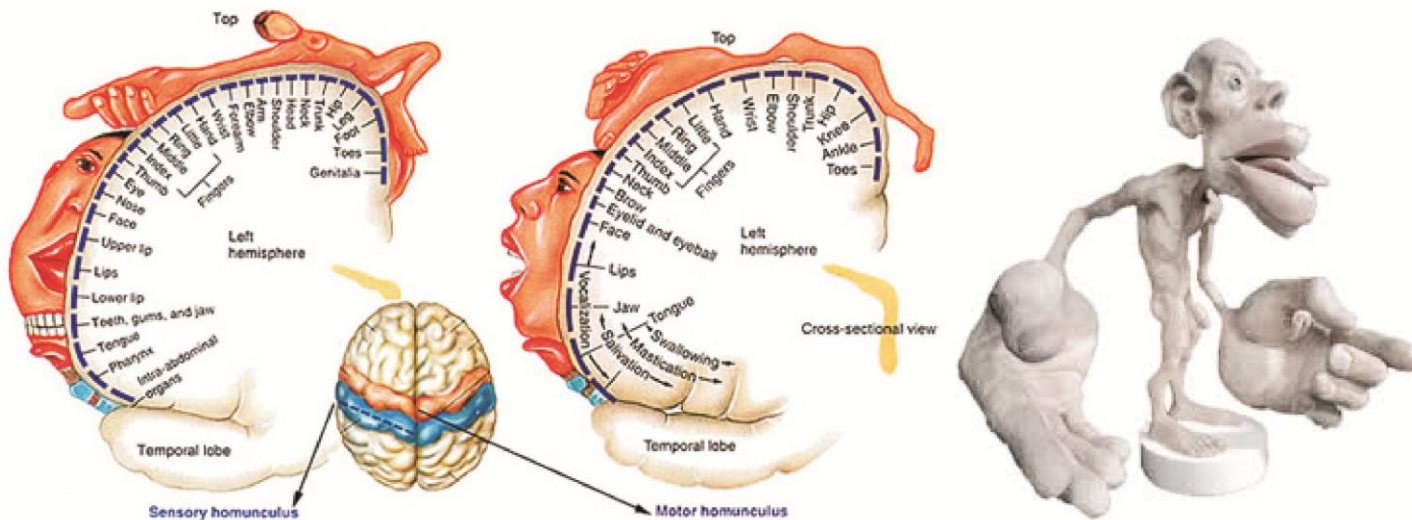
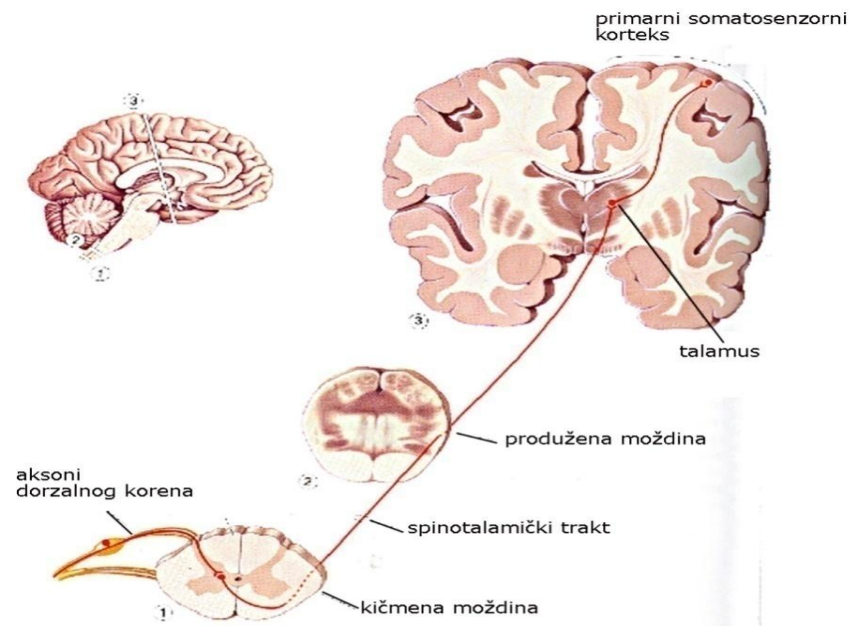
# Receptivno polje

- “Prostor” u kojem prisustvo stimulusa izaziva aktivaciju čulnog receptora naziva se *receptivno polje*.
- Kod Pačinijevog telašca - površina kože čija taktilna stimulacija izaziva aktivaciju pojedinačnog receptora.
- Receptori se razlikuju prema veličini receptivnog polja

Receptivna polja taktilnih receptora



# Šifra obeleženih linija



# ON-OFF receptori

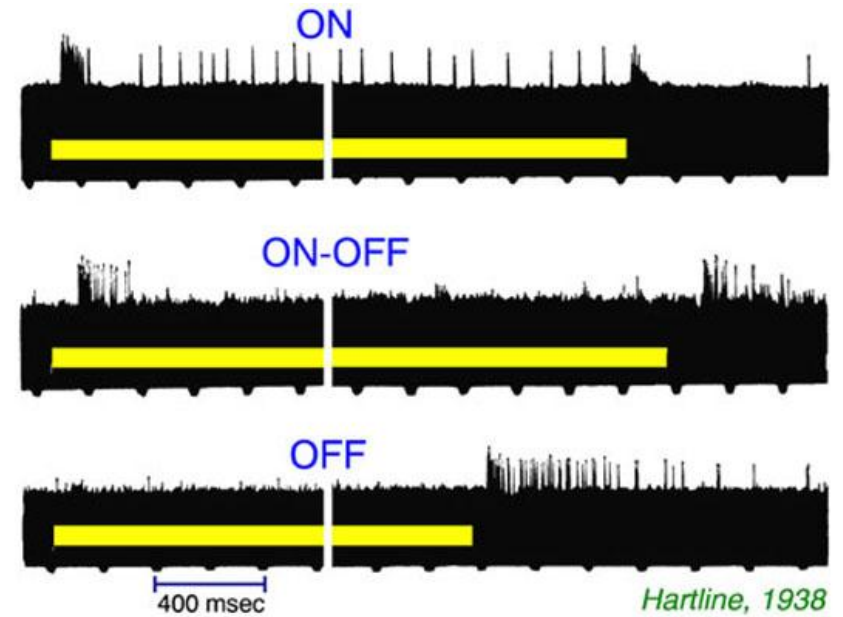
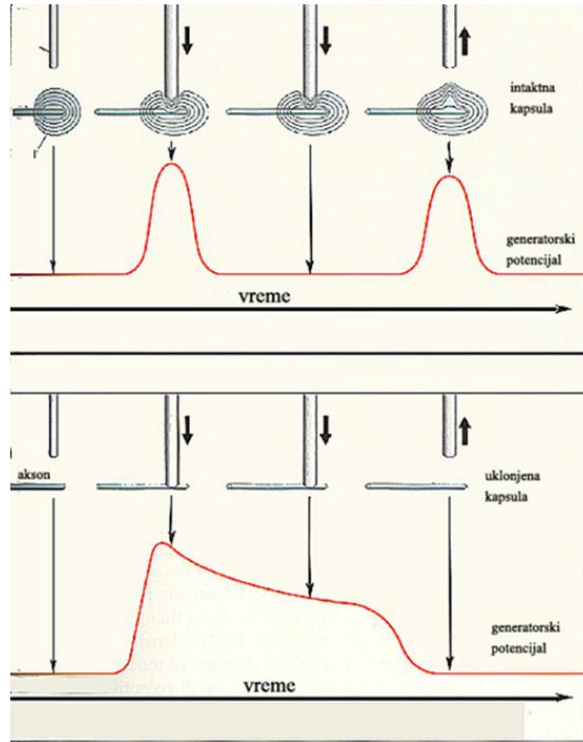


Fig. 3. ON, OFF and ON-OFF ganglion cells (after Hartline, 1938; 1967).

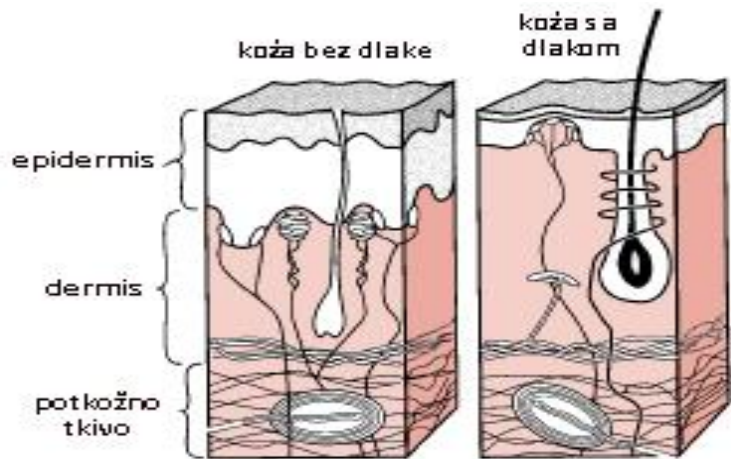
Преузето из: Н. Недељковић (2012) Општа физиологија

# Specifični primeri senzorne transdukcije



# Somatosenzorni sistem

# Taktilni receptori u koži



## Receptivna polja

Pačinijevih telašaca

Majsnerovih telašaca



Merkelovi dis kovi



taktilni disk

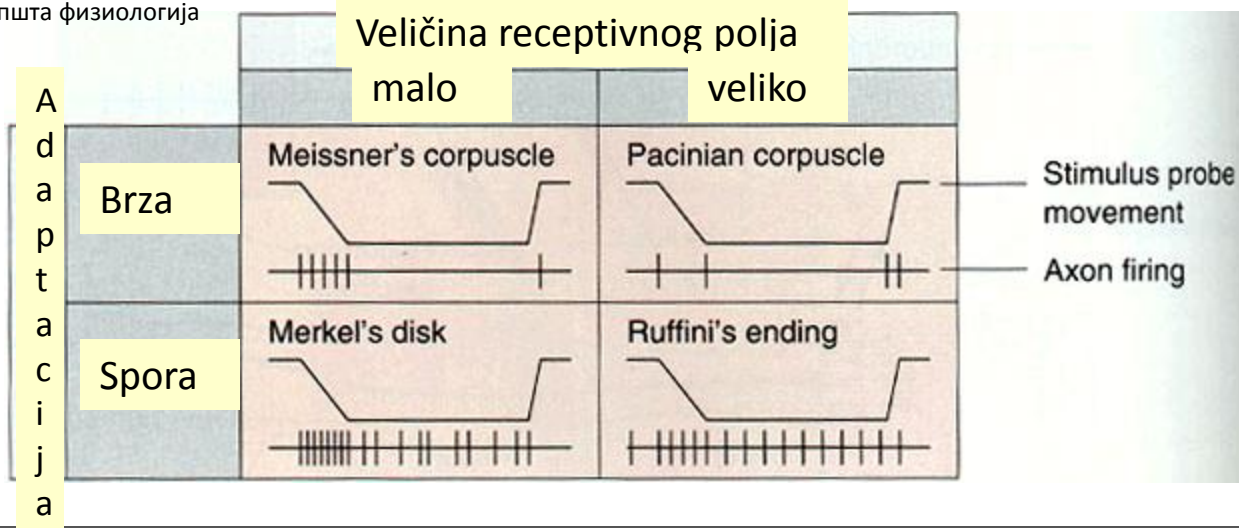


Pačinijeva telašca

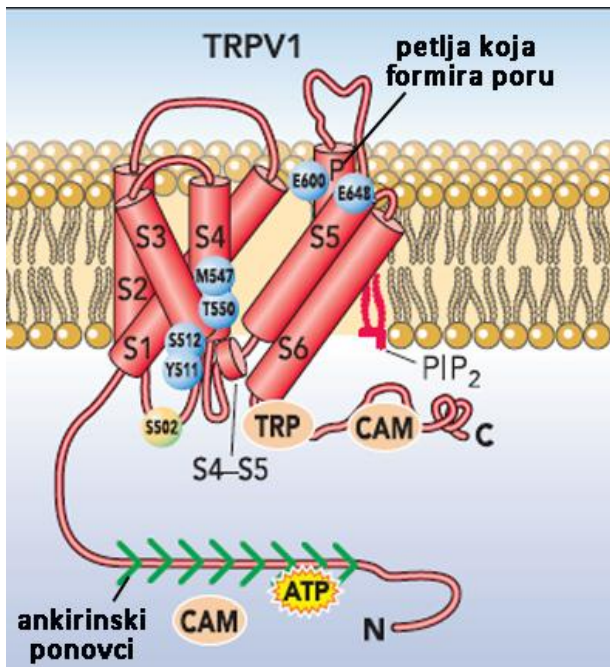
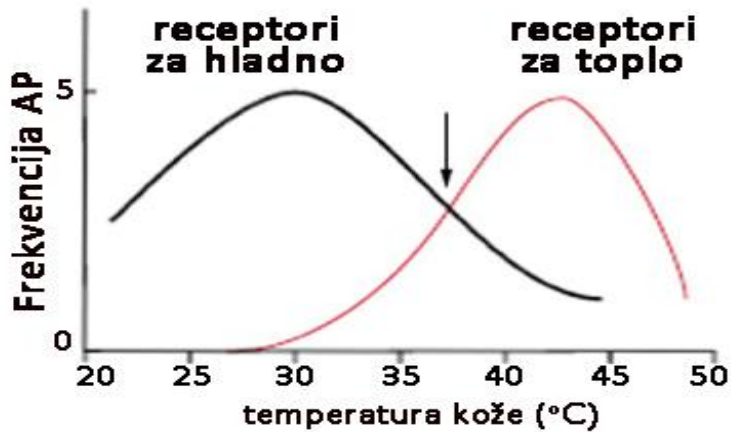


Rufinijevi završeci

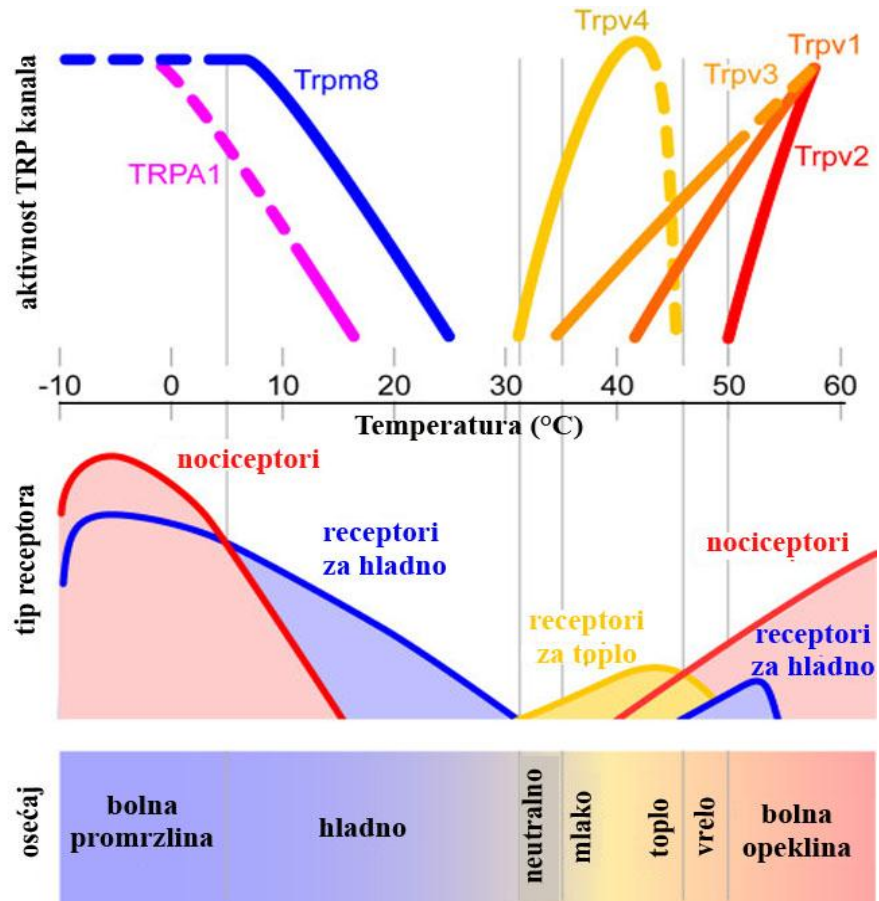
Preuzeto iz: H. Недељковић (2012) Општа физиологија



# Termoreceptori



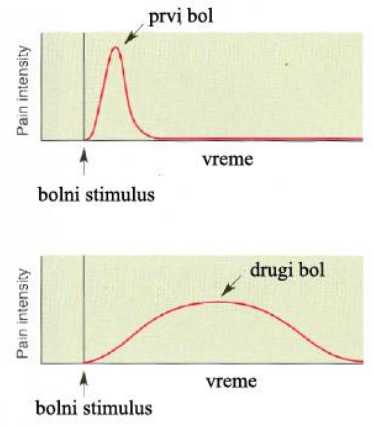
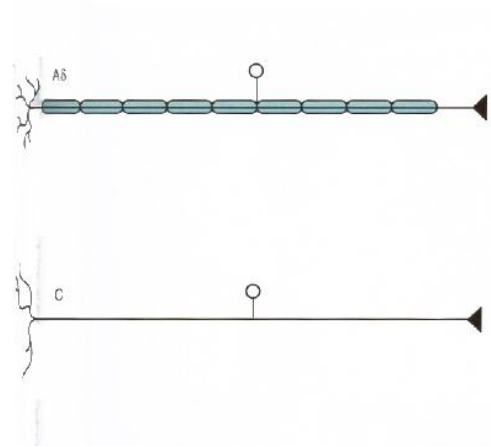
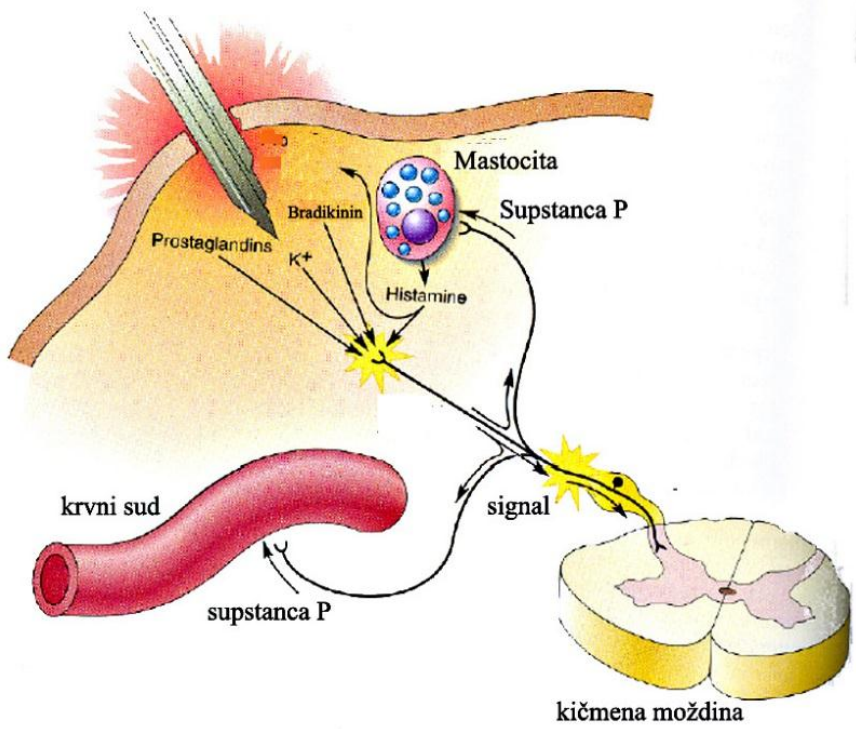
- Prema morfološkoj vrednosti - slobodni i učaureni nervni završeci.
- Prema fiziološkoj dispoziciji – termoreceptori.
- Transdukcioni kanali – TRPM, TRPA, TRPV



Preuzeto iz: H. Neđelković (2012) Opšta fiziologija

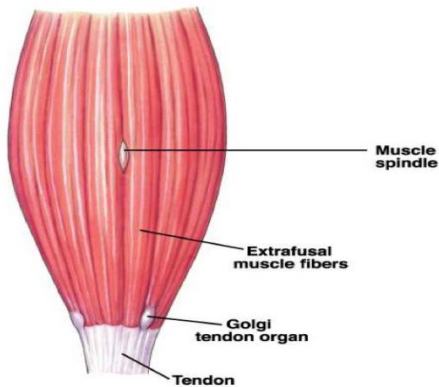
# Nociceptori (receptori za bol)

- Bol – osećaj, nocicepcija – senzorni proces
- Slobodni nervni završeci (A $\delta$  i C tipa)
- Aktivira ih jak stimulus - potencijalno ili stvarno oštećenje tkiva
- Prema fiziološkoj dispoziciji:
  - Mehanosenzitivni
  - Hemosenzitivni
  - Termosenzitivni
  - Polimodalni
- Medijatori bola
  - K<sup>+</sup>, ATP, bradikinin, histamin

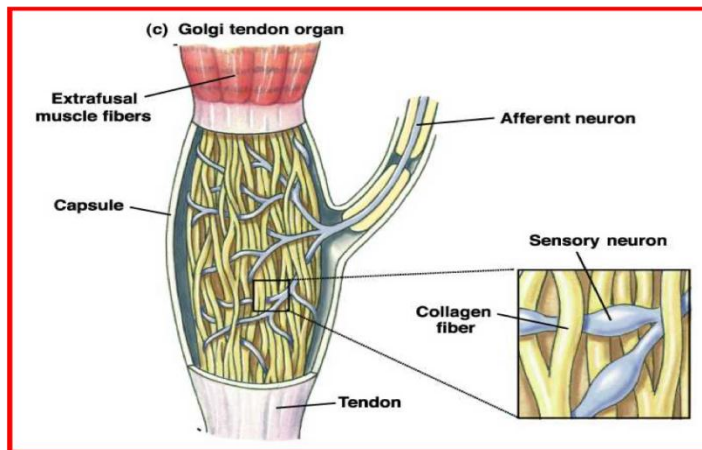


# Proprioceptori

## Mišićno vreteno



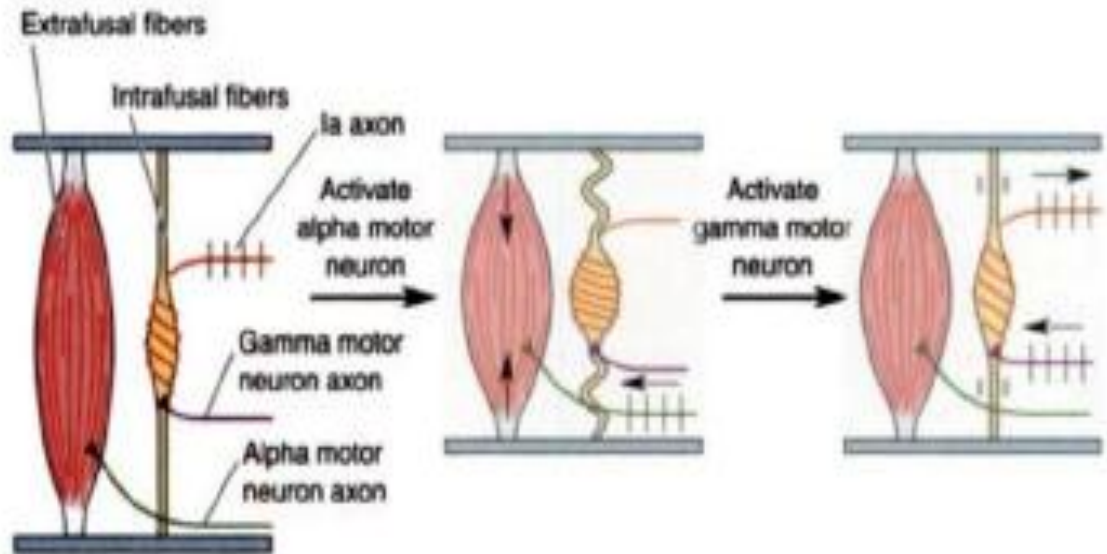
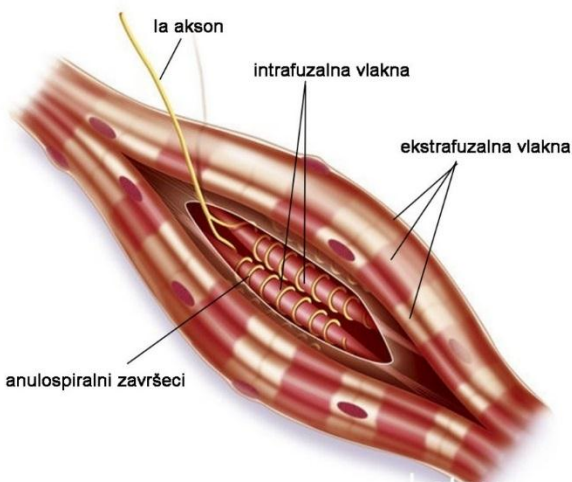
## Golžijev tetivni organ



- Mišićna vretena i Goldžijev tetivni organ

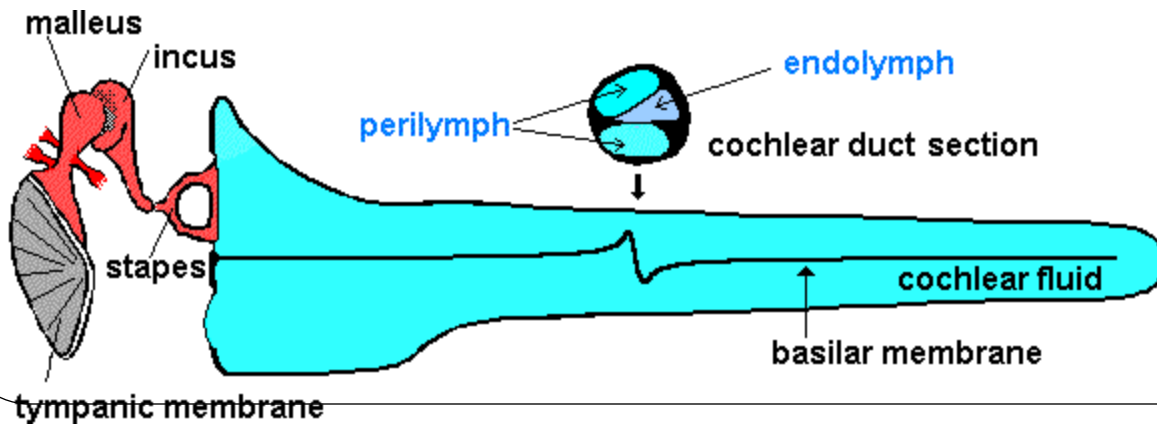
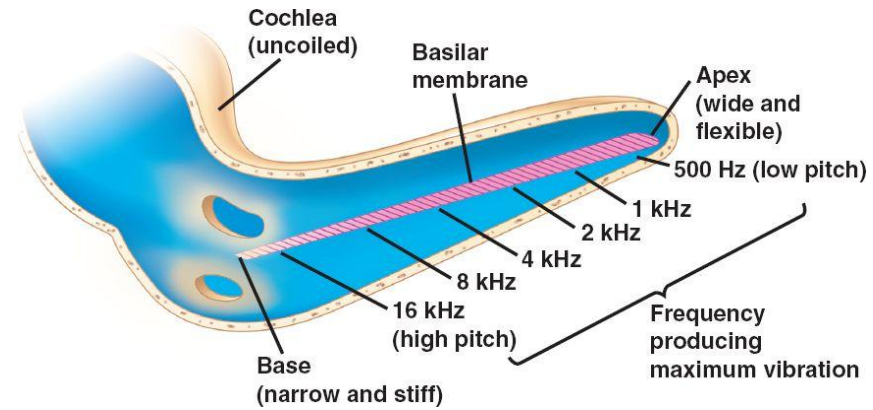
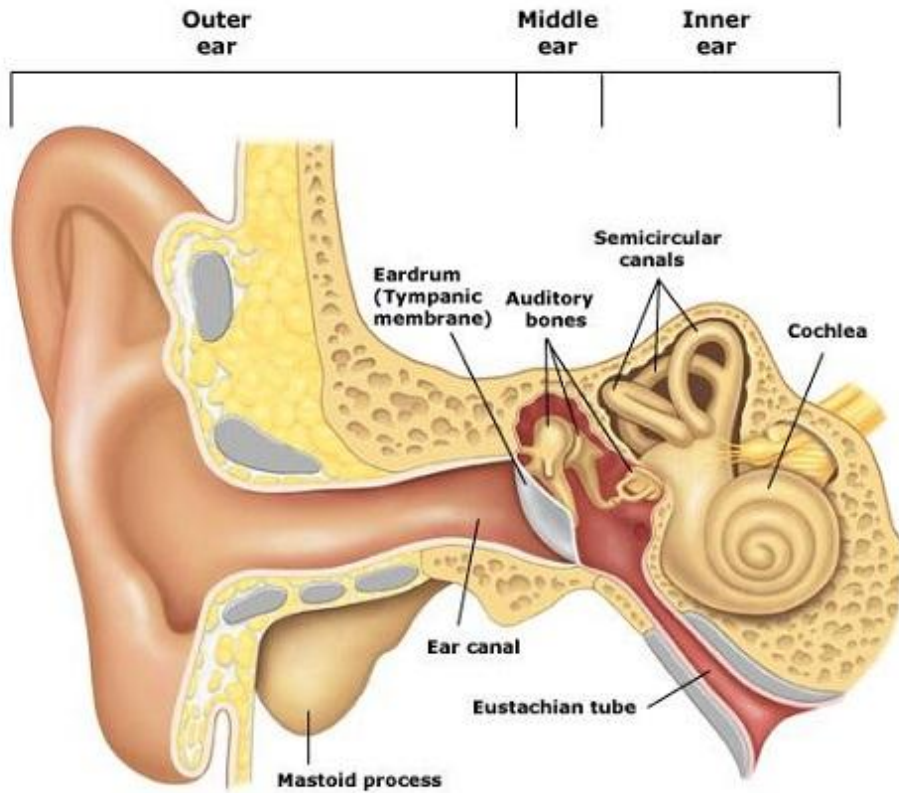
- Prema lokalizaciji – **interoceptori**

- Prema morfološkoj vrednosti – **učaureni nervni završeci Ia i Ib senzitivnih vlakana**

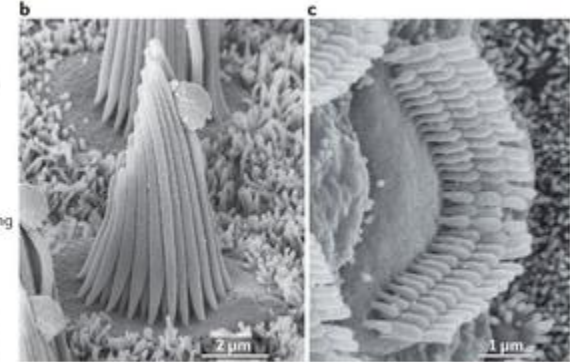
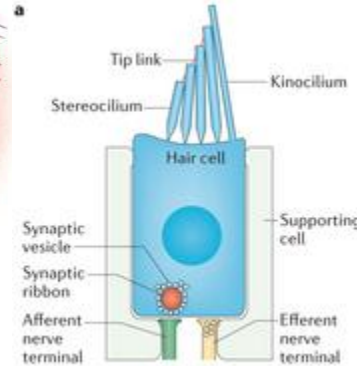
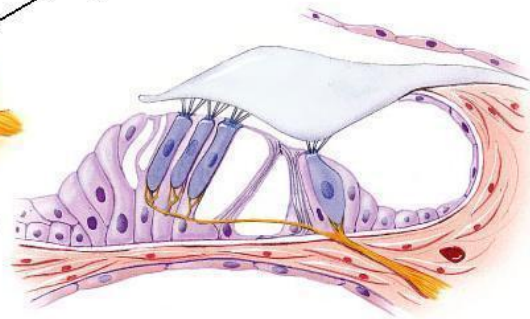
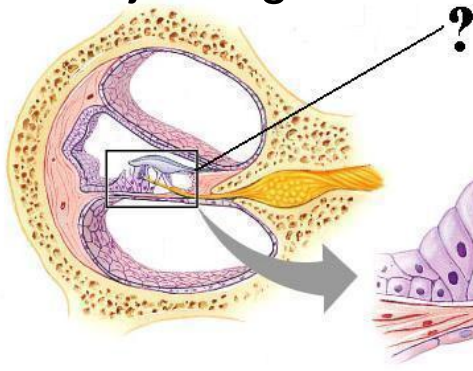


# Mehanorecepcija sluha i položaja tela

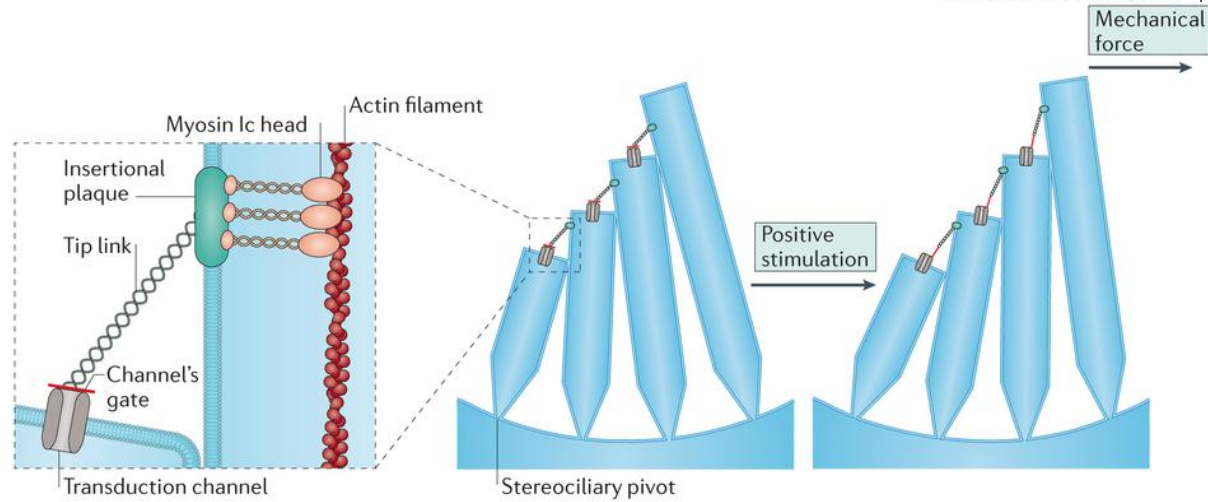
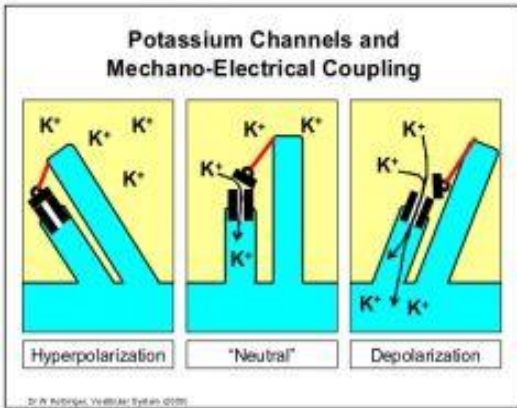
# Čulo sluha



# Kortijev organ



Nature Reviews | Neuroscience

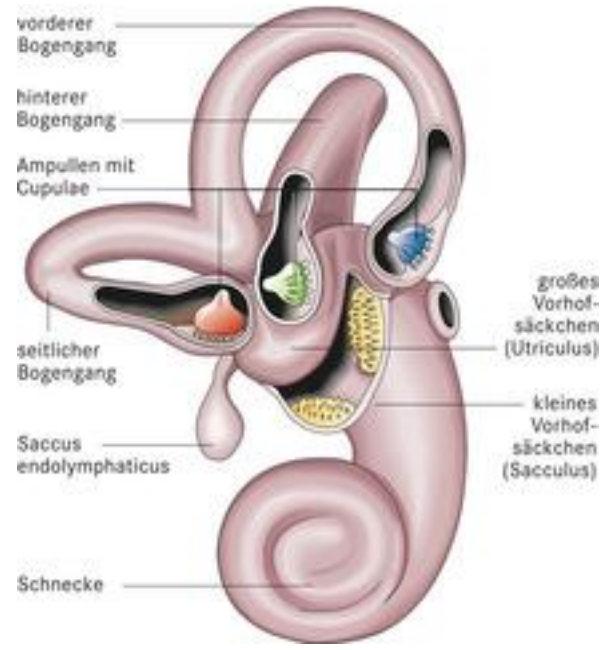
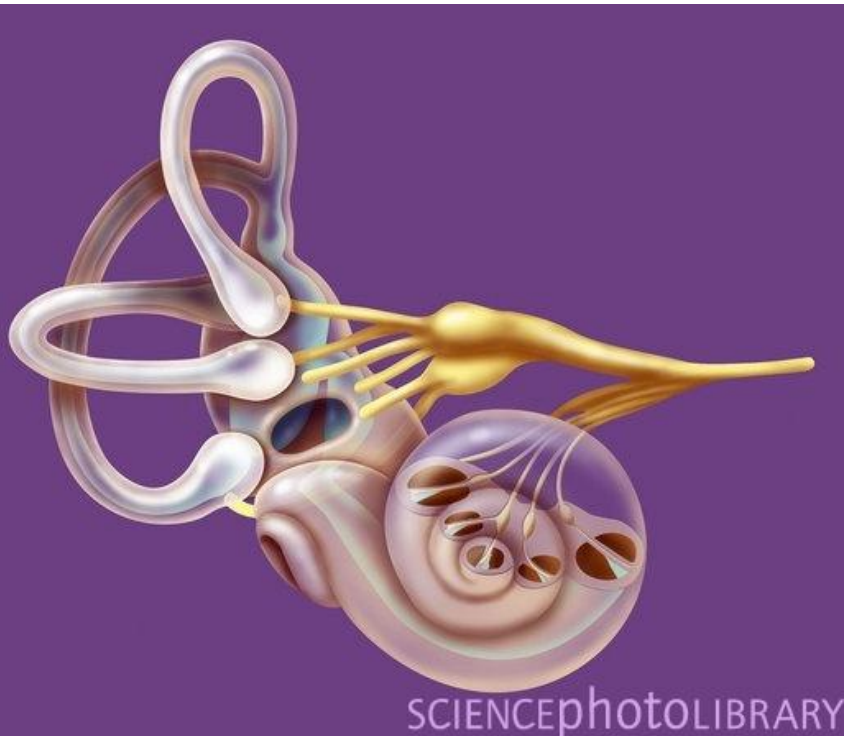


Nature Reviews | Neuroscience

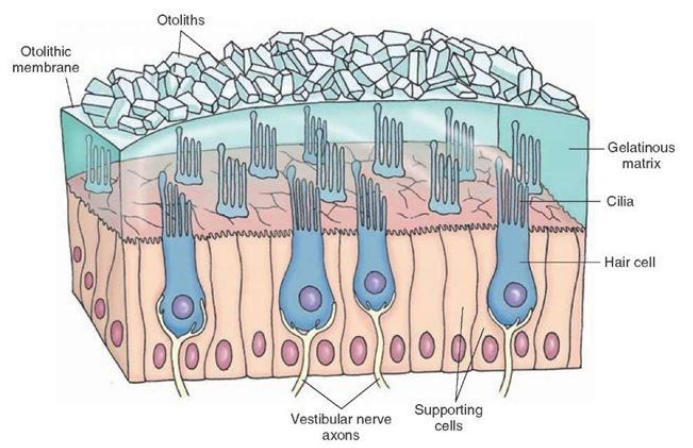
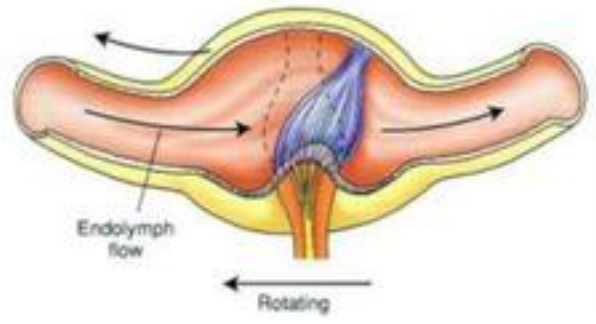
From: A. J. Hudspeth. Integrating the active process of hair cells with cochlear function. *Nature Reviews Neuroscience* 15, 600–614 (2014) doi:10.1038/nrn3786



# Mehanorecepcija položaja tela



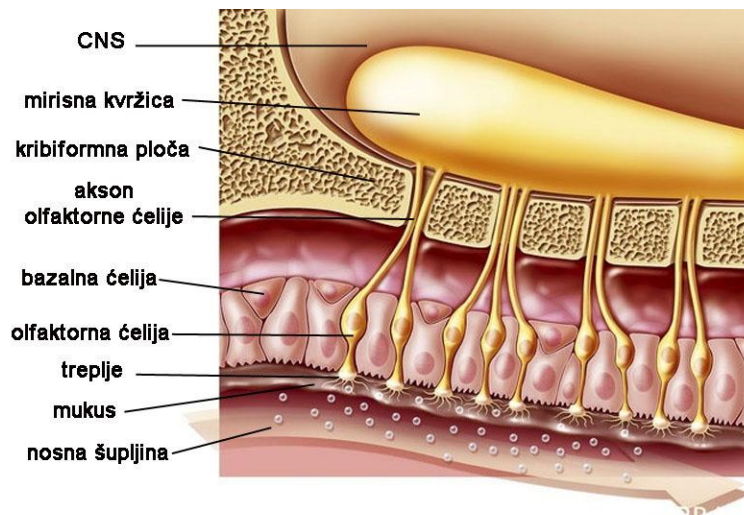
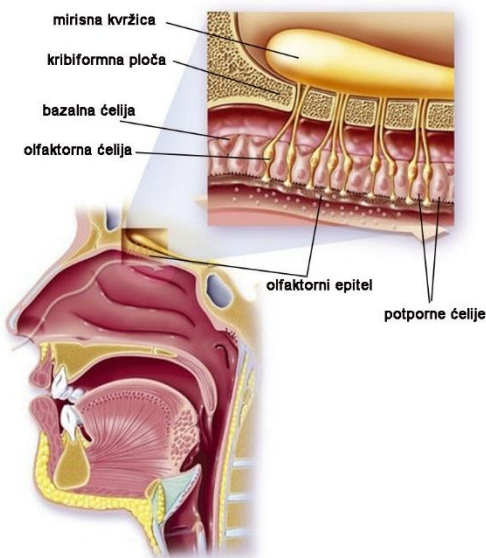
Semicircular Canals detect Angular Acceleration



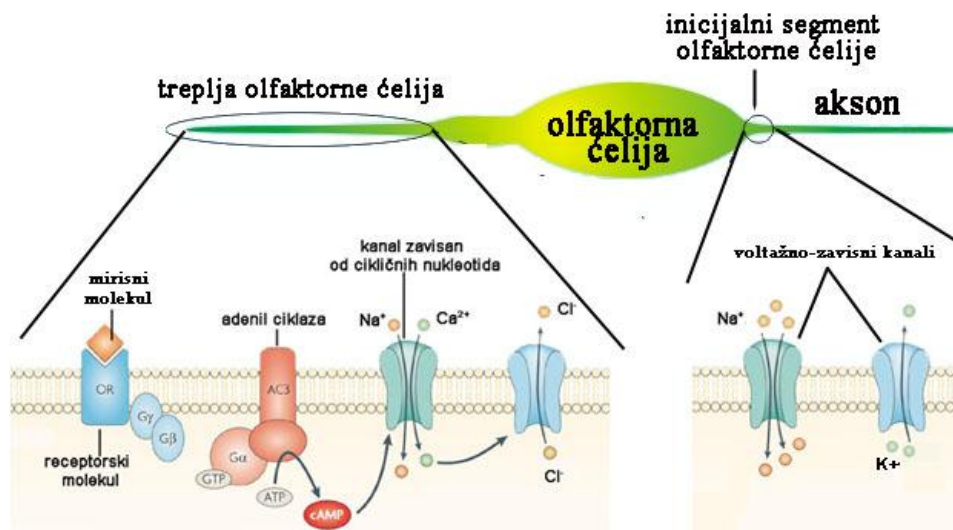
Hemoreceptori

Olfaktorna i gustativna recepcija

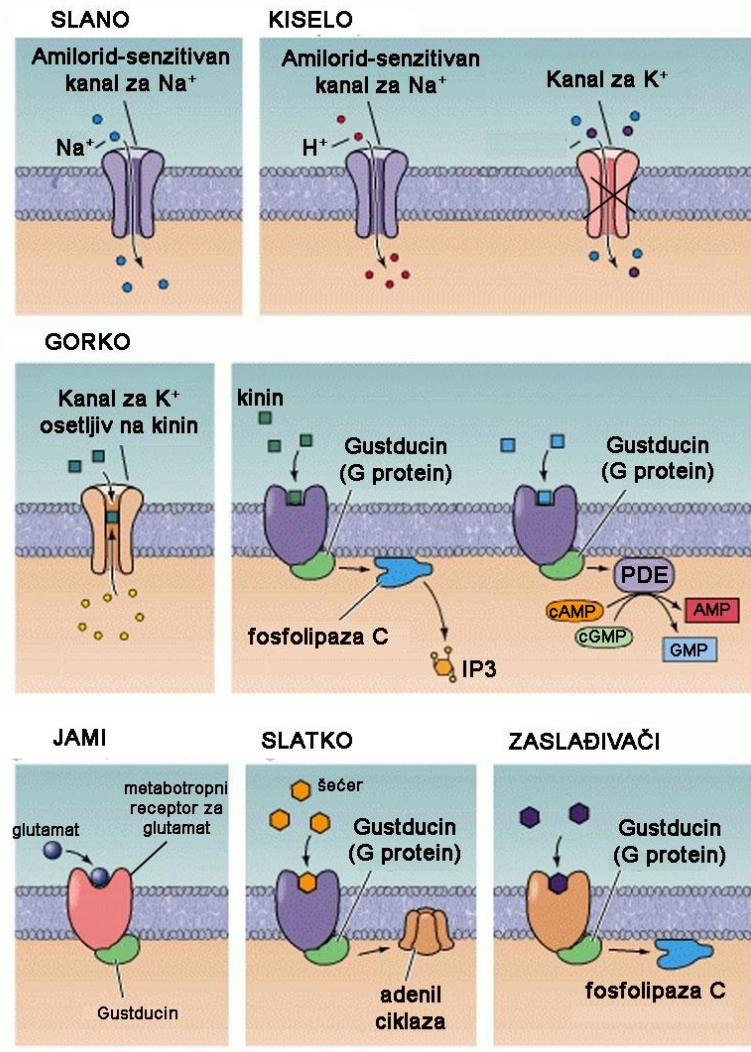
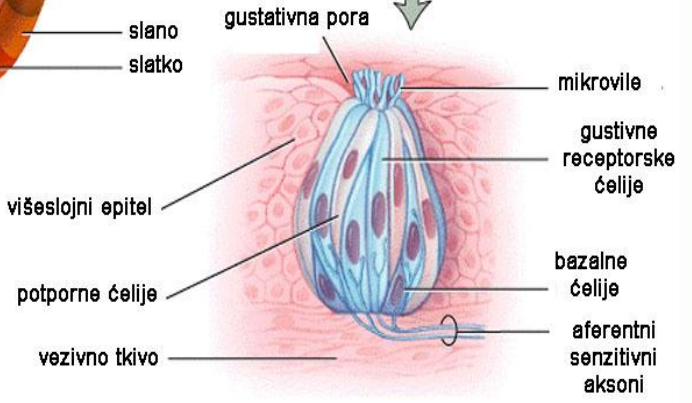
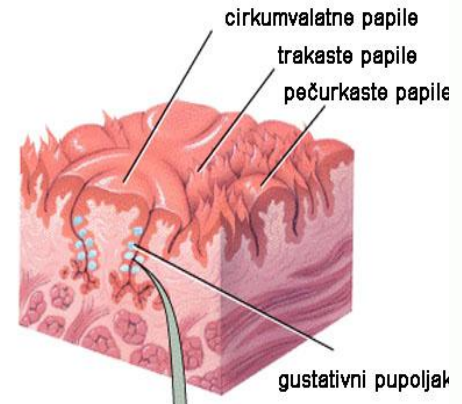
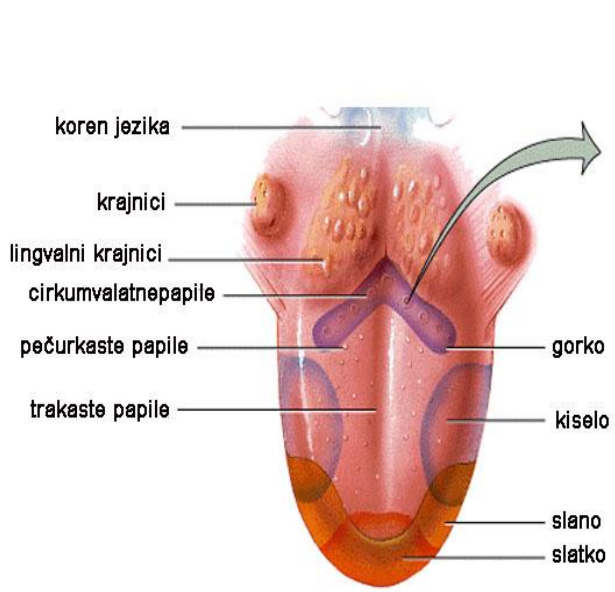
# Olfaktorni receptori

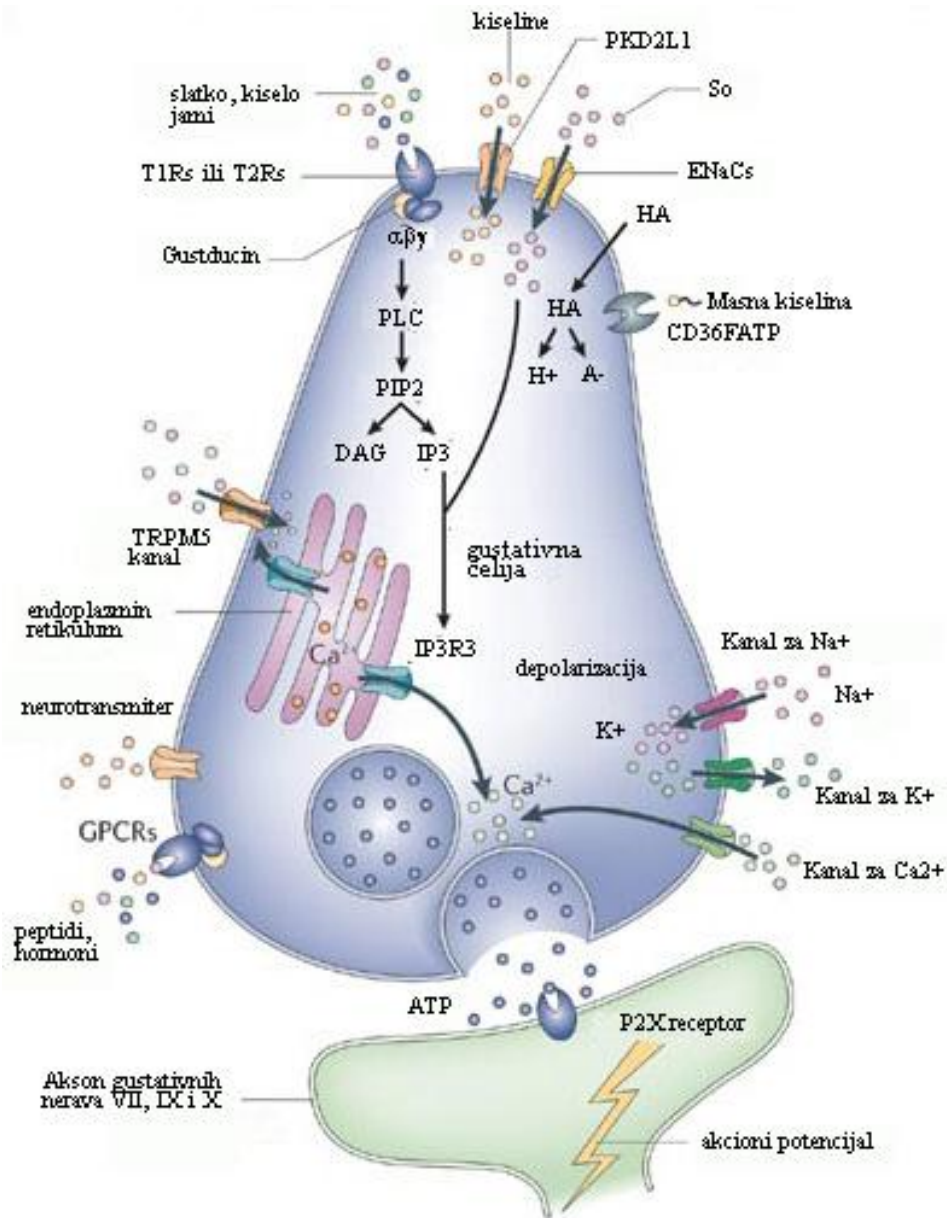


- Prema lokalizaciji – **eksteroceptor**
- Prema morfološkoj vrednosti – **primarna čulna ćelija**
- Prema fiziološkoj dispoziciji – **hemoreceptor**
- Transkucioni kanal – **zavisan od cikličnih nukleotida**



# Gustativni receptori

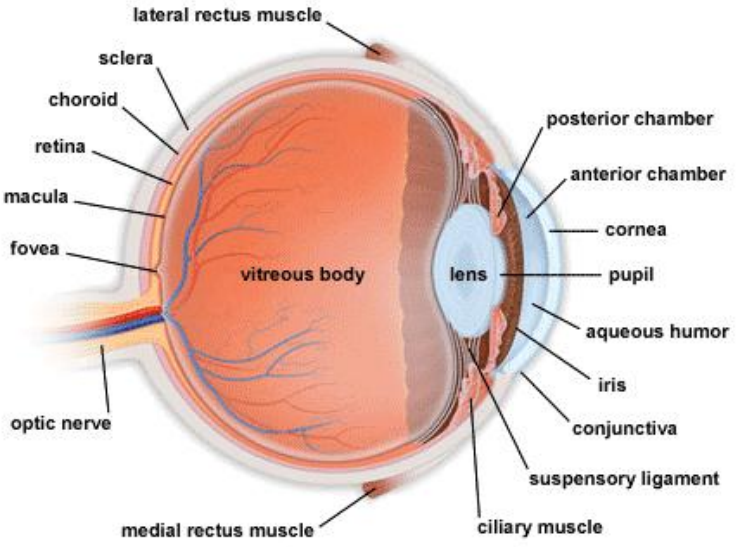
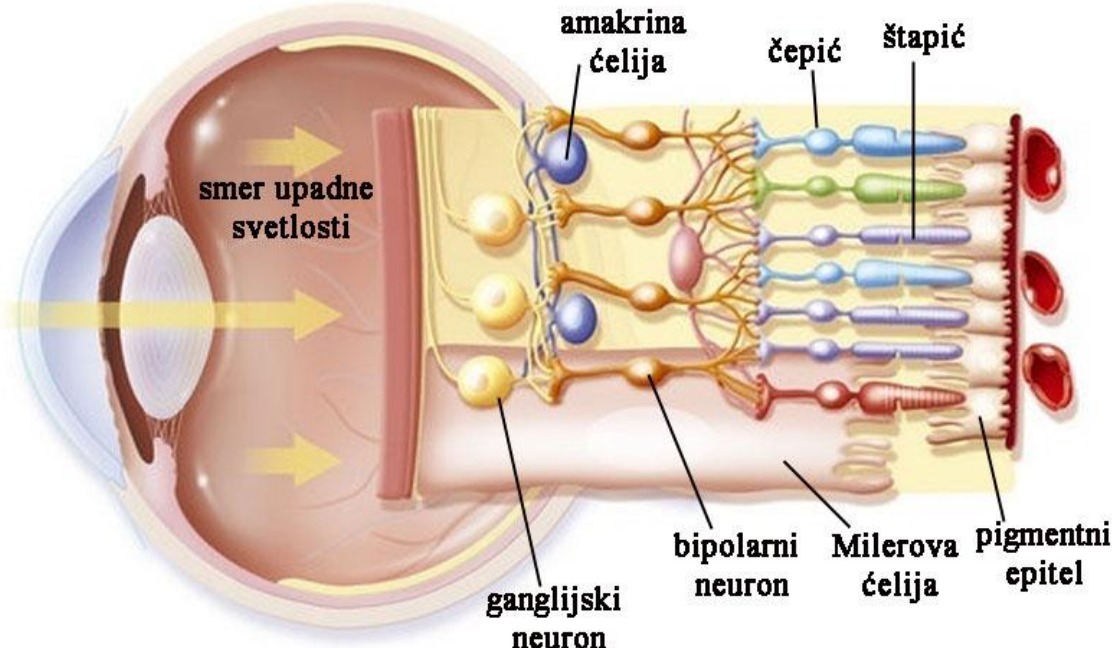




Preuzeto iz: H. Neđelković (2012) Opšta fiziologija

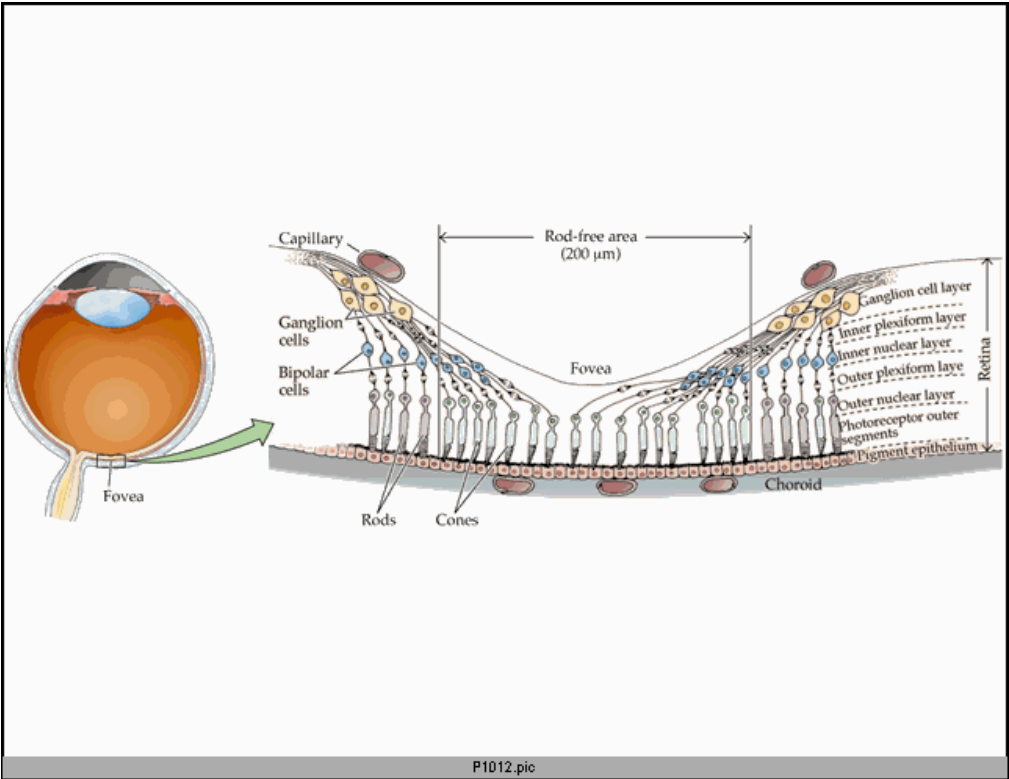
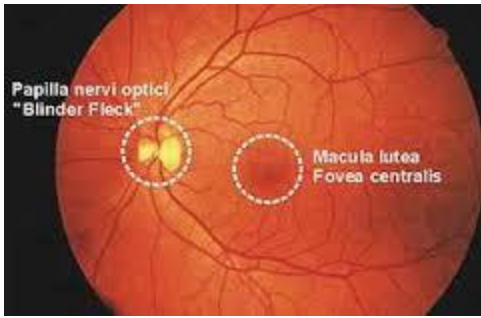
Fotorecettori

# Mrežnjača

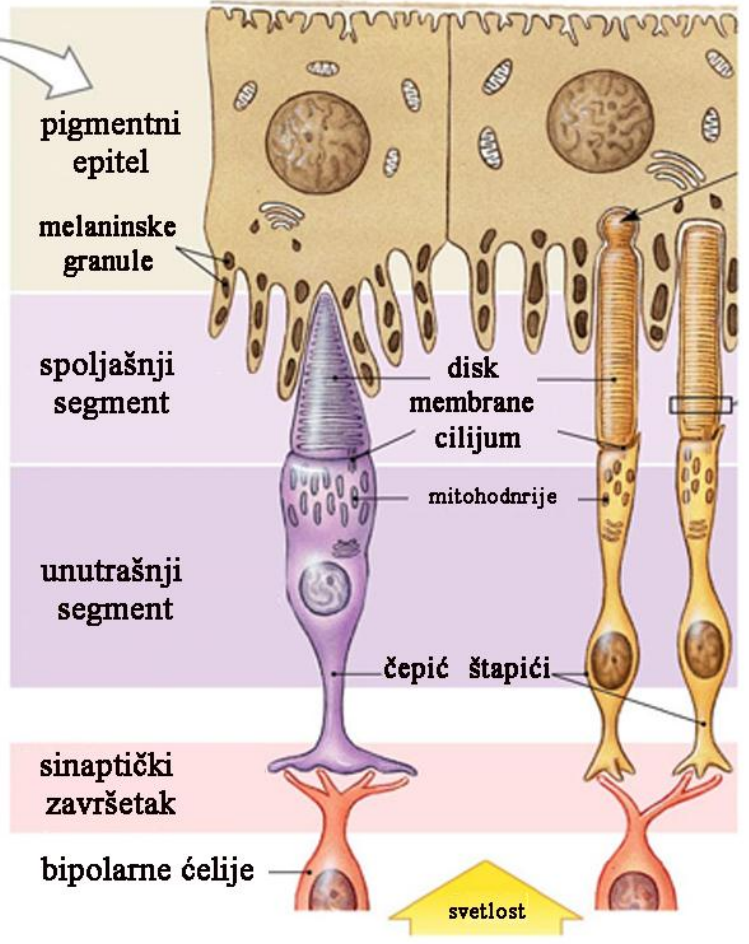


Преузето из: Н. Недељковић (2012) Општа физиологија

# Fotoreceptorske ćelije – štapići i čepići



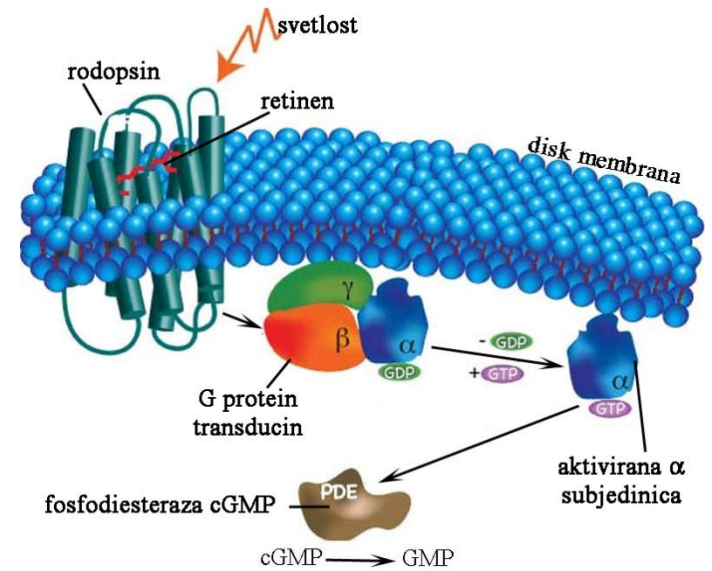
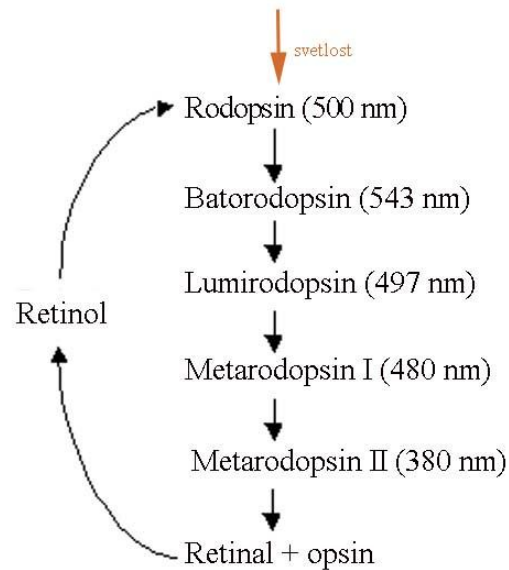
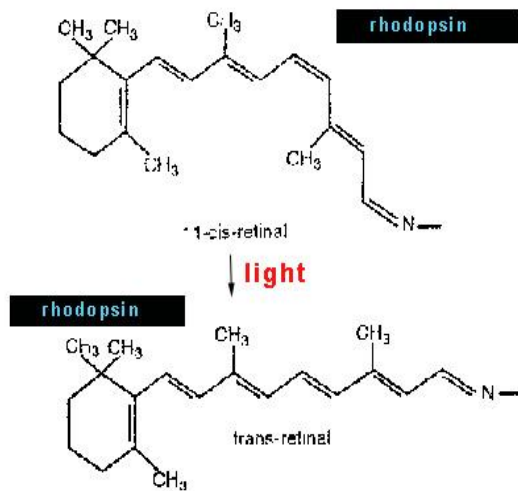
P1012.pic



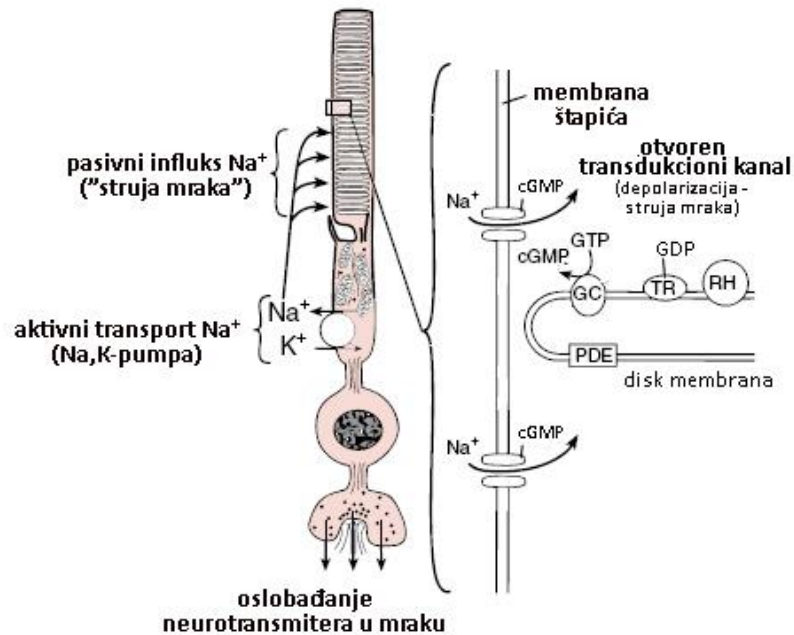
Преузето из: Н. Недељковић (2012) Општа физиологија



# Fototransdukciona kaskada

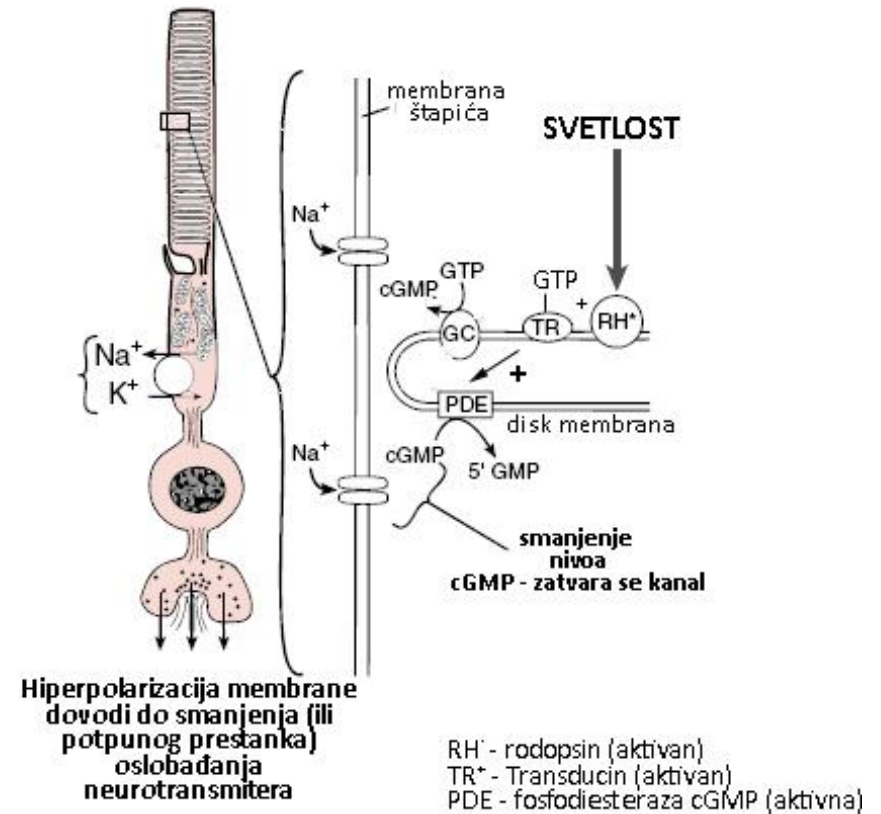


## Događaji u mraku



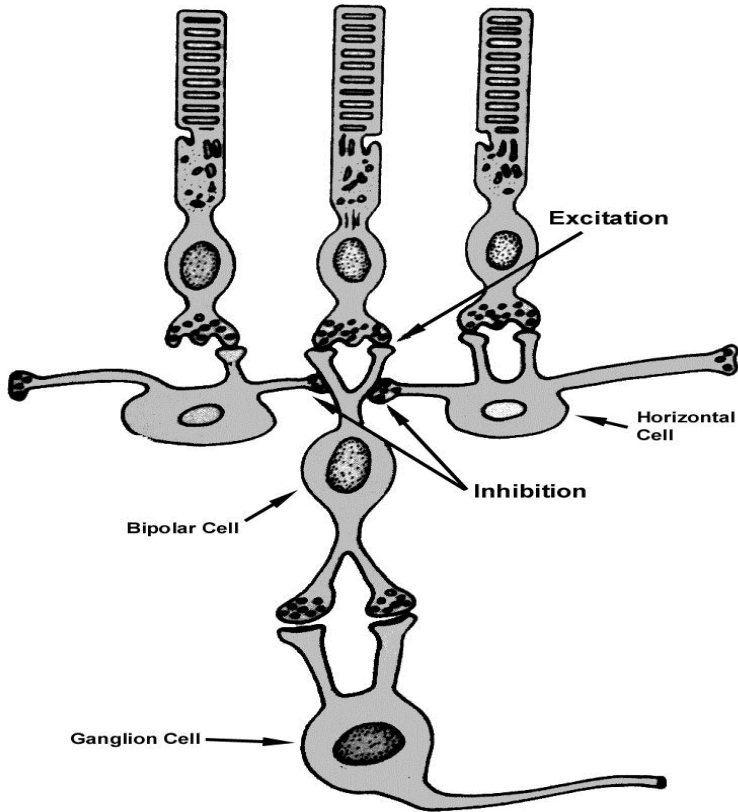
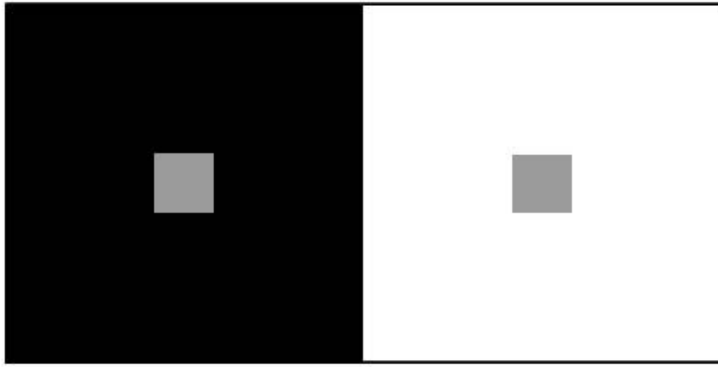
RH - rodopsin (neaktivan)  
 TR - transducin (neaktivan)  
 PDE - fosfodiesteraza cGMP (neaktivna)  
 GC - guanil ciklaza (aktivna)

## Događaji na svjetlu

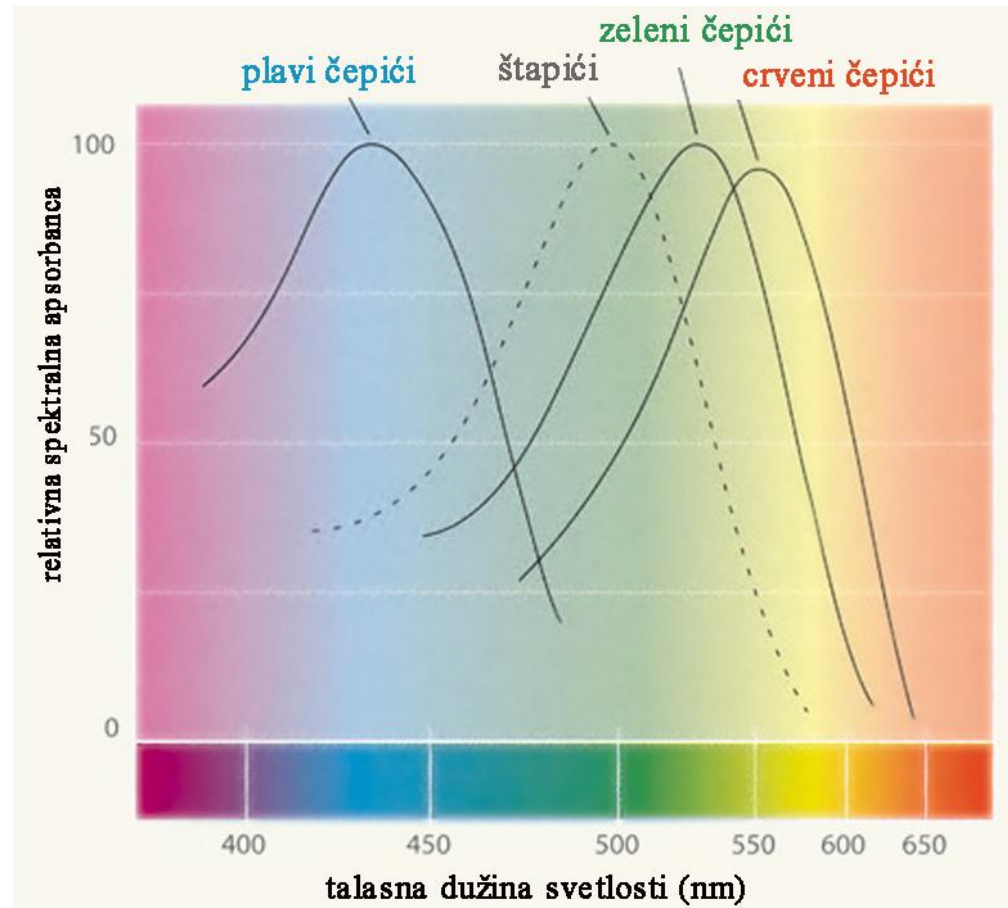


Preuzeto iz: H. Neđelković (2012) Opšta fiziologija

# Pojačanje kontrasta



# Razlikovanje boja



Preuzeto iz: N. Neđelković (2012) Opšta fiziologija