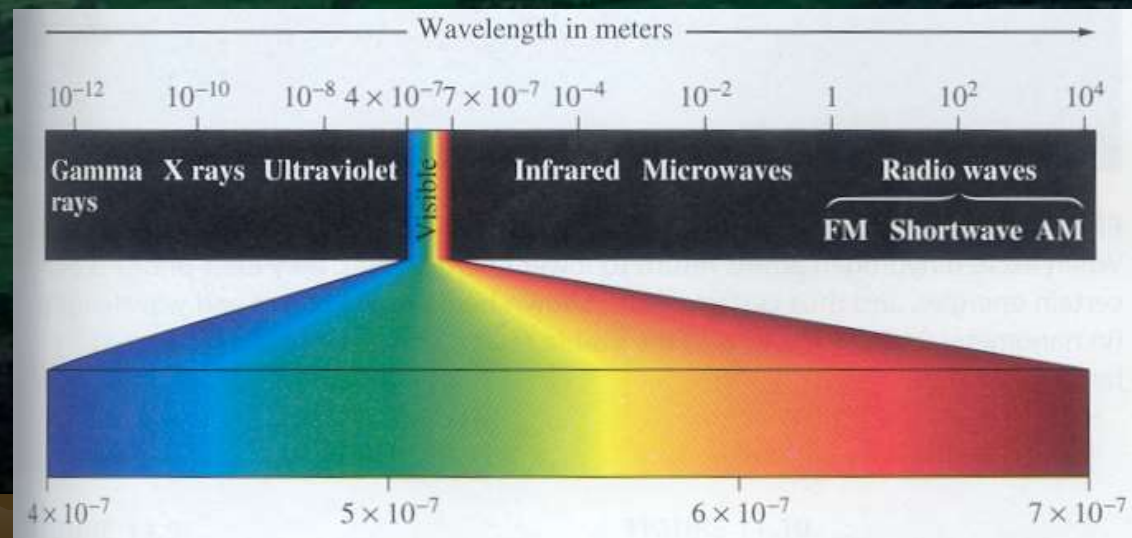


Fotorecepce



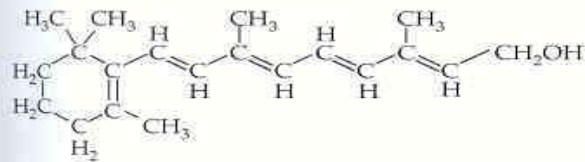
Využití vlastností světla a jeho absorpce při průchodu a odrazu.
Zrakem až 90% informací.
Tvar, barva, umístění v prostoru, rychlost a směr pohybu.



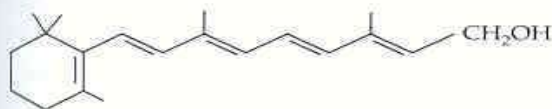
Proteiny mohou absorbovat viditelné spektrum teprve ve spojení s chromoforem – část molekuly odpovědná za absorpci záření (také zvaná prostetická skupina – nebílkovinná sl.)

-Stereoizometrie Retinalu

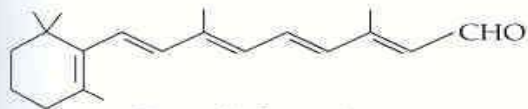
(a) Retinal and vitamin A



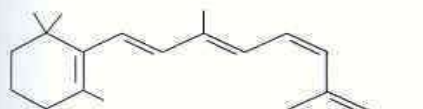
Complete structure of vitamin A (all-trans)



Condensed structure of vitamin A (all-trans)

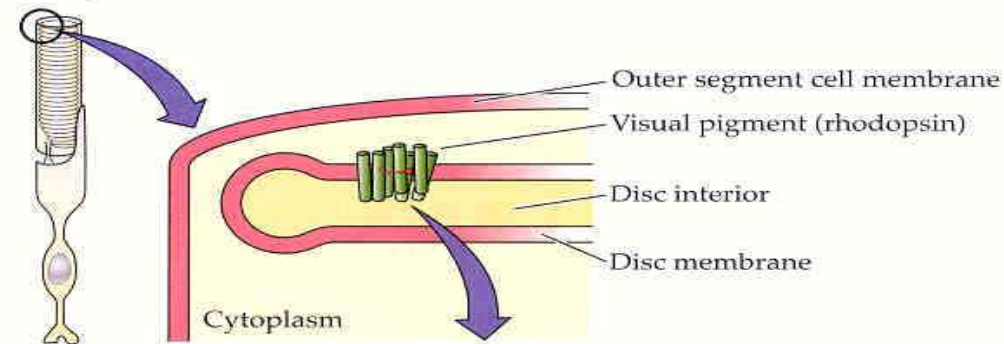


Retinal (all-trans)



Retinal (11-cis)

(b) Opsin



SENSORY PRO

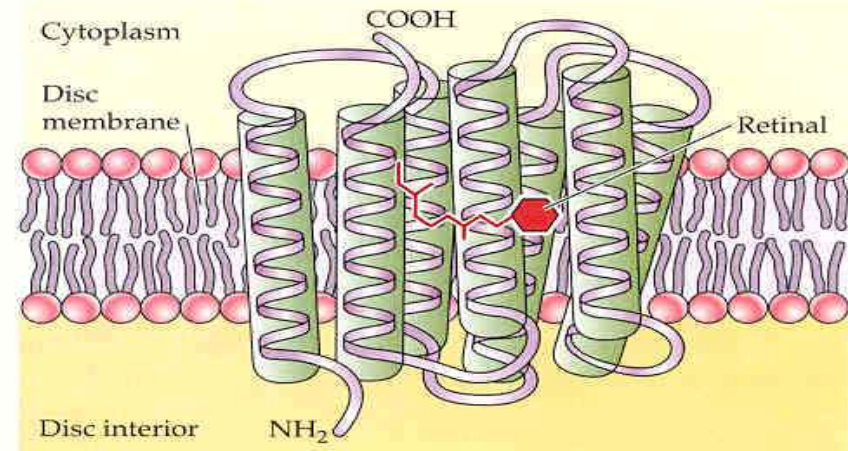


Figure 13.13 Rhodopsin is a photopigment composed of two parts: retinal and opsin
 (a) Chemical structures of vitamin A and of retinal. Vitamin A is shown both as a complete structure (top) and as a skeleton structure (middle). Vitamin A is converted to retinal, which has two isomers (11-cis and all-trans). (b) Three-dimensional structure of the protein (opsin) portion of vertebrate rhodopsin. Seven α -helical regions of the protein span the membrane; retinal is attached to an amino acid residue within the seventh membrane-spanning region.

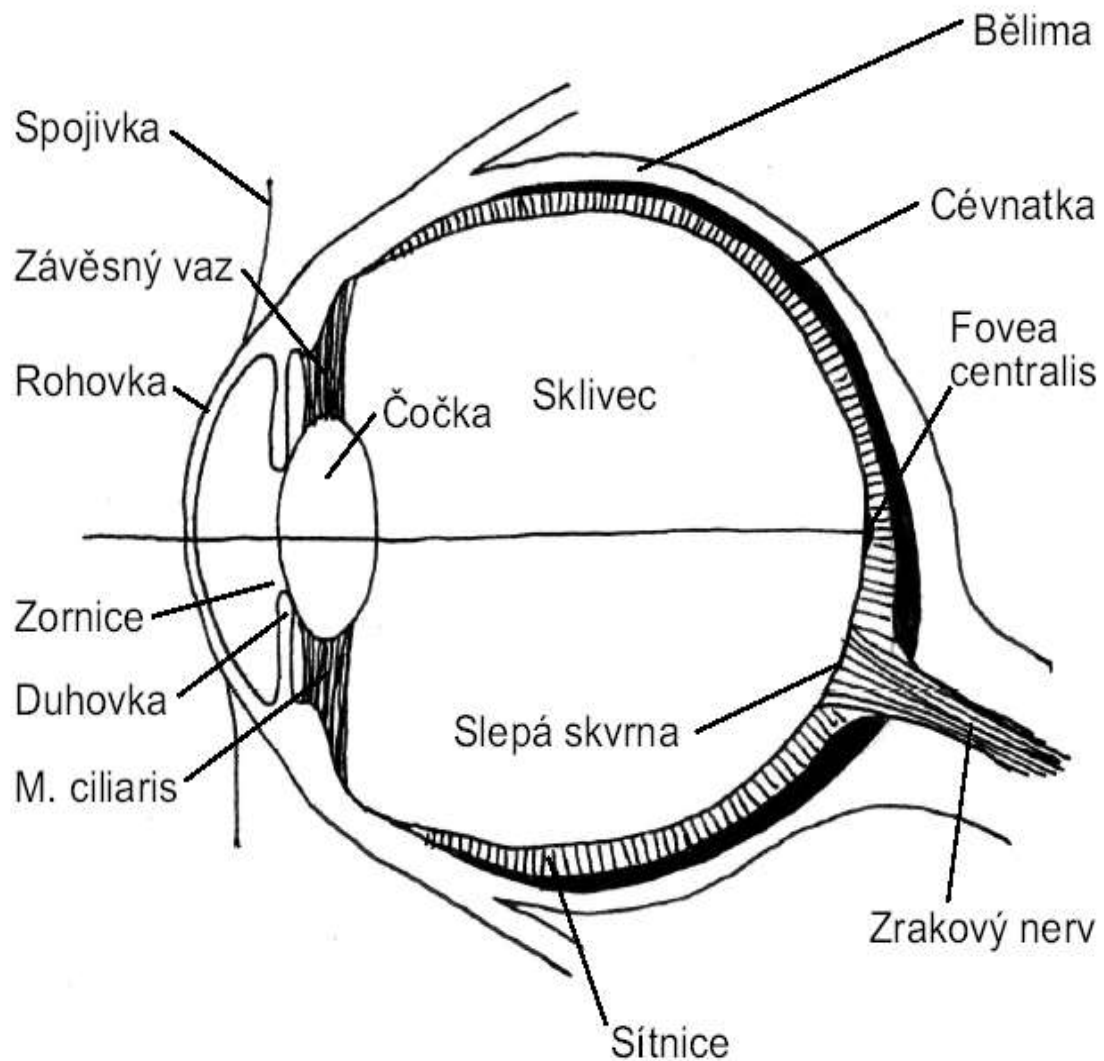
- Optický systém oka
- Fotoreceptory sítnice
- Optická dráha
- Korová zraková oblast

David Hubel's web page

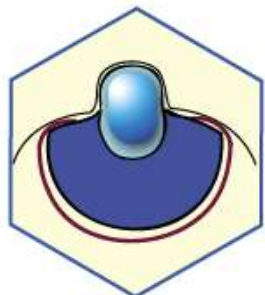
<http://hubel.med.harvard.edu/index.html>



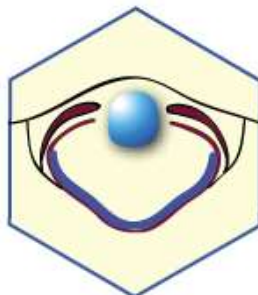
Od bakterií schopnost detekce.
Komorové oko – dokonalý optický nástroj



Variace na jedno téma.

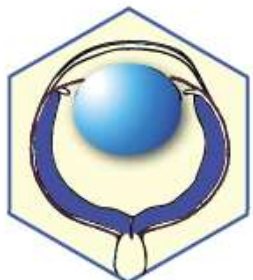


čtyřhranka

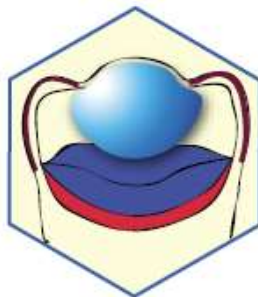


oliheň

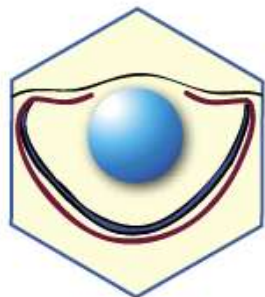
-  čočka
-  stínící pigment
-  sítnice
-  tapetum - zrcátko



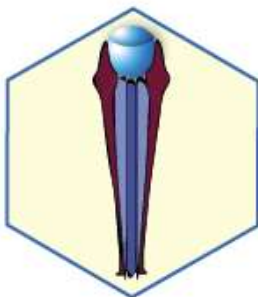
myš



hřebenatka



zebříčka

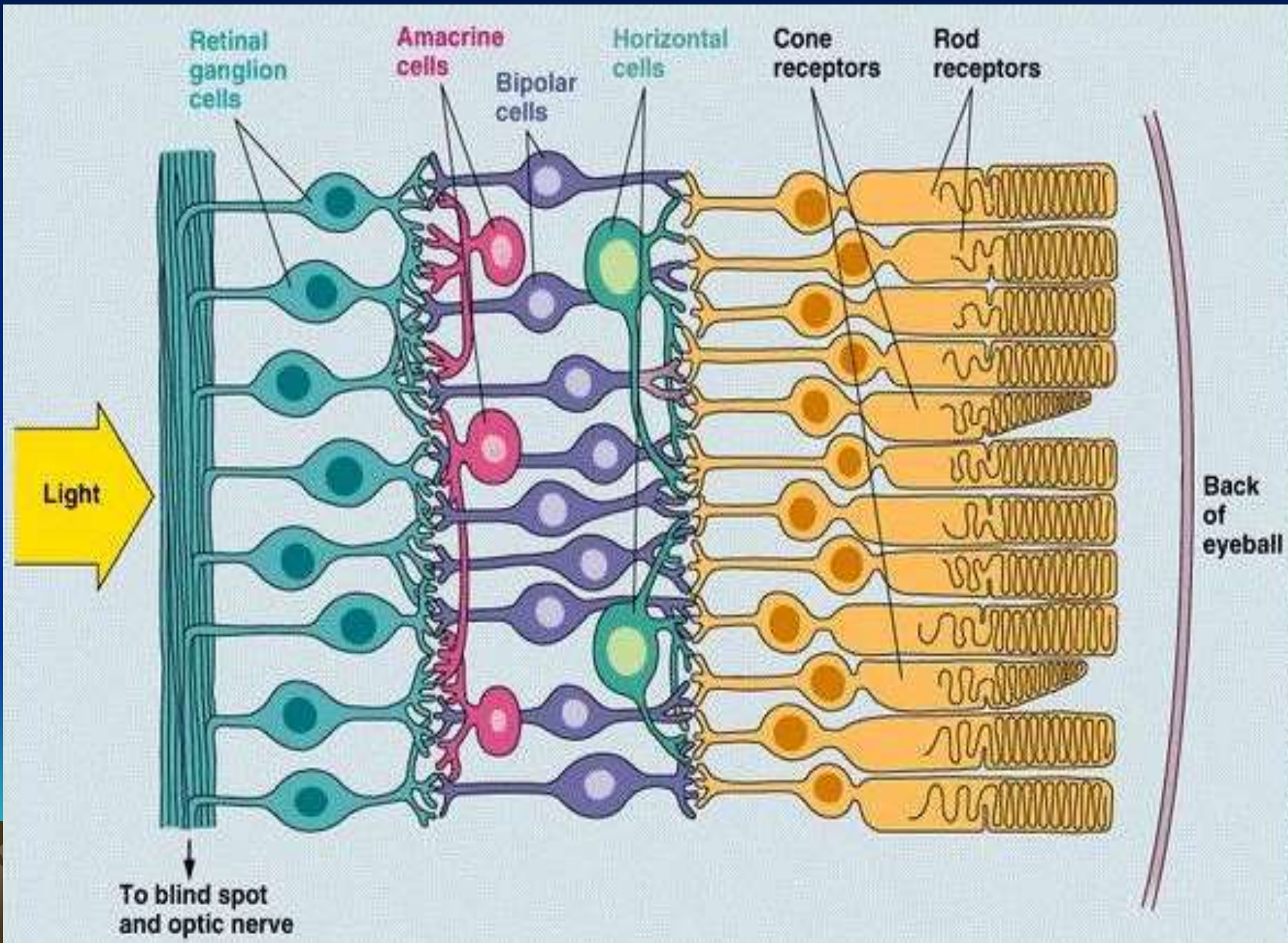


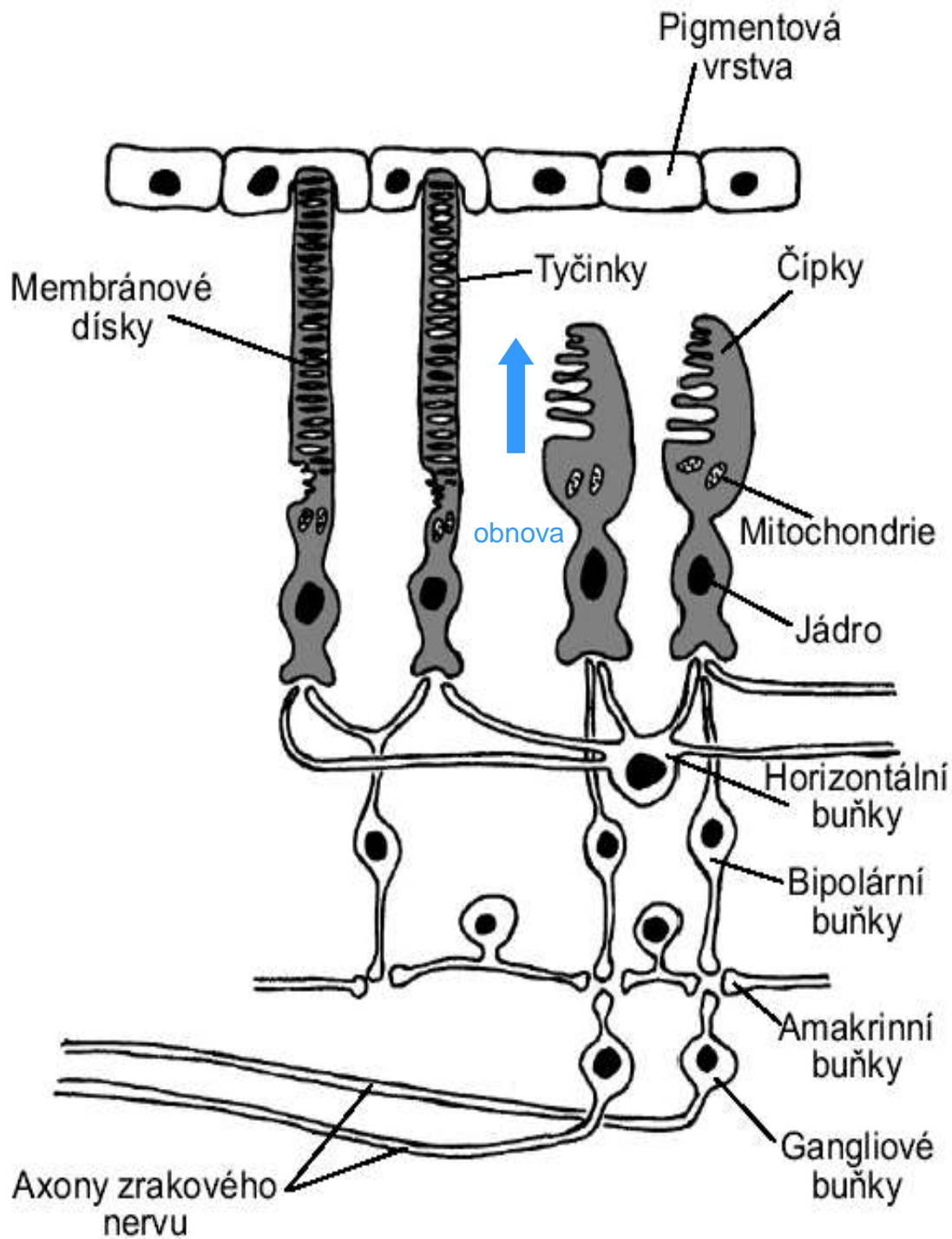
octomilka

1. Šest modelových organismů a šest různých typů očí. Fotografie živočicha je vždy doplněna o schematizovaný průřez jeho okem. Snímky © Kristýna Marková-Jonášová, Jana Růžičková, Roger Hanlon a Marek Jindra.

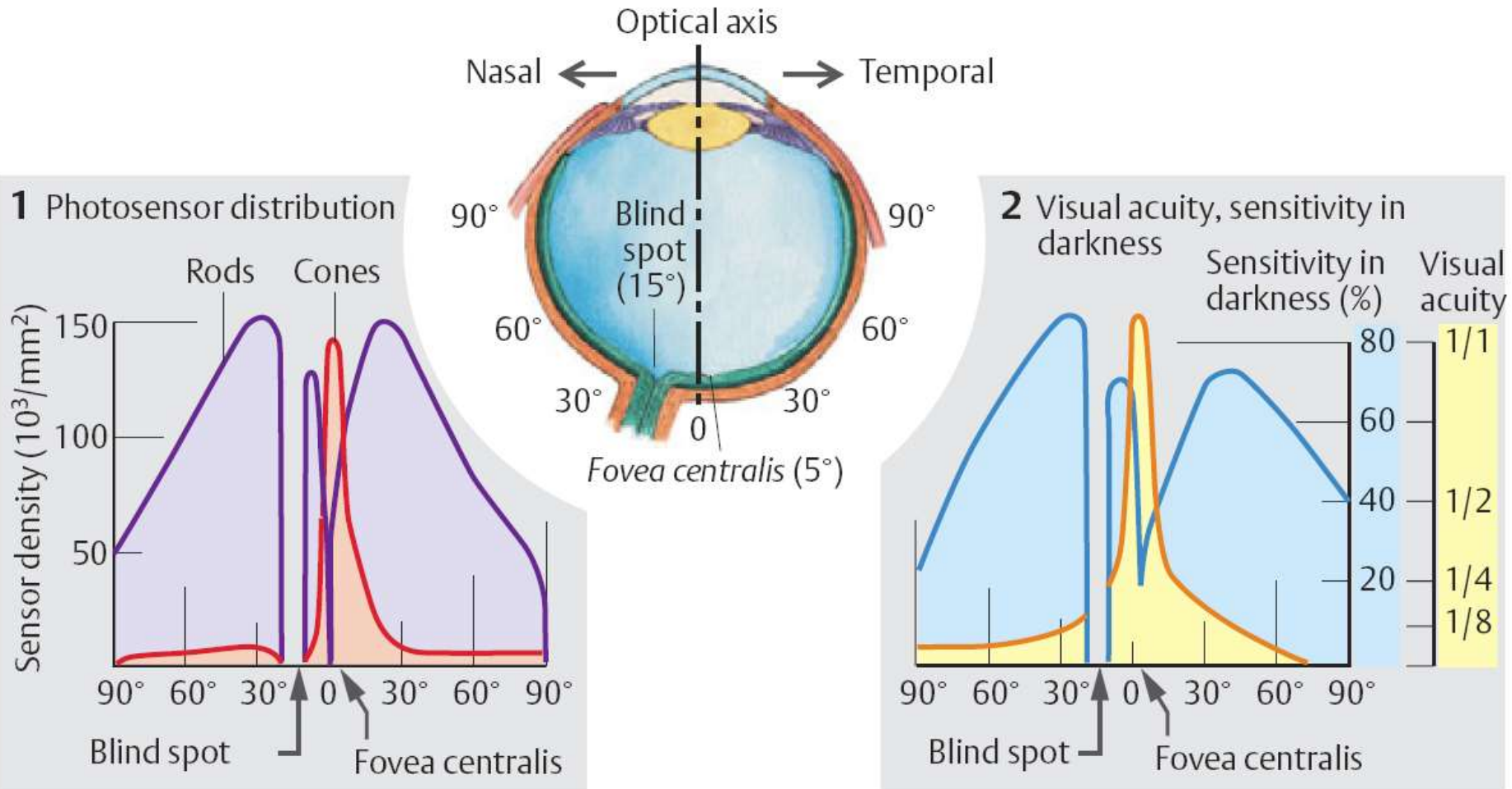
Inverzní sítnice savců.

120 mil. tyčinek, 6 mil. čípků. – jen 1 mil axonů - konvergence





B. Retina: Photosensor distribution, sensitivity in darkness and visual acuity

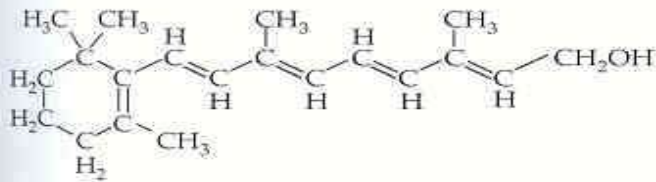


RGB čípky, ale jen RG ve fovei. Tyčinky jsou velmi štíhlé 2-5mm, čípky v periférii 5-8 mm, ve fovei ale pouze 1,5 mm.

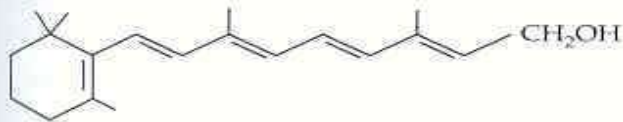
Absorbce světla - Karotenoidy (vit.A) a pyrolové kruhy

SENSORY PRO

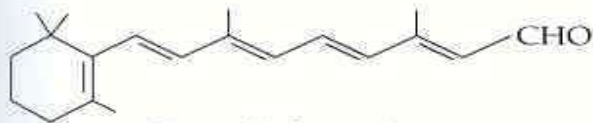
(a) Retinal and vitamin A



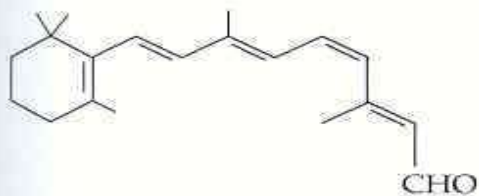
Complete structure of vitamin A (all-trans)



Condensed structure of vitamin A (all-trans)



Retinal (all-trans)



Retinal (11-cis)

(b) Opsin

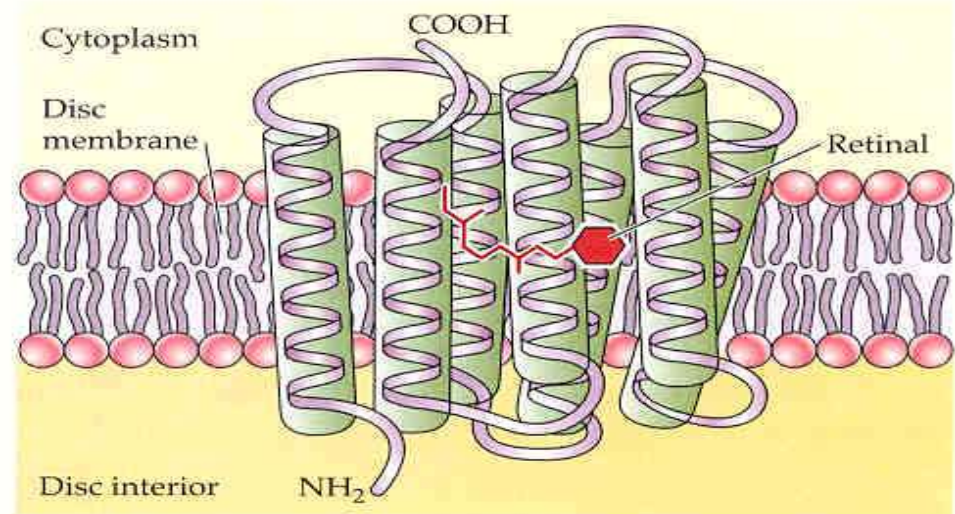
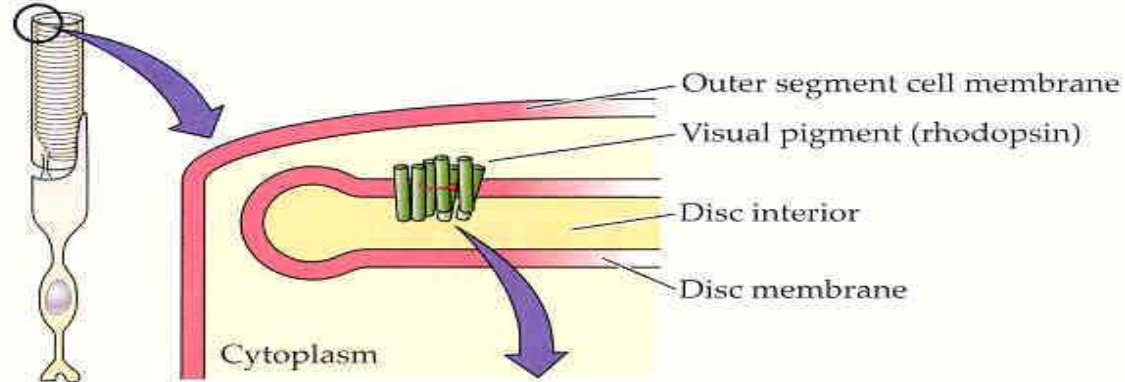
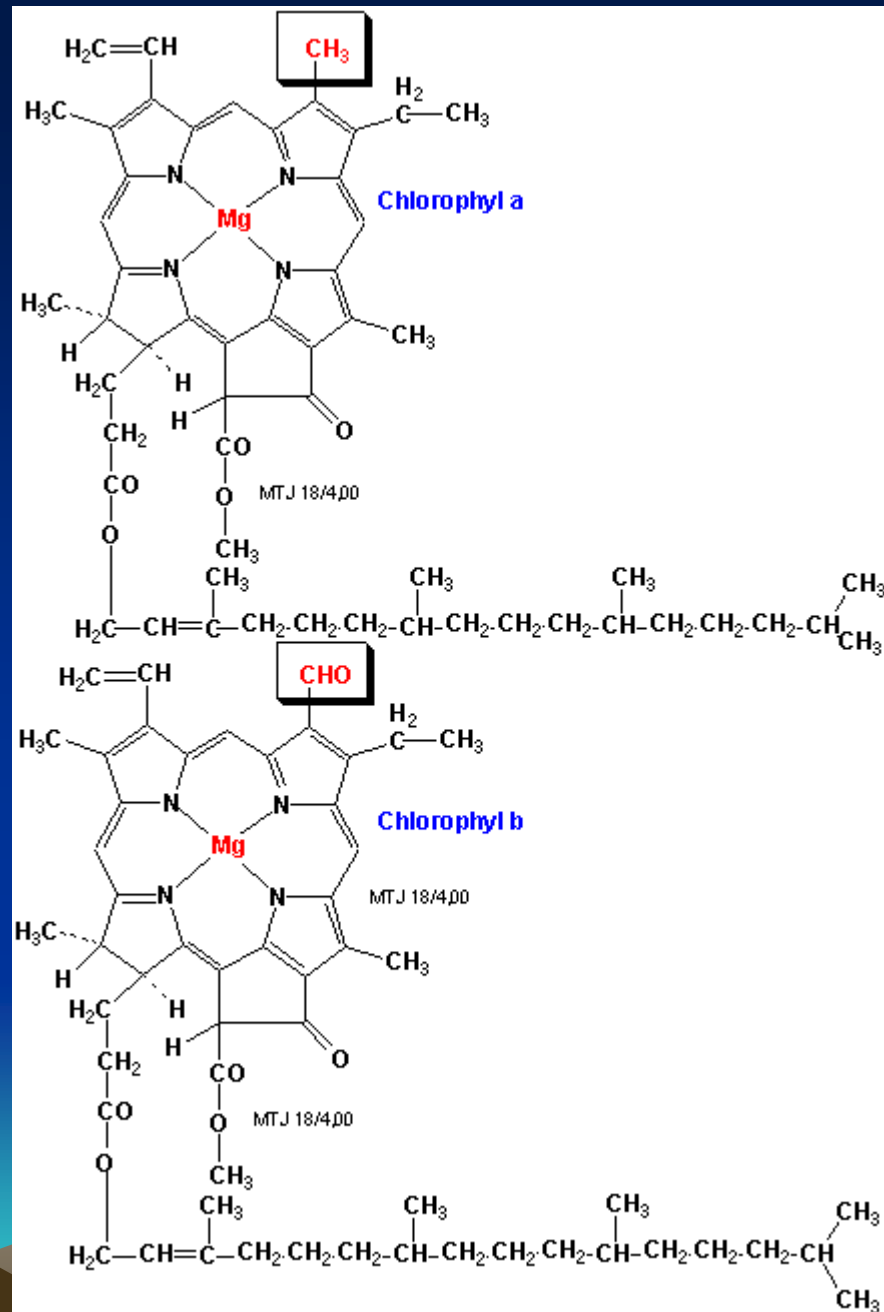


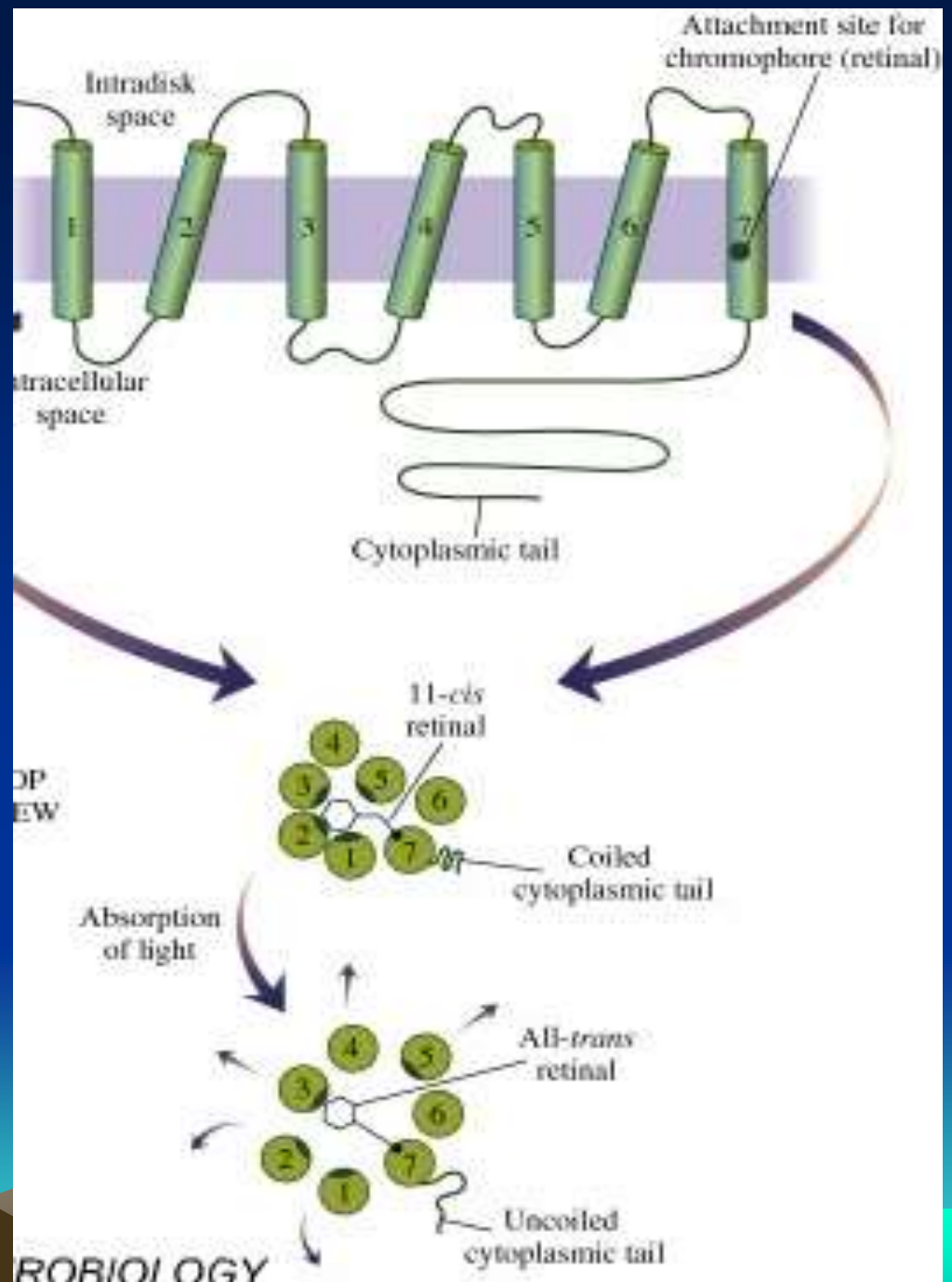
Figure 13.13 Rhodopsin is a photopigment composed of two parts: retinal and opsin
 (a) Chemical structures of vitamin A and of retinal. Vitamin A is shown both as a complete structure (top) and as a skeleton structure (middle). Vitamin A is converted to retinal, which has two isomers (11-cis and all-trans). (b) Three-dimensional structure of the protein (opsin) portion of vertebrate rhodopsin. Seven α -helical regions of the protein span the membrane; retinal is attached to an amino acid residue within the seventh membrane-spanning region.

[Video cis - trans](#)

Absorbce světla - Karotenoidy
(vit.A) a pyrolové kruhy
(chlorofyl)



Spolupráce chromoforu retinalu a apoproteinu opsinu.



Video aktivace rhodopsinu

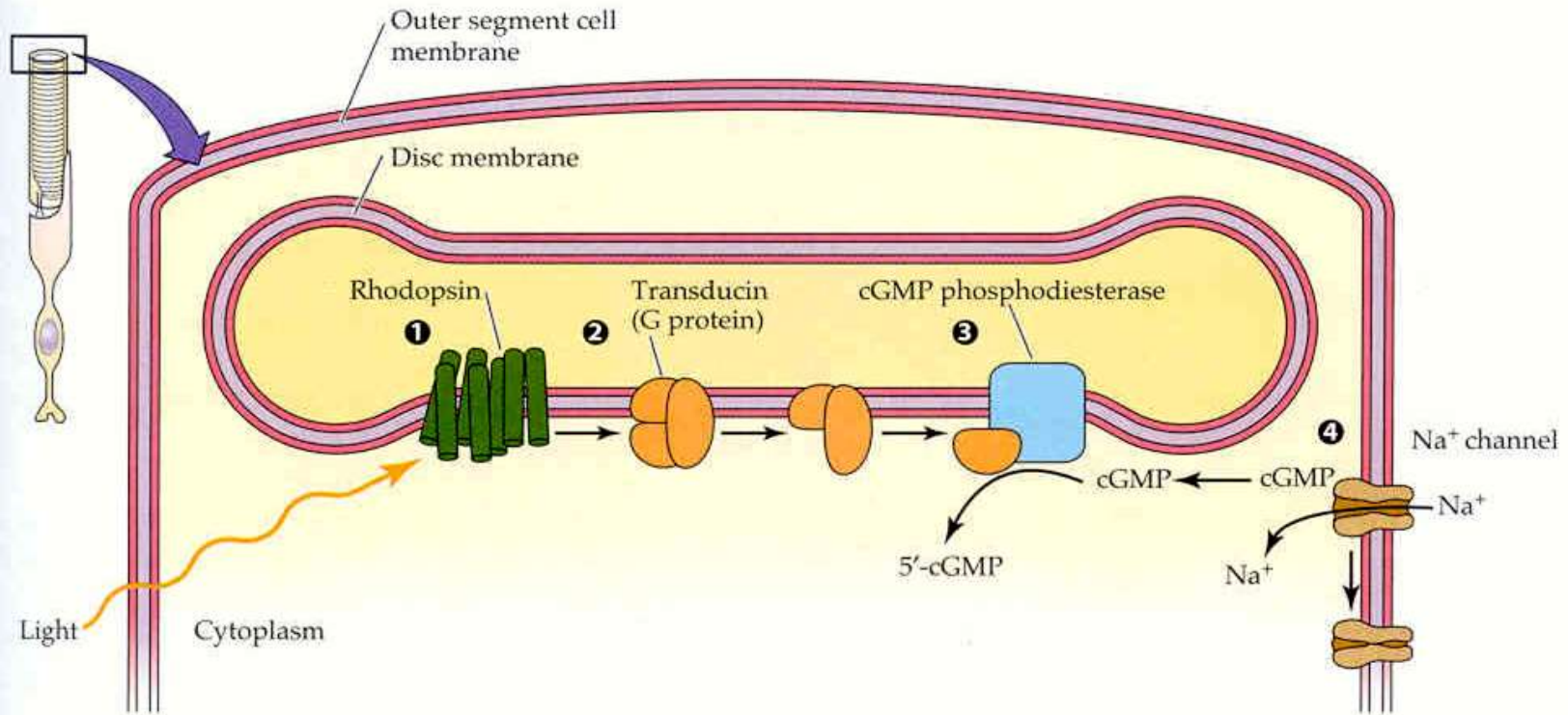
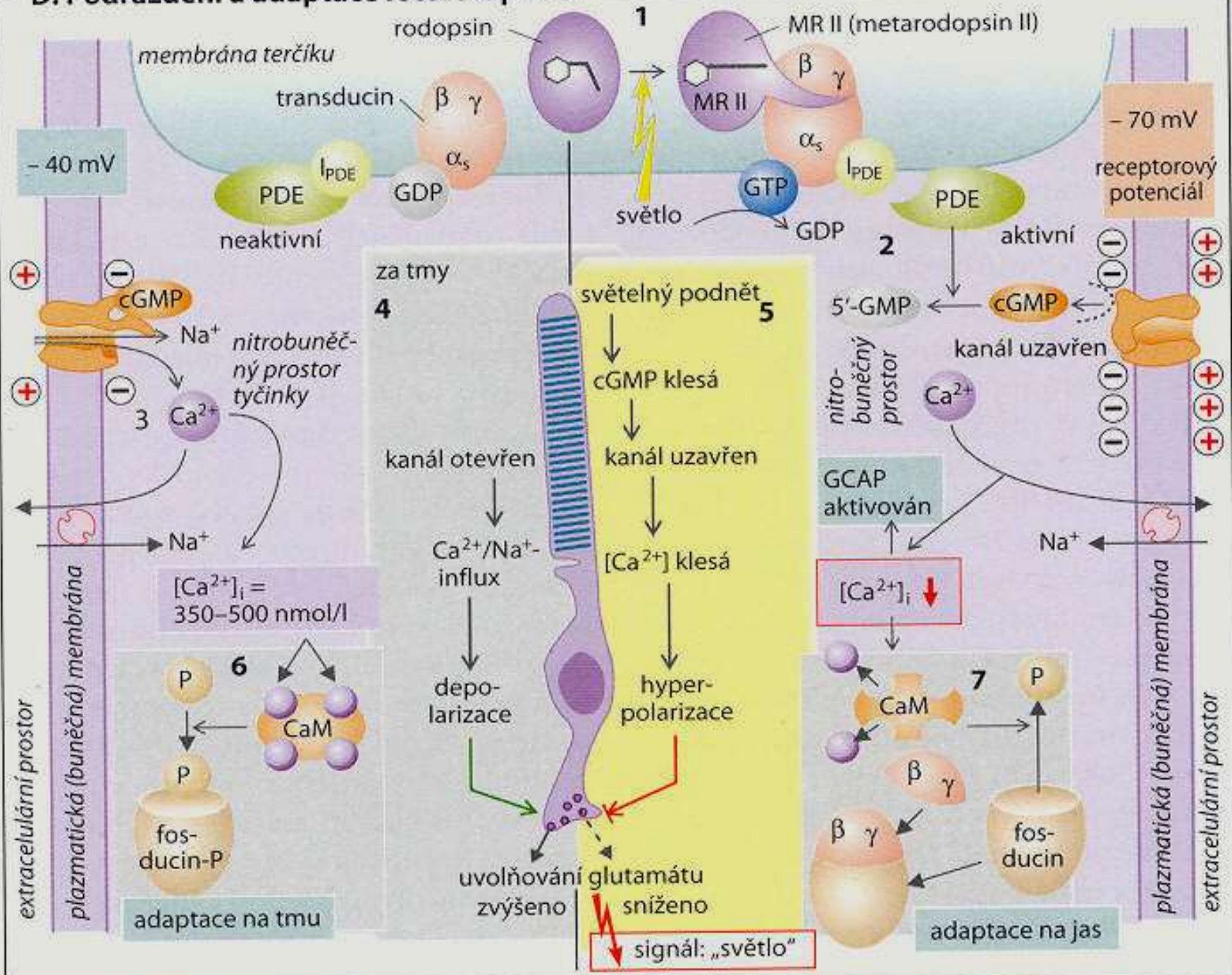


Figure 13.14 Phototransduction closes cation channels in the outer segment of the photoreceptor membrane In the dark, the cation channels are kept open by intracellular cGMP and conduct an inward current, carried largely by Na^+ . When light strikes the photoreceptor, these channels are closed by a G protein-coupled mechanism. **1** Rhodopsin molecules in the disc membrane absorb light and are acti-

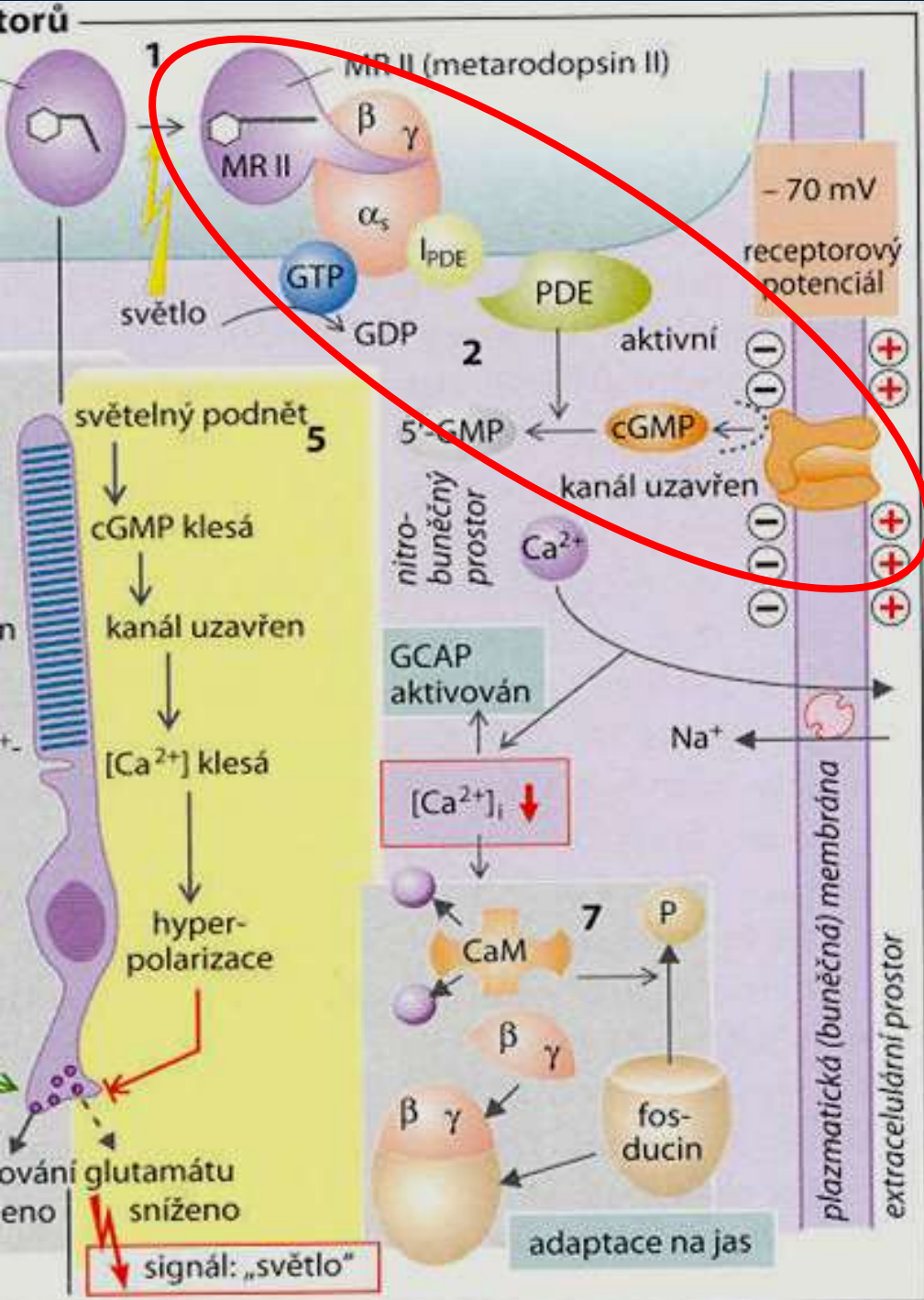
vated. **2** The activated rhodopsin stimulates a G protein (transducin in rods), which in turn activates cGMP phosphodiesterase. **3** The phosphodiesterase catalyzes the breakdown of cGMP to 5'-cGMP. **4** As the cGMP concentration decreases, cGMP detaches from the cation channels, which close.

D. Podráždění a adaptace fotoreceptorů

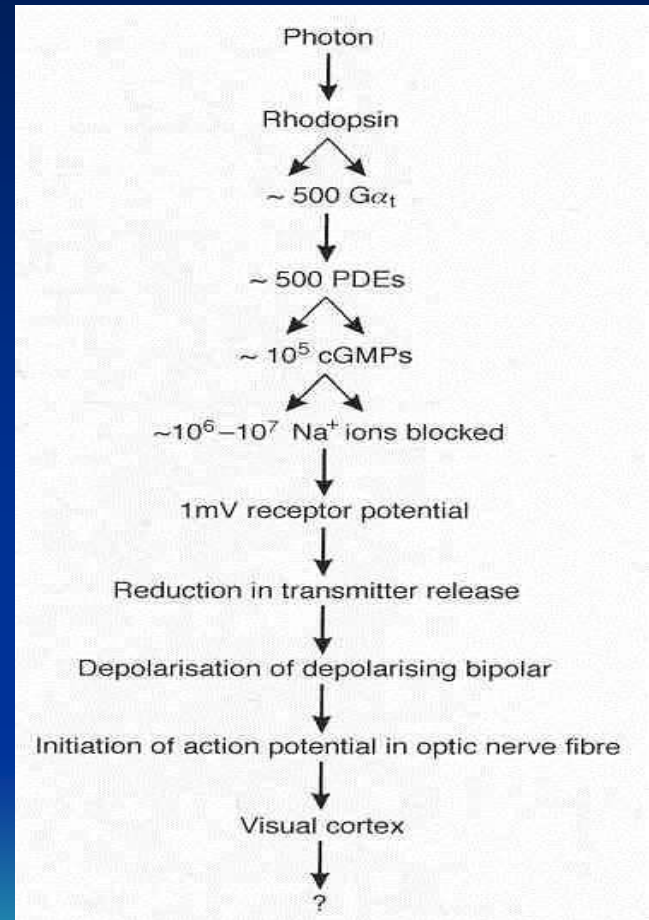


U chemorecepce ligand způsobí změnu konformace membránového 7TM receptoru tak, že alfa podjednotka G proteinu je uvolněna aby aktivovala membránové enzymy. A stejně je to i s opsinem. V tomto případě je však čichová nebo chuťový molekula v jistém smyslu již přítomna a připojena k 7TM receptoru. Je to chromofor, 11cis retinal. Ten je ve vazbě na lyzinový zbytek uložen do opsinu a je ve své poloze stabilizován slabými interakcemi se dvěma dalšími zbytky aminokyselin. Foton pak pouze změní konformaci retinalu z cis do trans pozice (2×10^{-14} s, takže se už déle nevejde do vazebné polohy v dutině opsinu. To způsobí, že opsin změní svou konformaci a pře několik meziproductů se přemění na konečný metarodopsin II. Ten reaguje s G-proteinem (**transducinem**), který se následně, po náhradě GDP za GTP, štěpí na alfa a beta gama podjednotky. Alfa potom, jako u jiných modalit, aktivuje specifické enzymy v membráně, a to takto: na aktivovaný alfa-GTP se nyní naváže inhibiční podjednotka cGMP-fosfodiesterázy, **PDE**. Takto dezinhibovaná PDE pak **snižuje** cytosolovou koncentraci cGMP.





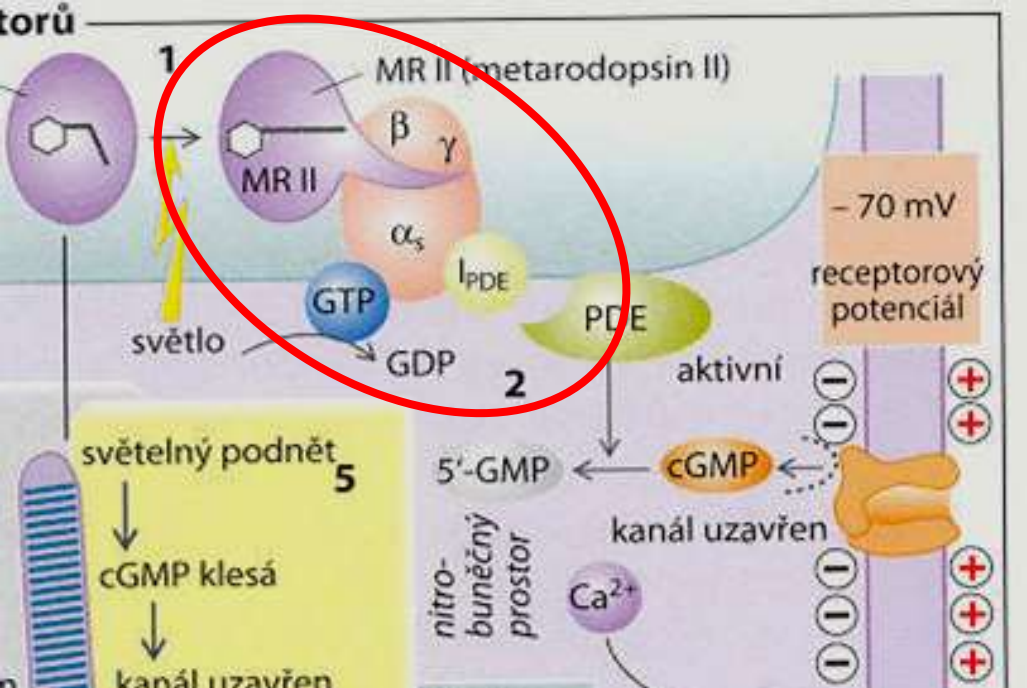
Zesílení



Řada zpětných vazeb:

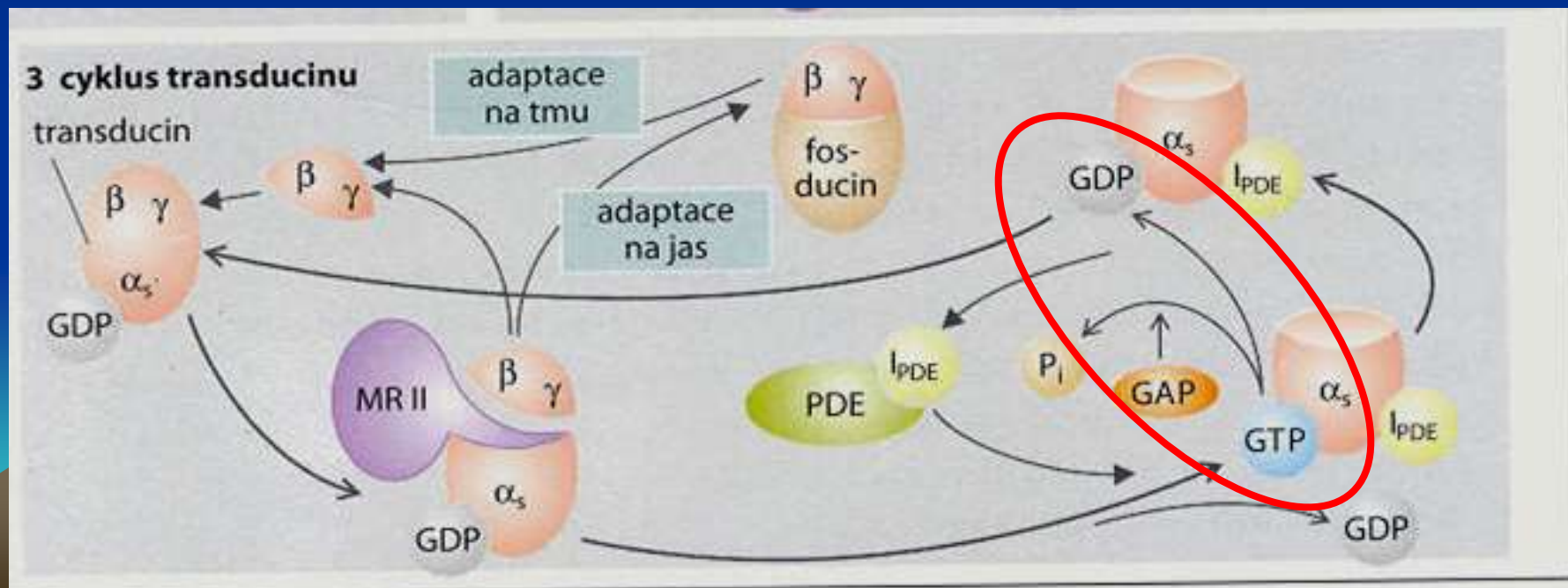
- Vypnutí – Arestin v G-prot. signalizaci, Ca
- Adaptace – rozsah od 1 po 10^6 fotonů / sec, úloha Ca iontů (čich, sluch)
- Regenerace



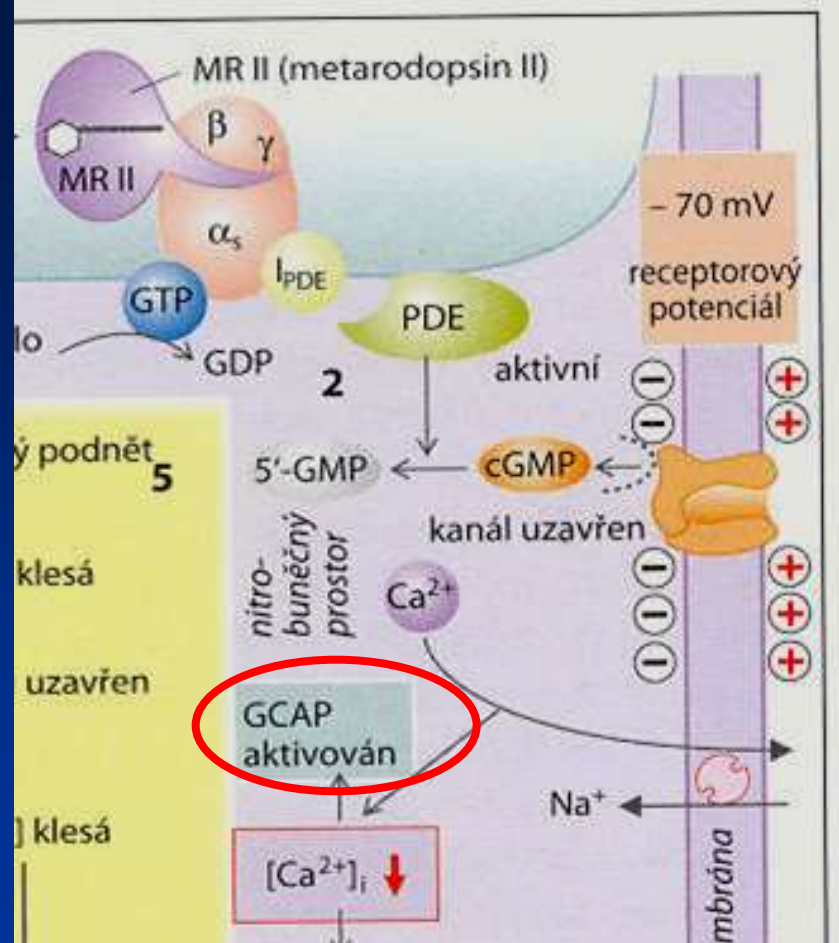


Inaktivace:

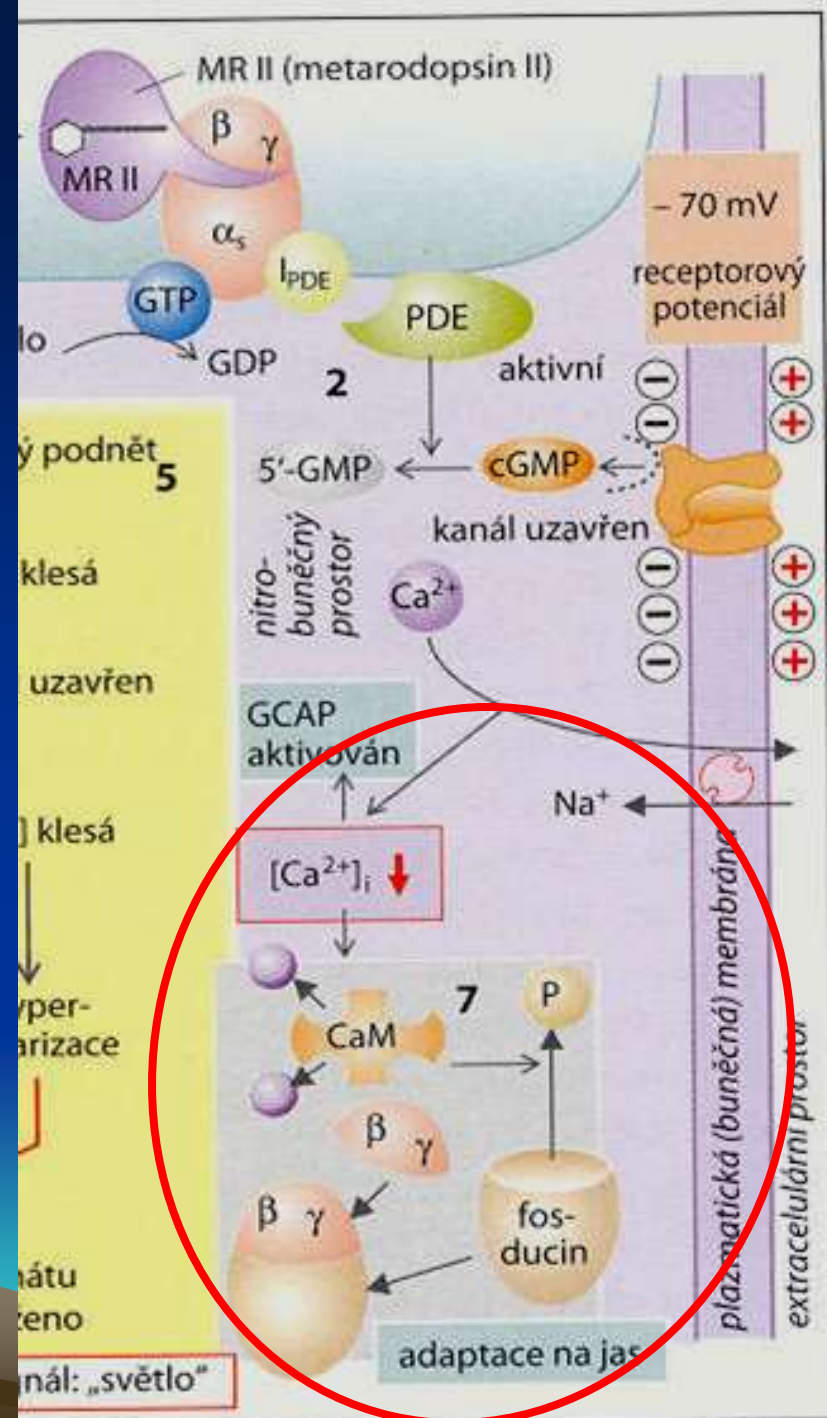
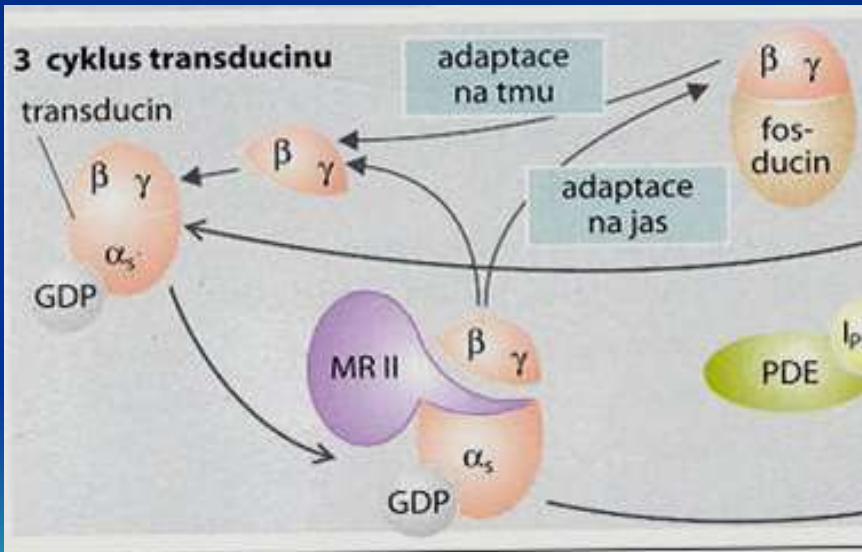
Samozhasnutí alfa Transducinu.
 Vlastní aktivitou štěpí GTP na GDP a
 uvolní inhibiční podjednotku Ipde.
 Katalytická aktivita alfa podjednotky
 tím končí.



Inaktivace:
GCAP (guanylyl cyclase activating Protein) ztratí 4 Ca a aktivuje GC. To zvýší cGMP a kanály se zase otevřou



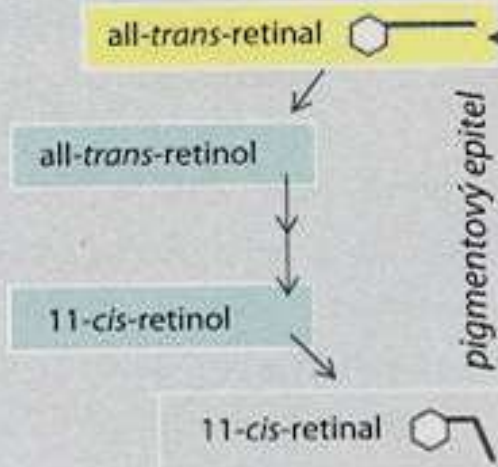
Adaptace:
 Soutěž mezi fosducinem a alfa podjednotkou o beta a gama podjednotky
 Ve světle je váže a tak blokuje regeneraci transducinu



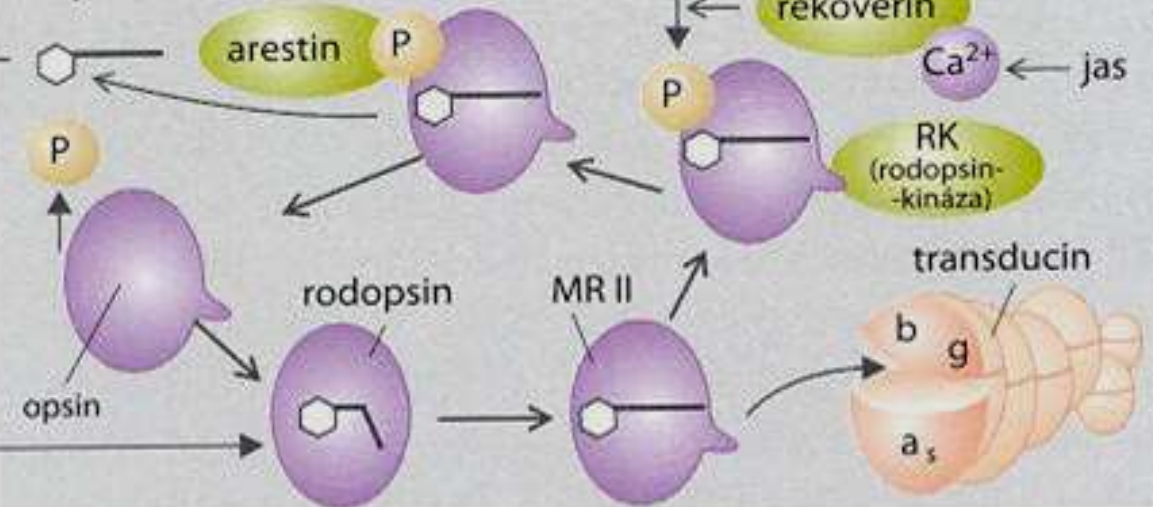
Regenerace retinalu v pigmentovém epitelu

E. Regenerační cykly

1 cyklus retinalu



2 cyklus rodopsinu



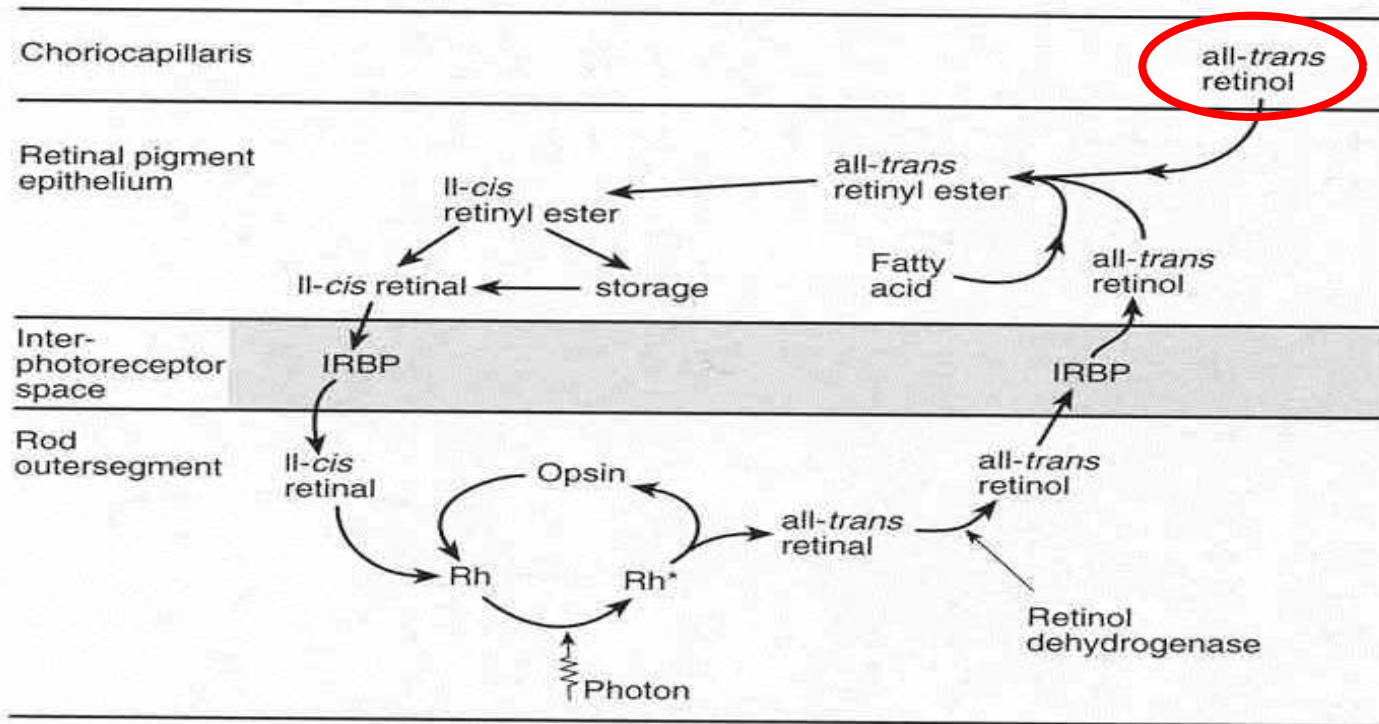
Inaktivace rodopsinu:

MR II odhalí vazebné místo RK. Fosforyluje se, naváže arrestin a dál už nereaguje s transducinem. All-trans-retinal se oddělí. – str.920 Alberts

Ca adaptace:

Rekovertin citlivý na Ca se podílí na redukci životnosti rodopsinu

Regenerace retinalu v pigmentovém epitelu

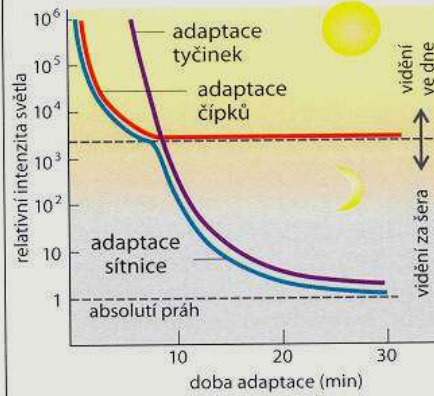


Vitamin A

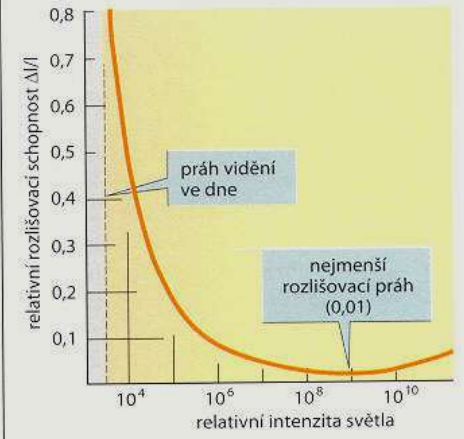
Figure 16.13 Regeneration of 11-*cis* retinal. Explanation in text. IRBP = interphotoreceptor retinoid binding protein; Rh = rhodopsin; Rh* = activated rhodopsin. Simplified from Harding, 1997

Adaptace:

A. Průběh adaptace

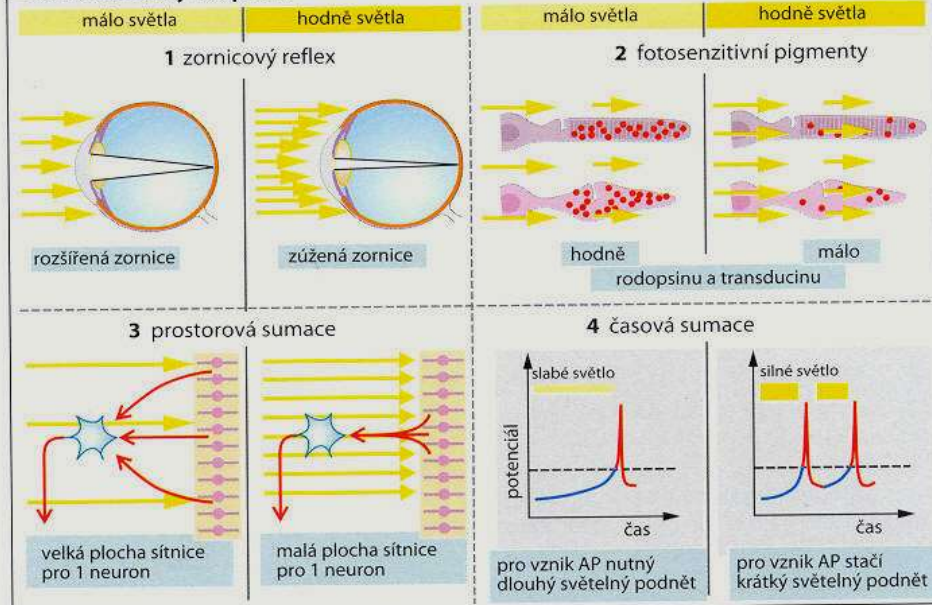


B. Rozlišovací práh a intenzita světla

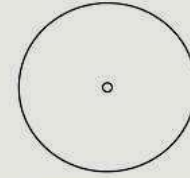


(podle G. Schuberta)

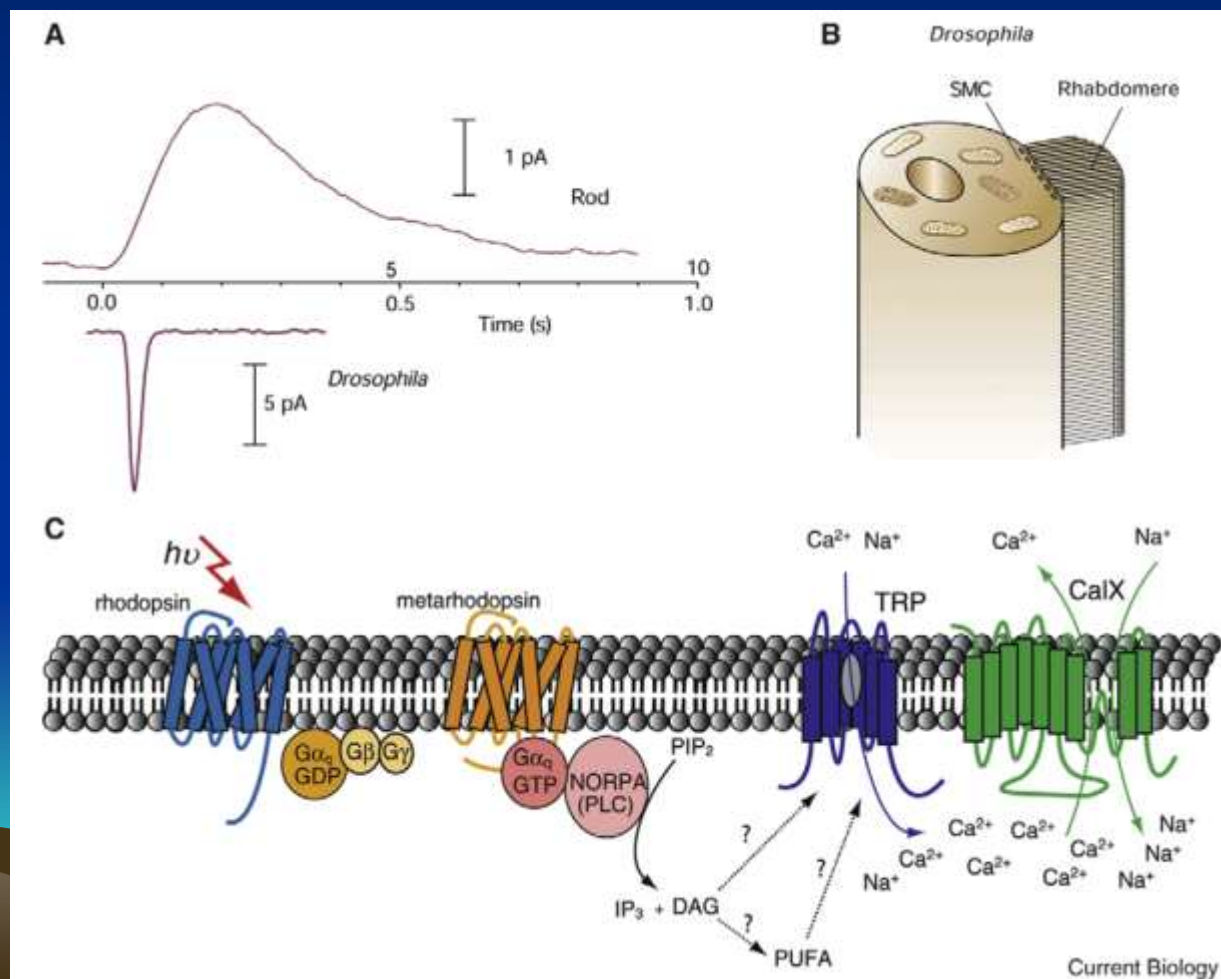
C. Mechanismy adaptace



D. Sukcesivní kontrast („lokální adaptace“) viz text



Drosophila jako užitečný model zrakové transdukce:
 Mimořádné zesílení – reakce na jediný foton
 Nízký šum ve tmě (spontánní termální izomerizace)
 Široká adaptace – rozsah až 10^6 (arrestin, Ca)
 Rychlá terminace odpovědi
 Nejrychlejší známá G signální dráha – 10x než obratlovci



Drosophila jako užitečný model zrakové transdukce:

Taková rychlost? PLC octomilky je jeden z nejvýkonnějších známých enzymů-
limitem je jen přísun cGMP

Výkonnost transdukce omezena pouze difuzním pohybem v membráně.

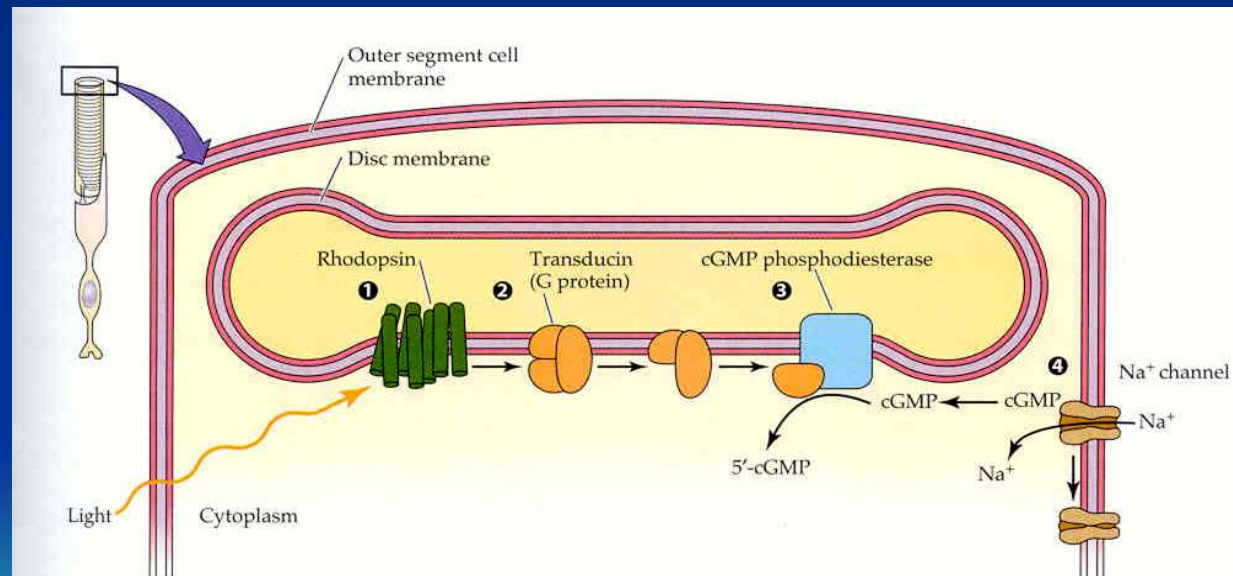
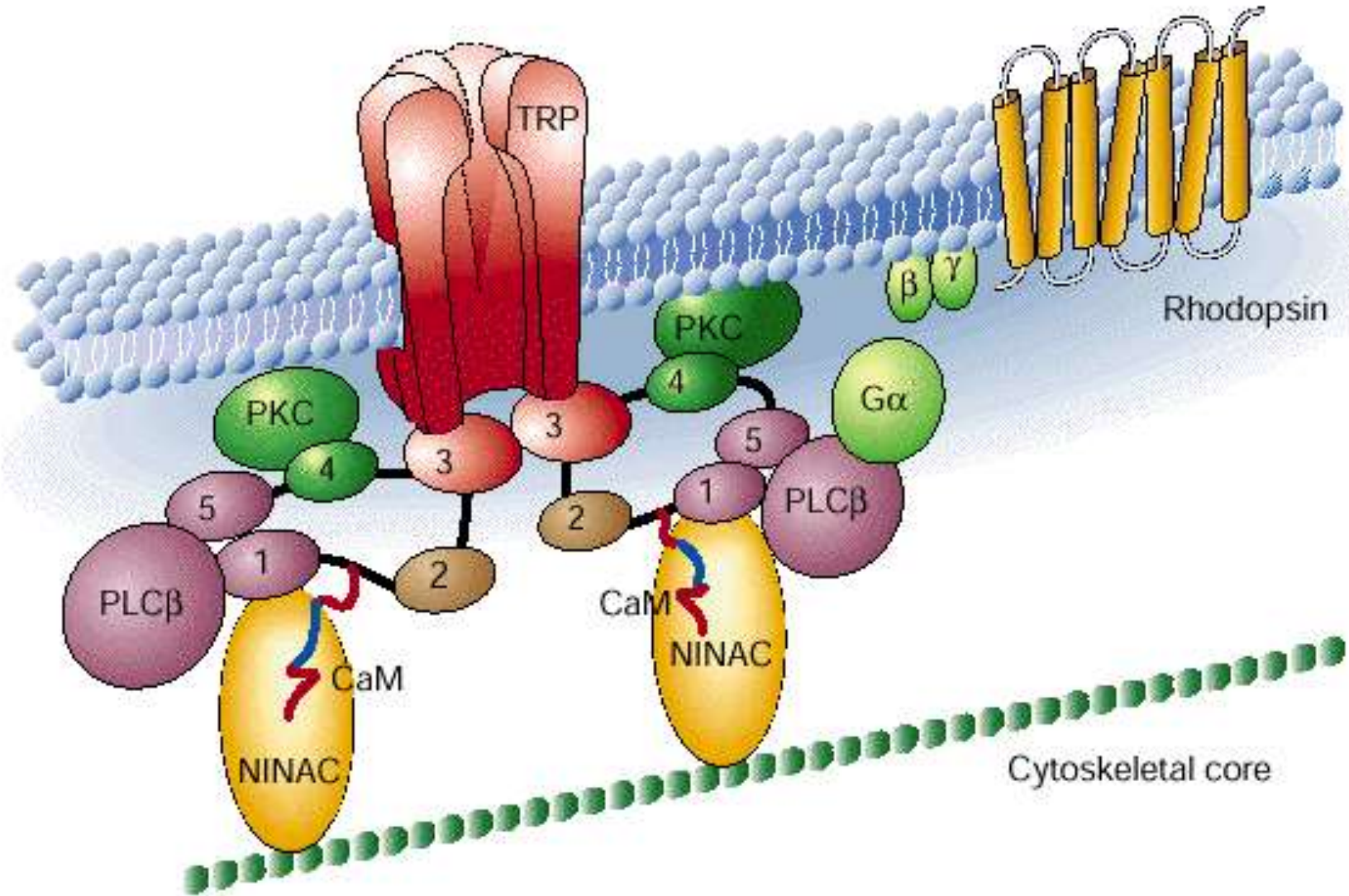


Figure 13.14 Phototransduction closes cation channels in the outer segment of the photoreceptor membrane In the dark, the cation channels are kept open by intracellular cGMP and conduct an inward current, carried largely by Na^+ . When light strikes the photoreceptor, these channels are closed by a G protein-coupled mechanism. **1** Rhodopsin molecules in the disc membrane absorb light and are acti-

vated. **2** The activated rhodopsin stimulates a G protein (transducin in rods), which in turn activates cGMP phosphodiesterase. **3** The phosphodiesterase catalyzes the breakdown of cGMP to 5'-cGMP. **4** As the cGMP concentration decreases, cGMP detaches from the cation channels, which close.

Drosophila jako užitečný model zrakové transdukce:
Difuzní model signálového přenosu x Signalplex, scaffolding proteins
Multimolekulární signalizační komplex



Drosophila jako užitečný model zrakové transdukce:
Organizace signálních proteinů
v čase a prostoru – oddělení, zhášení
v odpověď na světlo

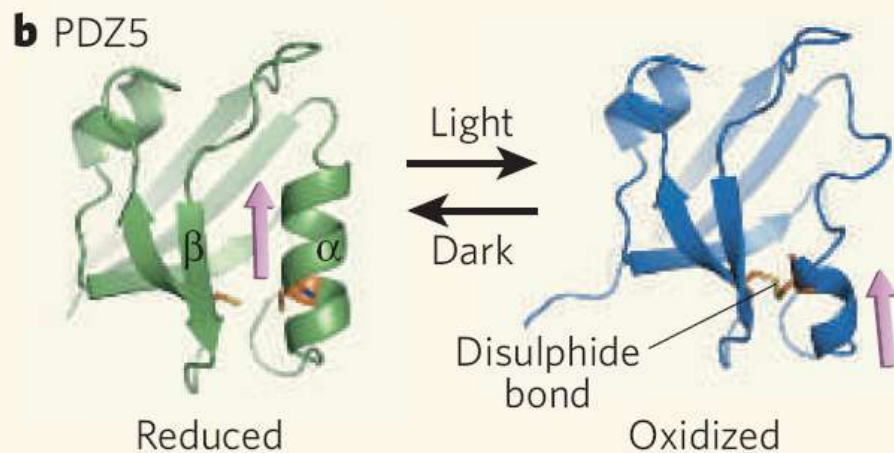
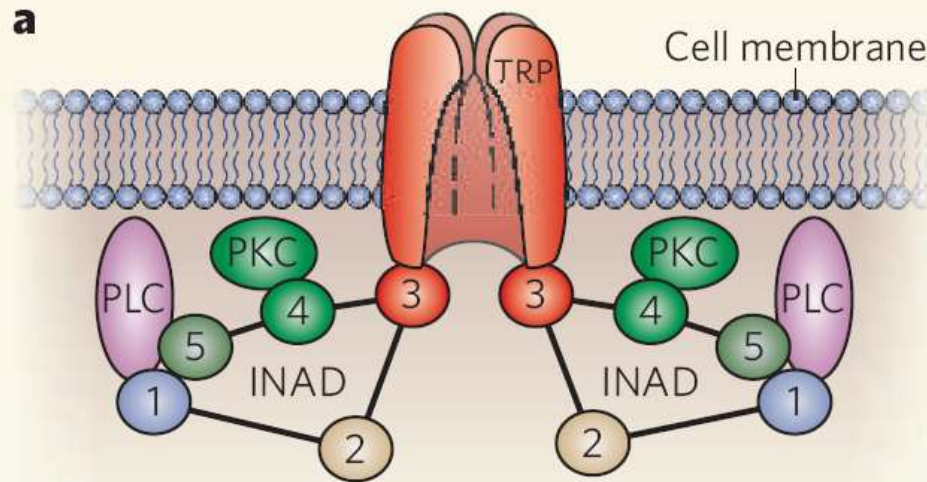
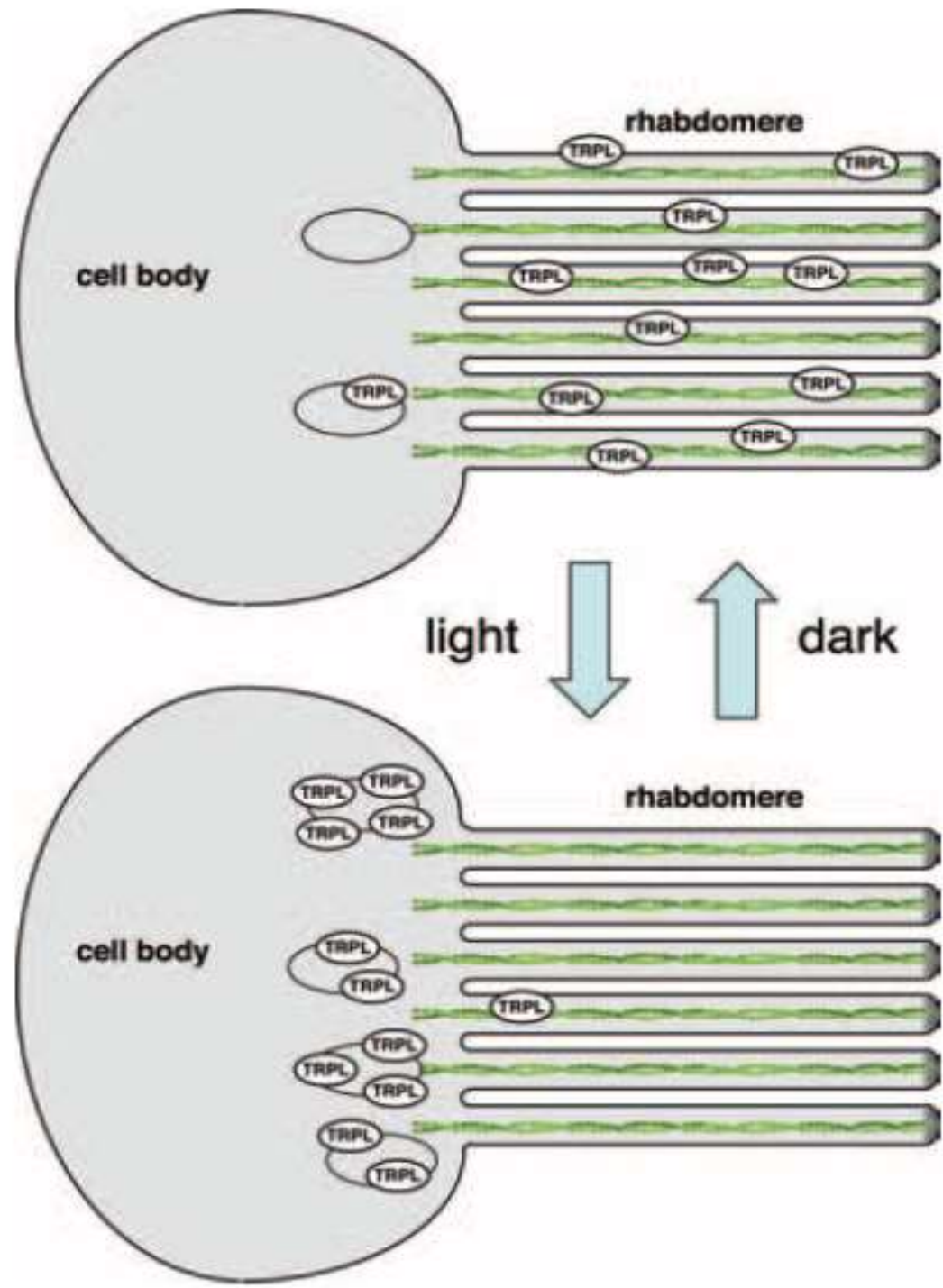


Figure 1 | Phototransduction in *Drosophila* and the INAD complex. **a**, The five PDZ domains of INAD (1–5) assemble components of the phototransduction cascade, including PLC, the TRP channel and PKC, into a signalling complex at the cell membrane. **b**, Mishra *et al.*² report that, in response to light, the PDZ5 domain of INAD undergoes a conformational change. In the dark, PDZ5 is in its canonical, reduced form, in which a groove between an α -helix and a β -sheet serves as a ligand-binding site. After stimulation with light, the PDZ5 domain undergoes a conformational change to an oxidized state, whereby the formation of a disulphide bond between two cysteine residues results in the unravelling of the α -helix and the distortion of the ligand-binding groove. Following this conformational switch, the ligand (arrowed) — putatively part of the PLC enzyme — can no longer bind. (Adapted from ref. 2.)

Drosophila jako užitečný model
zrakové transdukce:
Taková adaptace?
Translokace TRP –
mechanismus adaptace
na tmu a světlo



The Nobel Prize in Physiology or Medicine 1981



David Hubel's web page

<http://hubel.med.harvard.edu/index.html>

"for his discoveries concerning the functional specialization of the cerebral hemispheres"

"for their discoveries concerning information processing in the visual system"



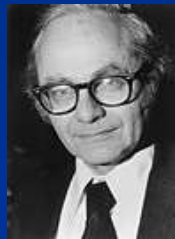
Roger W. Sperry

1/2 of the prize

USA

California Institute of Technology
Pasadena, CA, USA

b. 1913
d. 1994



David H. Hubel

1/4 of the prize

USA

Harvard Medical School
Boston, MA, USA

b. 1926
(in Windsor, ON, Canada)



Torsten N. Wiesel

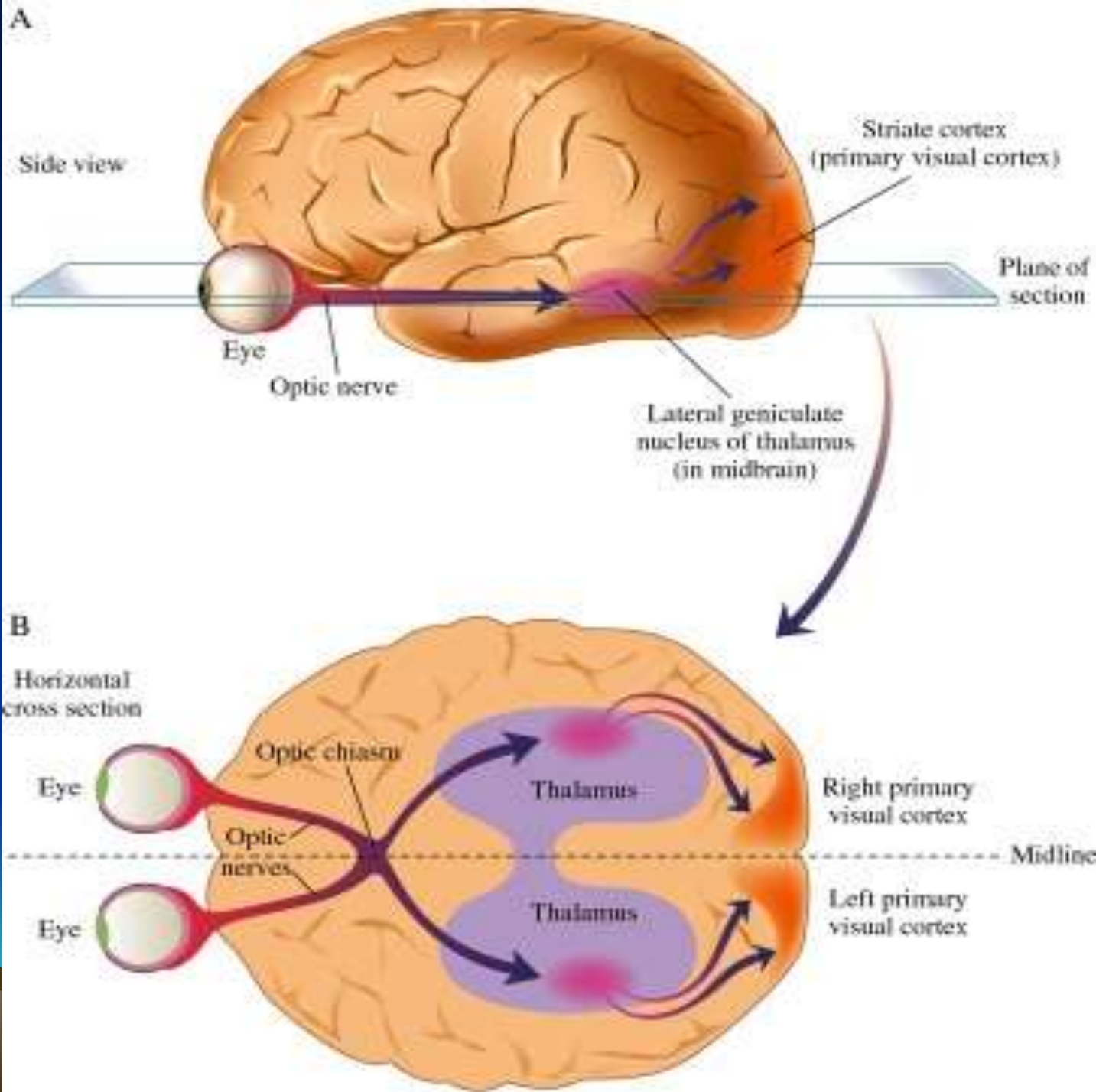
1/4 of the prize

Sweden

Harvard Medical School
Boston, MA, USA

b. 1924

Zraková dráha

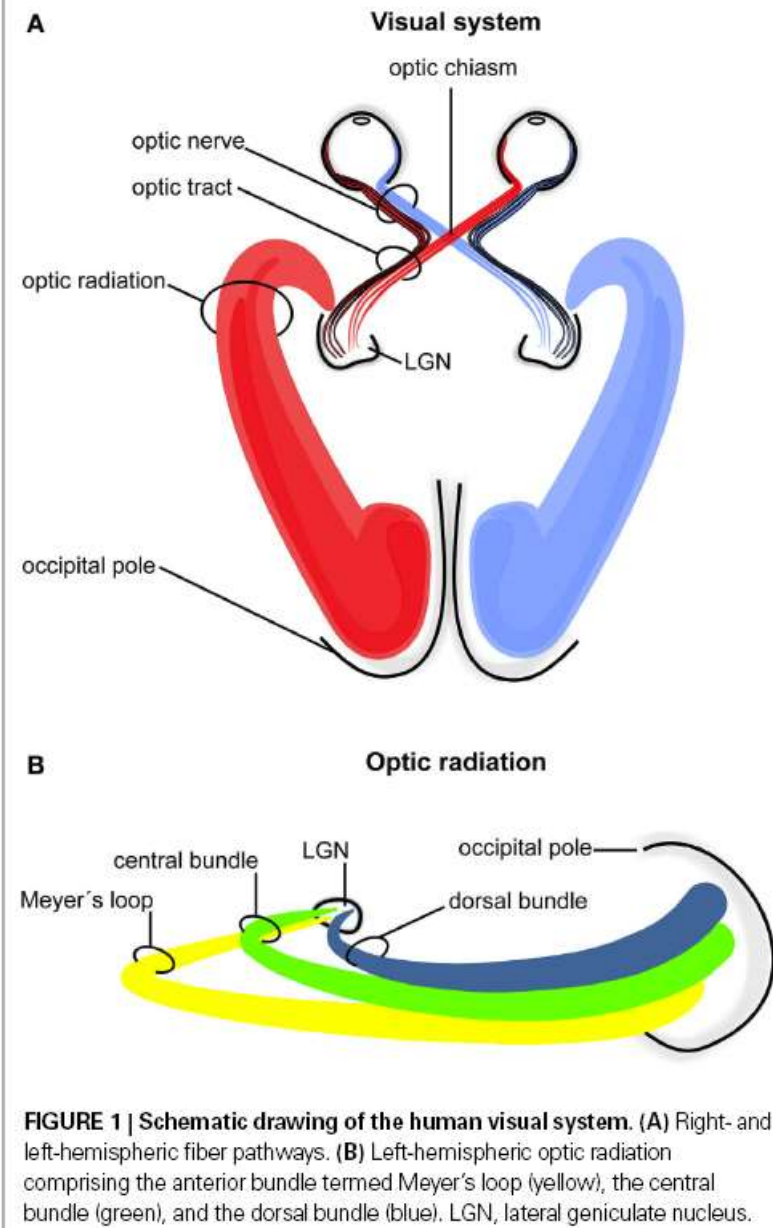
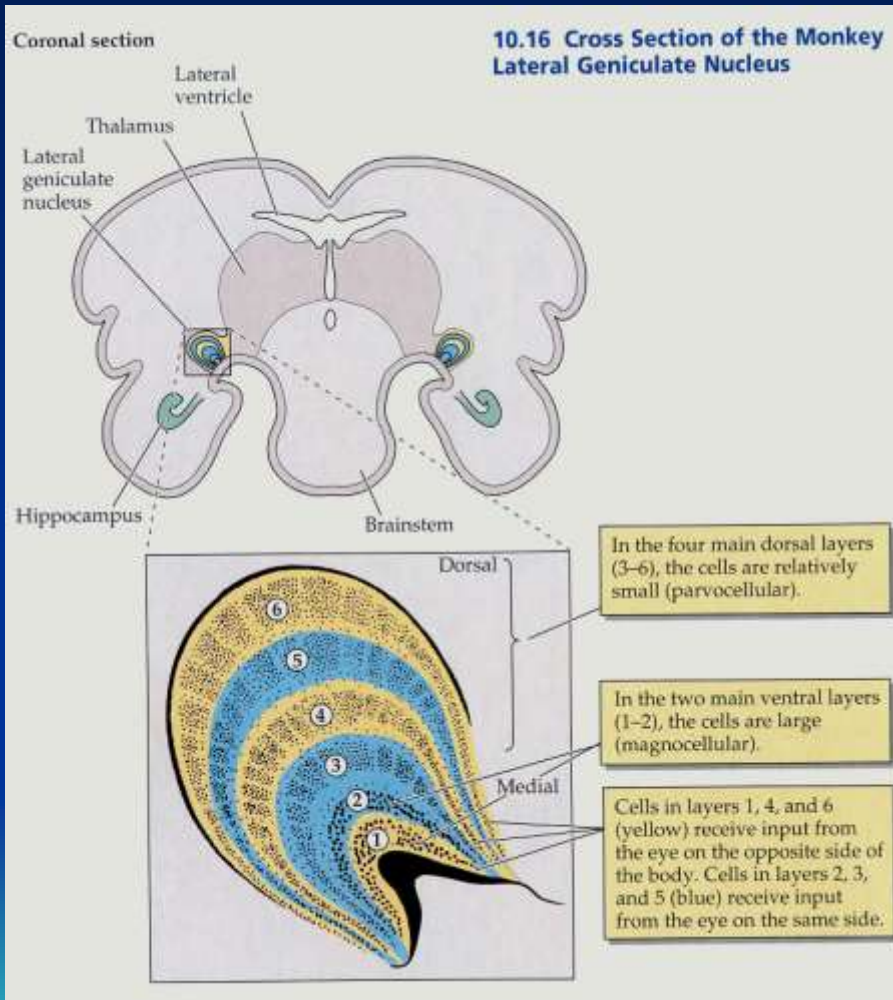


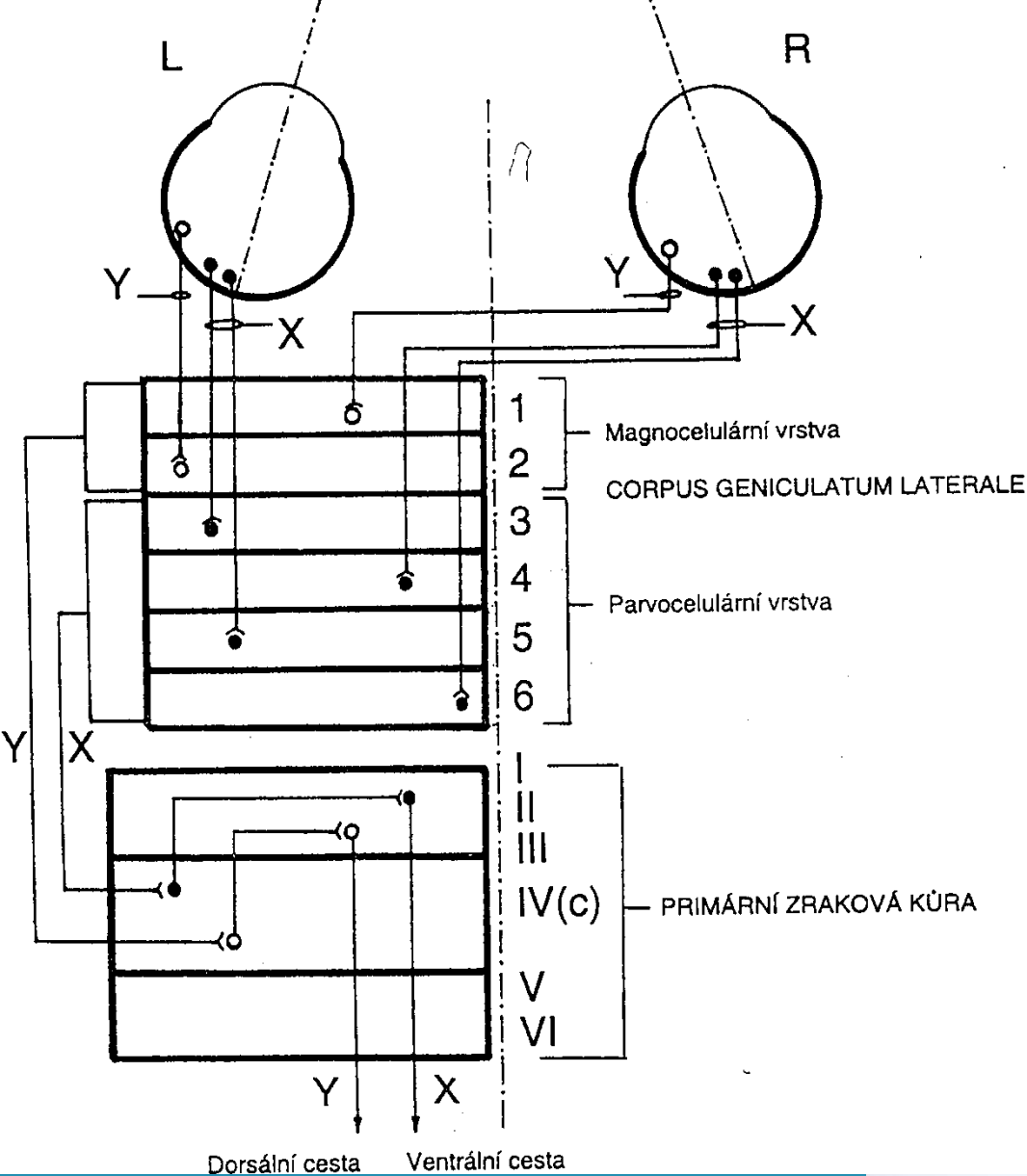
Většina vláken zrakového nervu končí v **corpus geniculatum laterale** (CGL) v talamu, ostatní ve středním mozku. CGL je po sítnici dalším místem, kde nastává zpracování vizuálních informací před jejich vstupem do primární zrakové kůry v týlním laloku. Z CGL vstupují nervové signály do primární zrakové kůry. K nejsložitější abstrakci vizuálních informací dochází v tzv. Vizuální asociační oblasti - sekundární a terciární zraková kůra.



Zraková dráha

LGN – 6 vrstev, po sítnici další zpracování zrkové radiace





Dvě samostatné sub-dráhy od sítnice až po kůru.

Parvocelulární – jemné rozlišování tvaru a barev

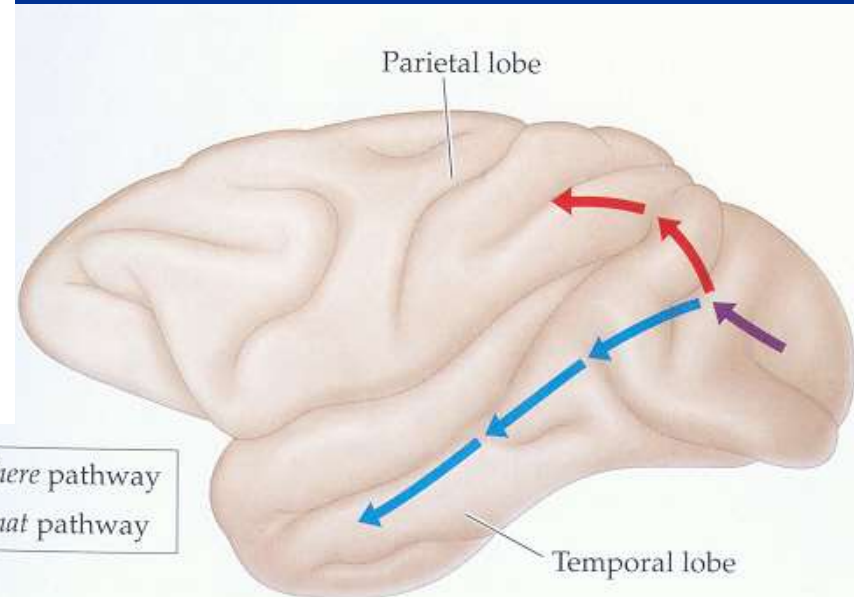
Magnoc. – pohyb a orientace

Identifikace x lokalizace

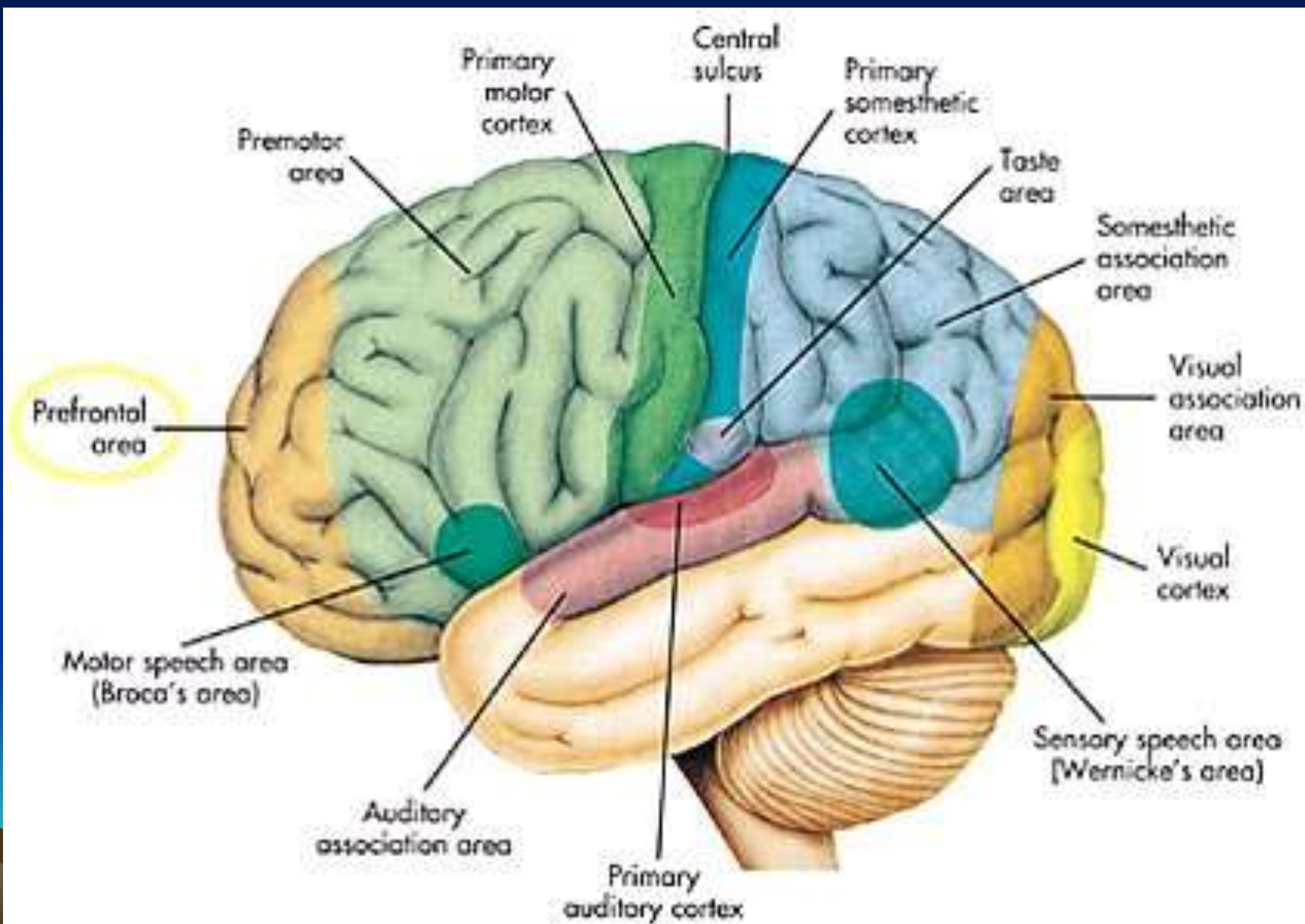
X - 80% gangliových bb

Y – 10% g.b.

W - 10% g.b. – pohyby očí



Primární (žíhaná kůra) , sekundární, (terciální) z.k.



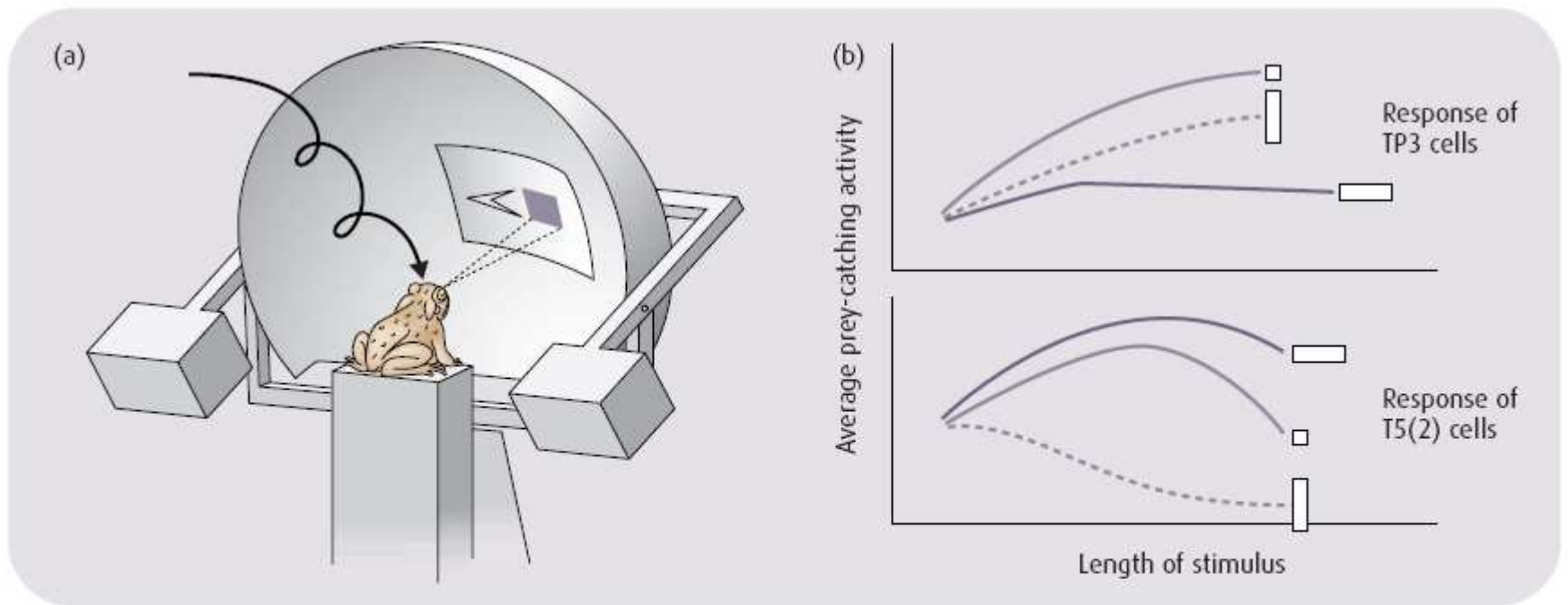
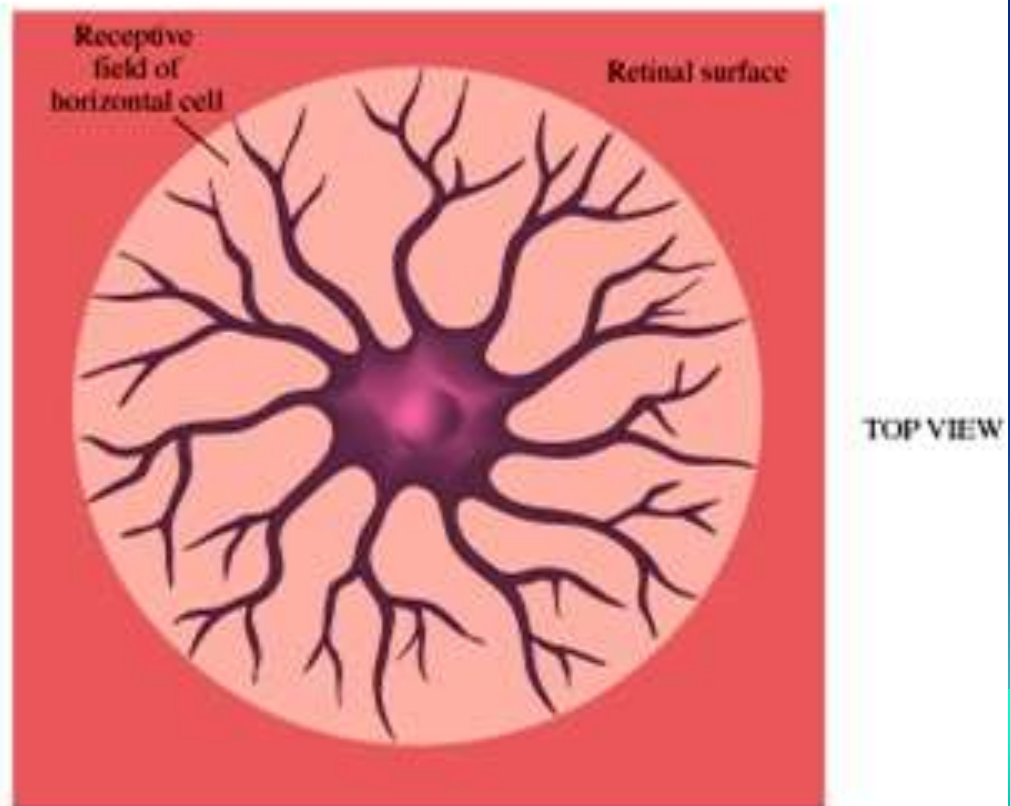
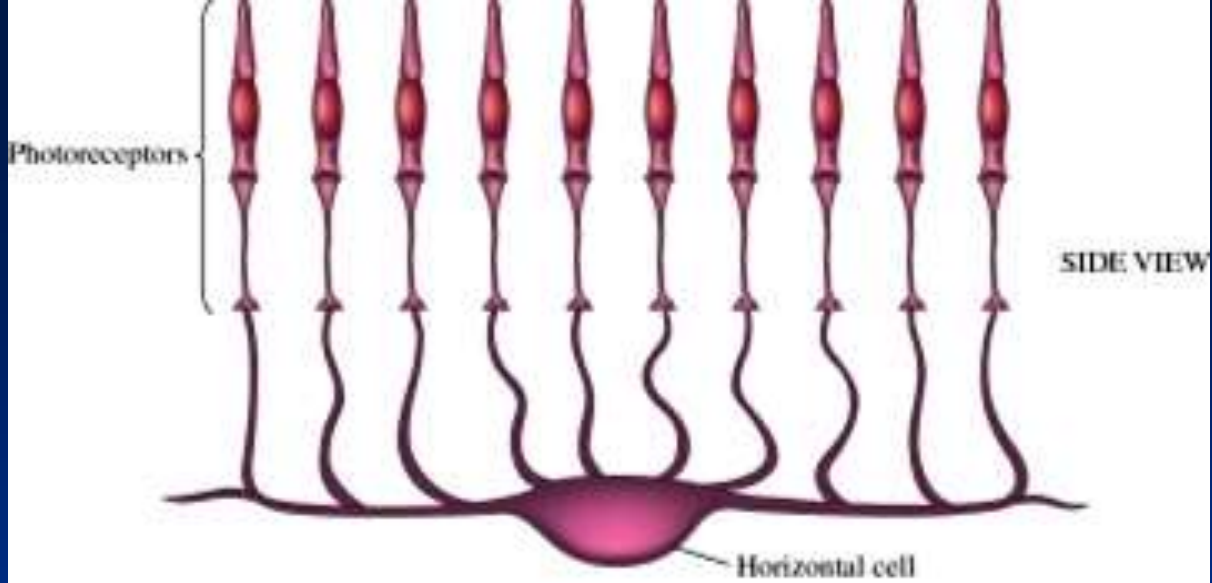
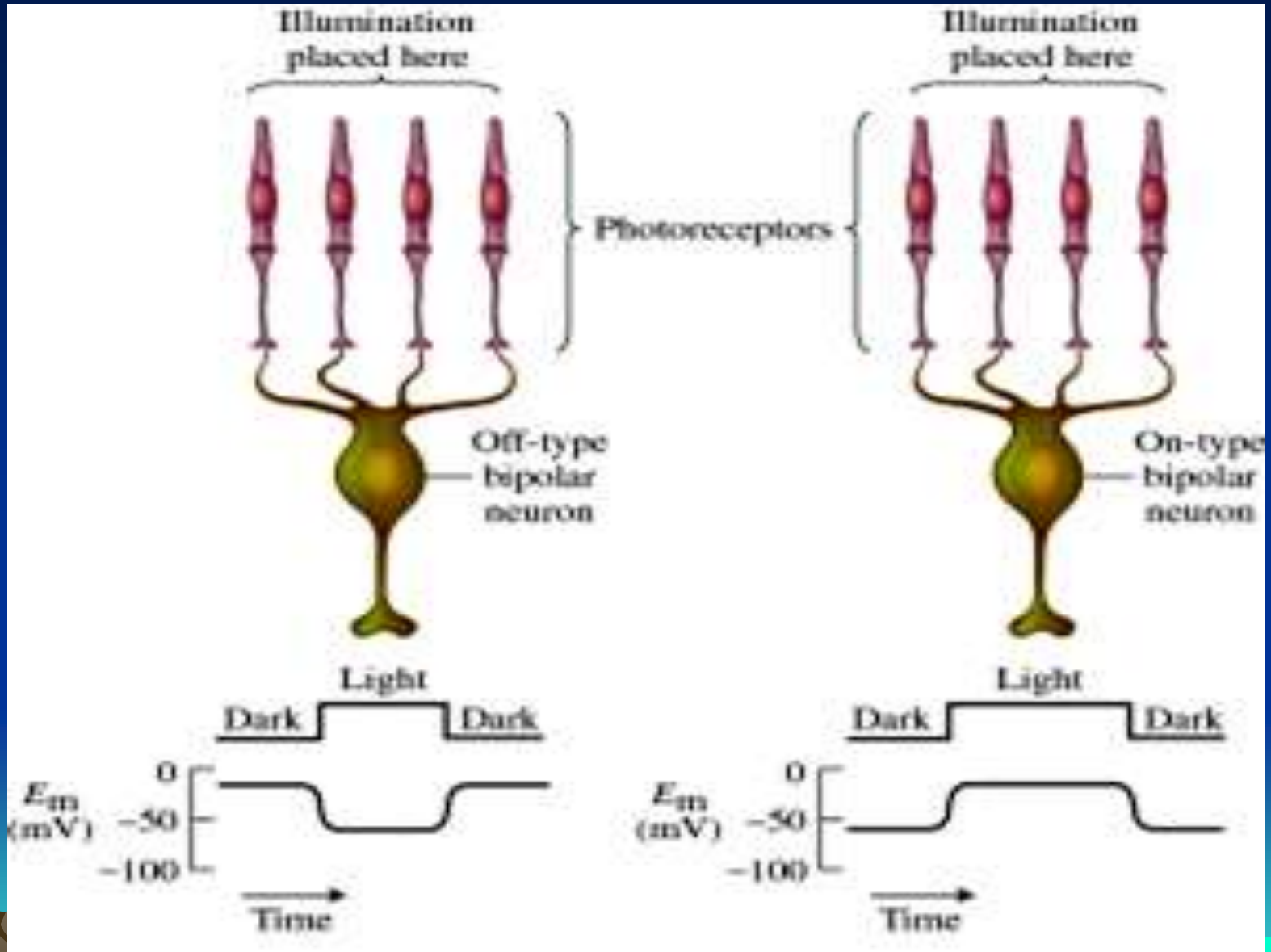


Fig. 2.9 (a) Measuring the response of TP3 and T5(2) cells. (b) Comparison of the behavioral response of a toad to varying moving stimuli with the activity of the animal's TP3 and T5(2) cells. Refer back to Fig. 2.6 to compare these patterns to the behavior of the toad. (From Ewart J-P. & von Wietersheim, A. (1974) Pattern analysis by tectal and thalamus/pretectal nerve nets in the visual system of the toad *Bufo bufo* (L.). *Journal of Comparative Physiology*, 92, 131–48. Reproduced with permission of Springer-Verlag.)

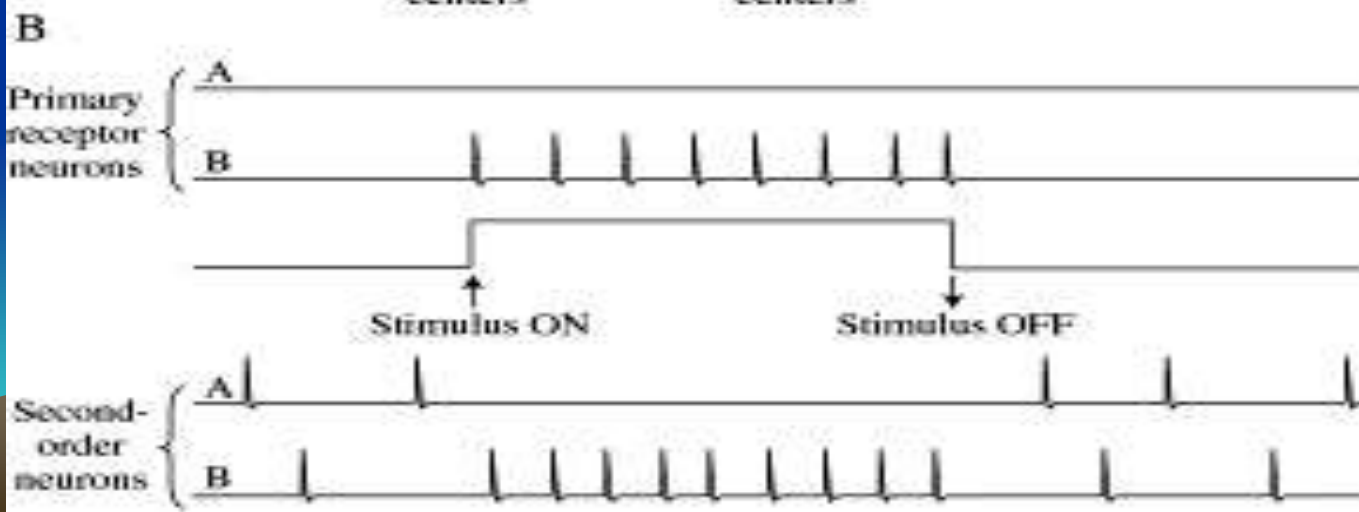
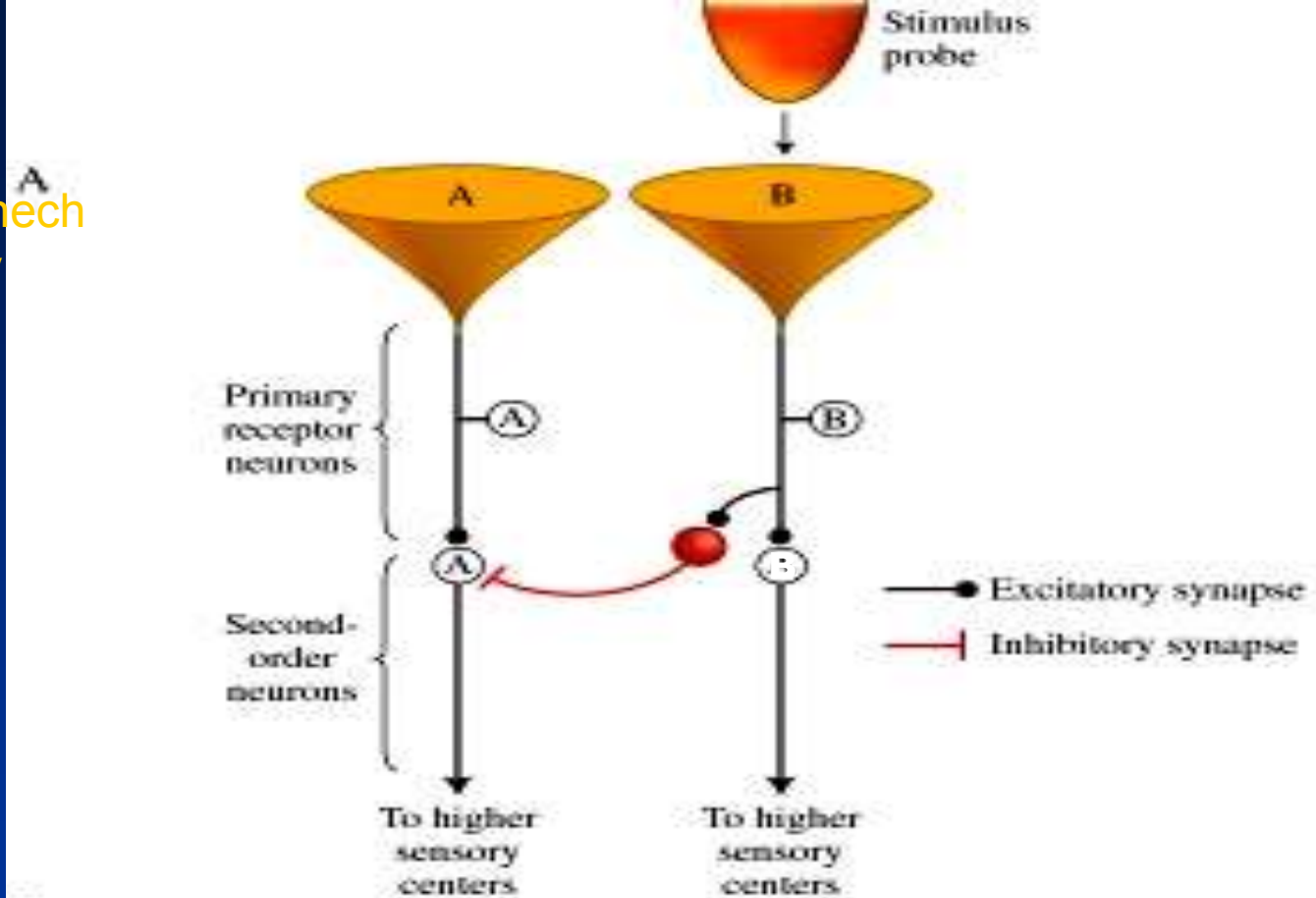
Receptivní pole ve zrakovém systému – primární rysový analyzátor



ON a OFF typy bipolárních neuronů.



Laterální inhibice:
Na sekundárních neuronech
je zesílen kontrast. Silný
posílí, slabý oslabí



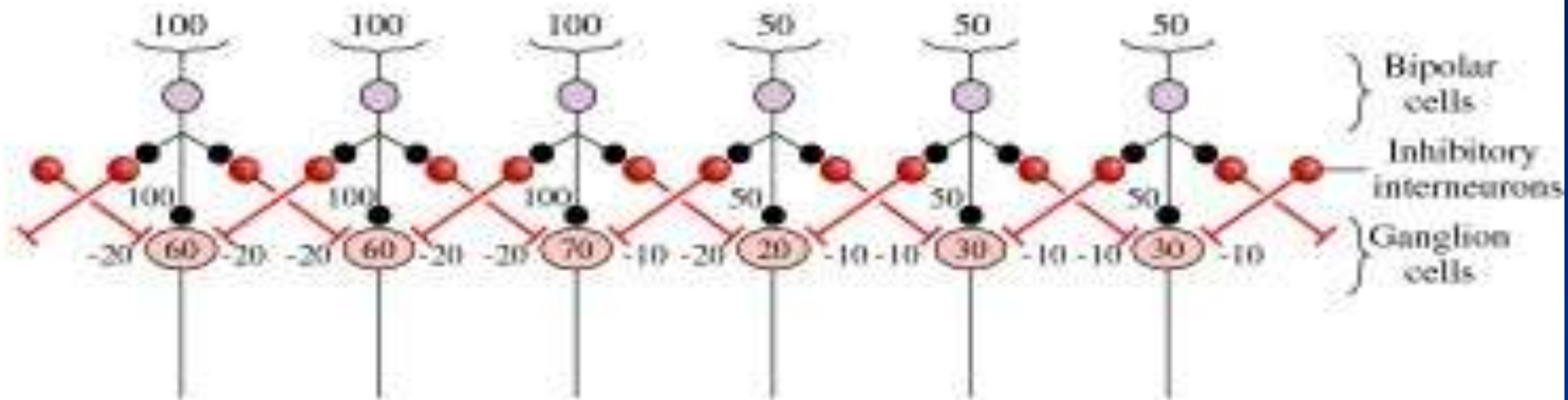
A

100 units

50 units

Light intensity

Laterální inhibice:
Na sekundárních neuronech
je zesílen kontrast.



B

Firing rate of ganglion cell
(arbitrary units)

50
0

● Excitatory connection
(gain = +1.0)
— Inhibitory connection
(gain = -0.2)

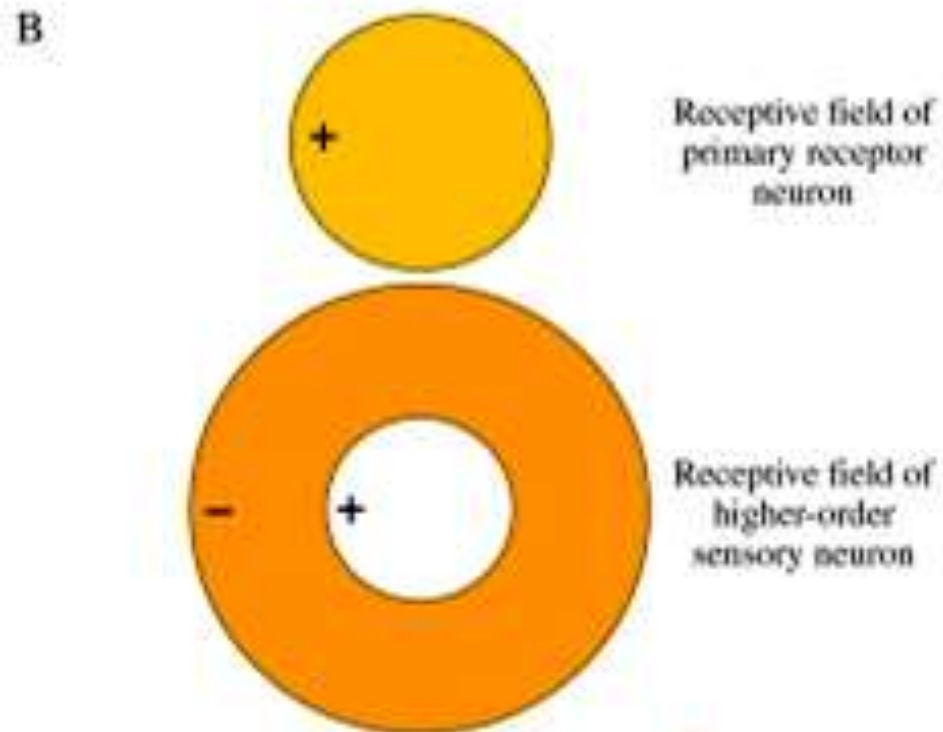
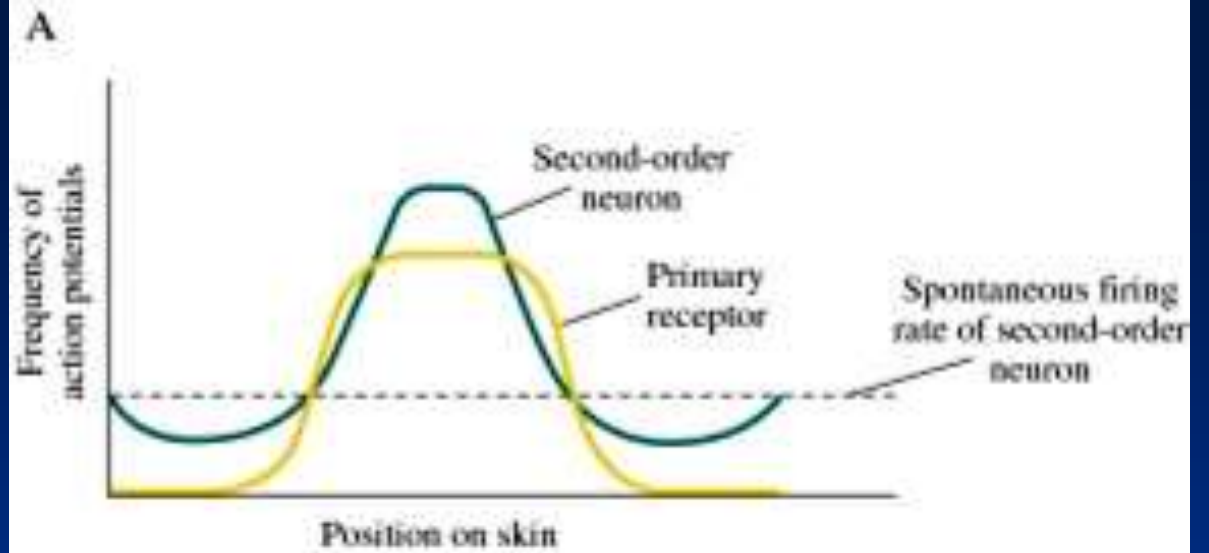
C

Perceived
brightness

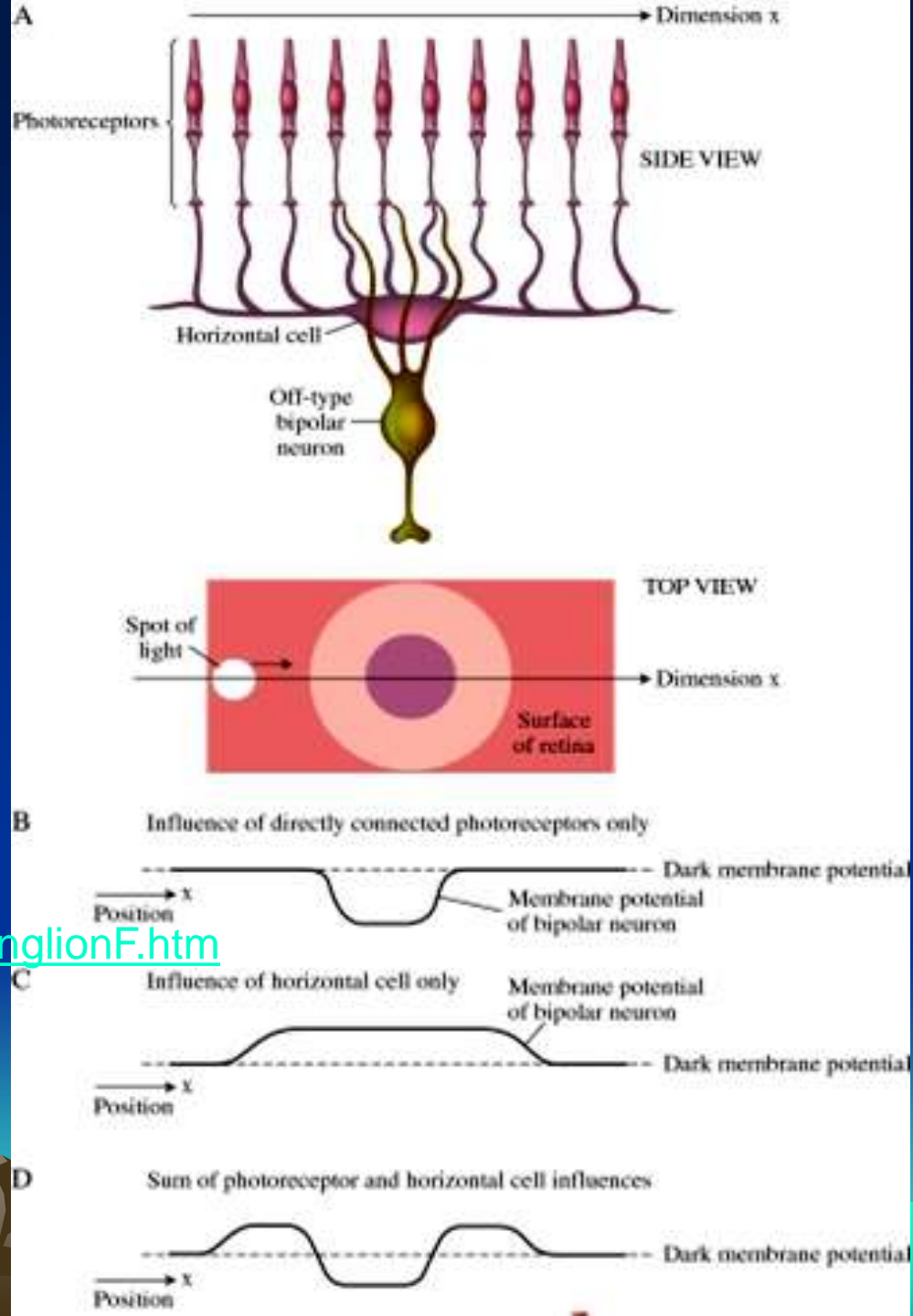
High
Low



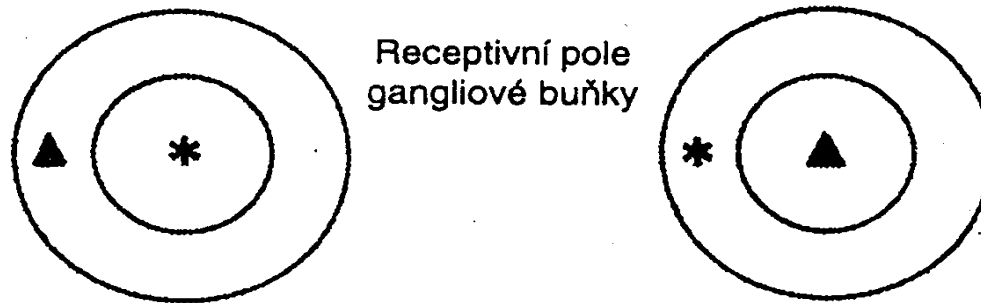
Laterální inhibice:
Na sekundárních neuronech
je zesílen kontrast.
Změna velikosti a struktury
receptivního pole.



Laterální inhibice:
 Na sekundárních neuronech
 je zesílen kontrast.
 Změna velikosti a struktury
 receptivního pole.
 Gangliové buňky jsou první rysově
 analyzátoři



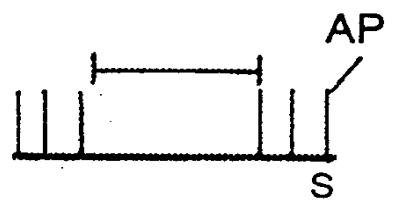
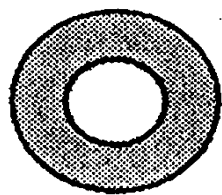
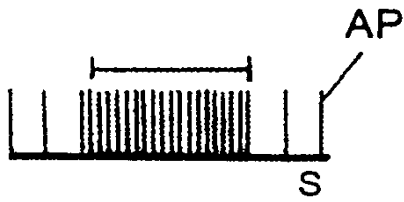
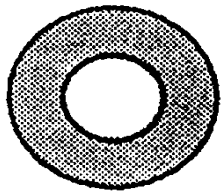
<http://sites.sinauer.com/wolfe3e/chap2/ganglionF.htm>



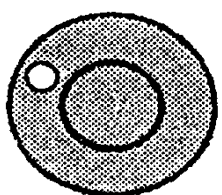
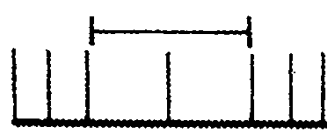
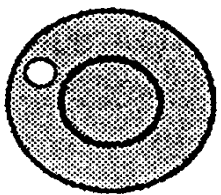
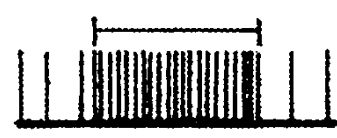
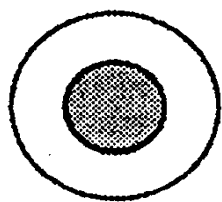
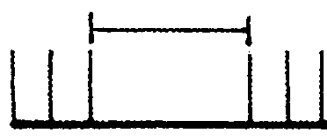
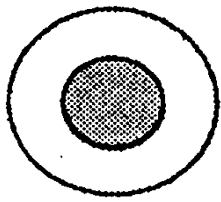
ON-centrum

OFF-centrum

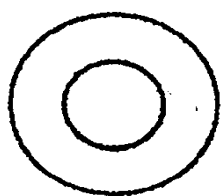
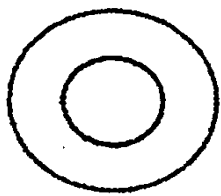
osvětlení
centra
světelnou
skvrnou



osvětlení
periferie
světelným
prstencem
nebo
skvrnou

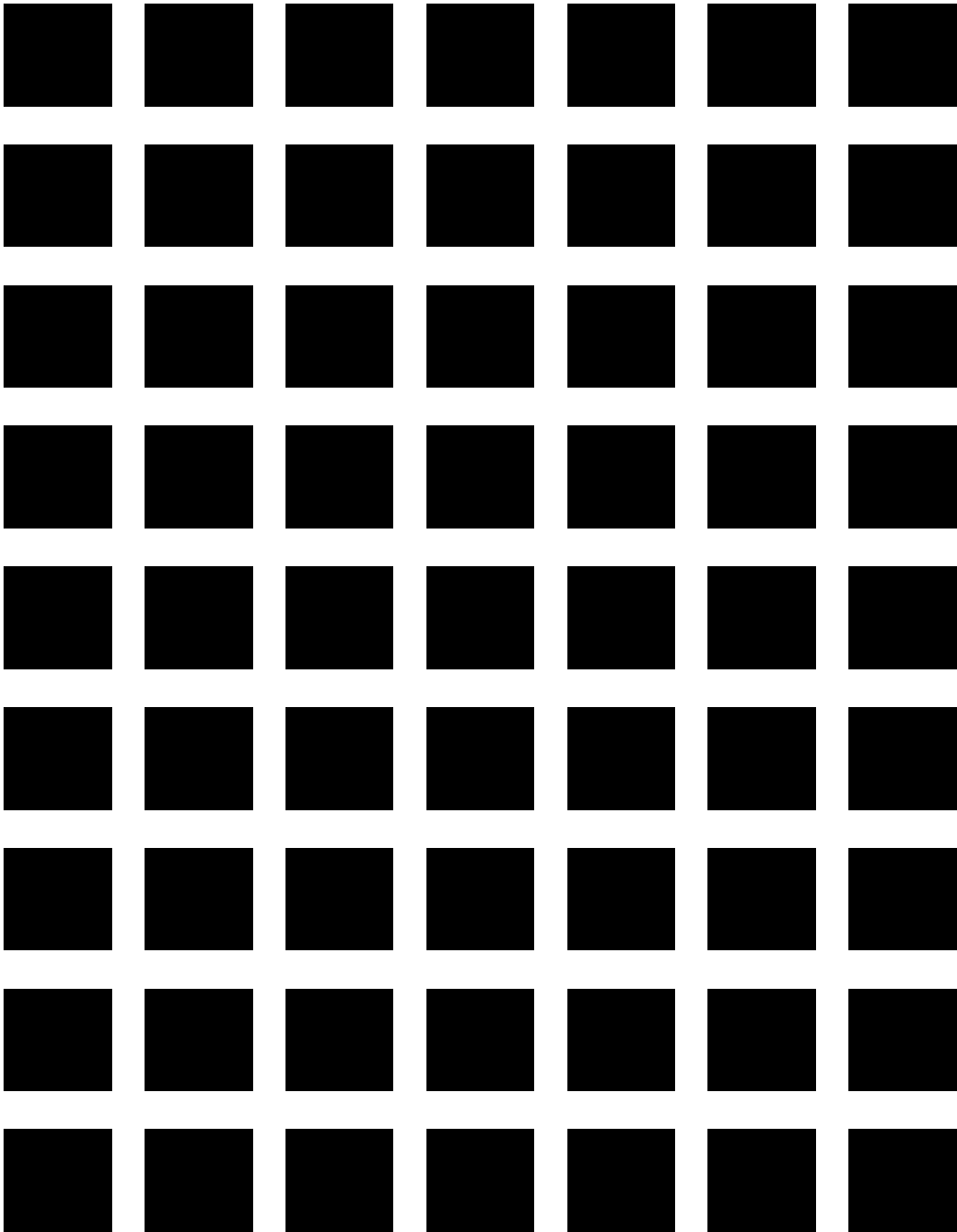


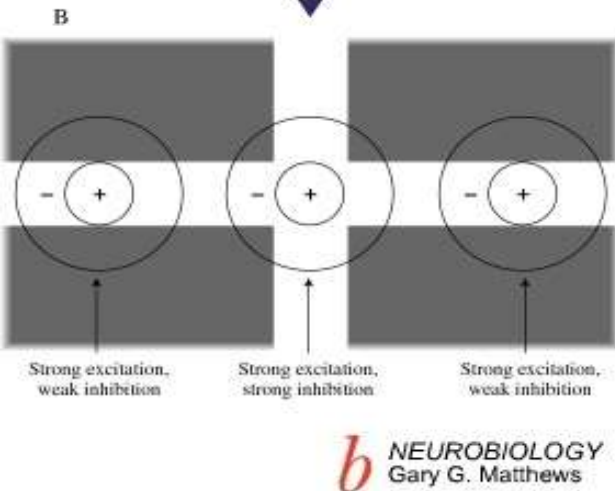
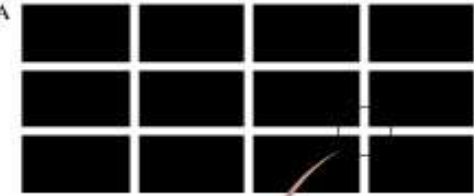
difusní
osvětlení



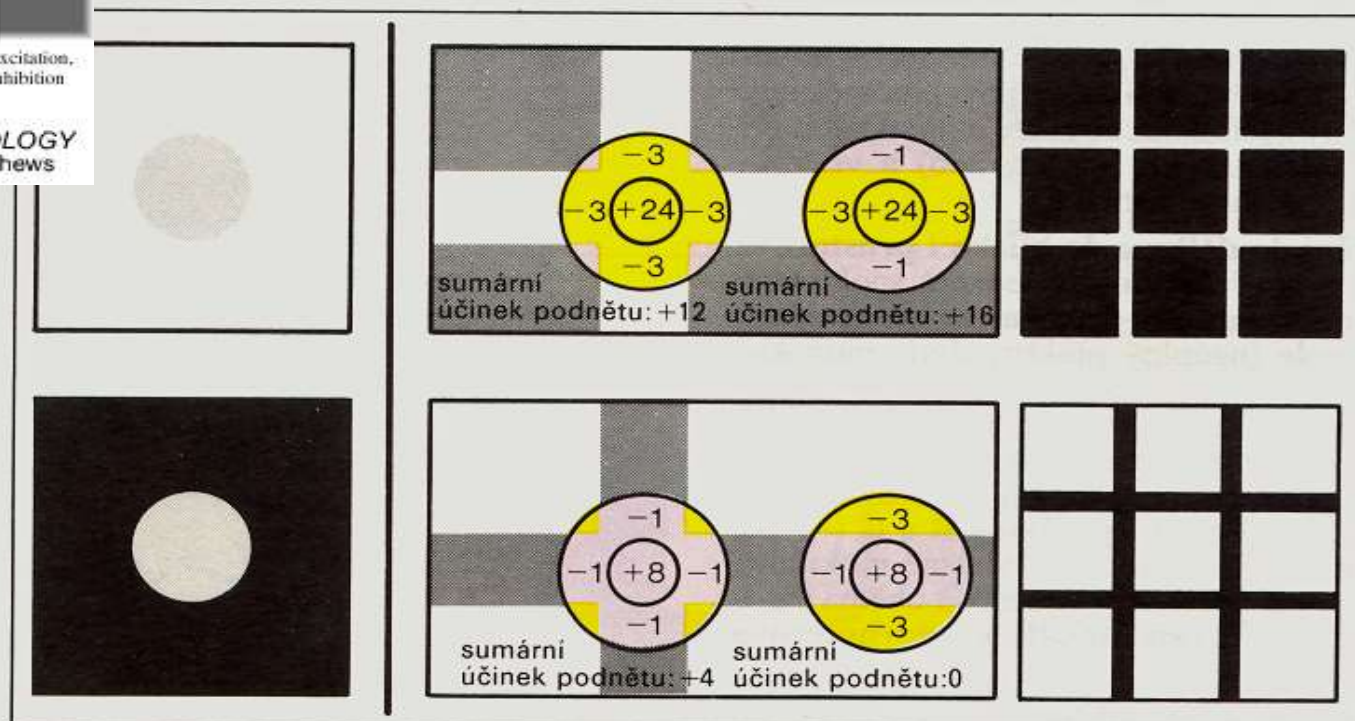
Záznam elektrické aktivity gangliových buněk sítnice s ON a OFF centrem při osvětlení jednotlivých částí jejich receptivního pole. Úsečka nad záznamem elektrické aktivity značí trvání osvětlení v sekundách.
 AP – potenciál. * – excitační zóna ▲ – inhibiční zóna

Proč ty šedé flíčky?



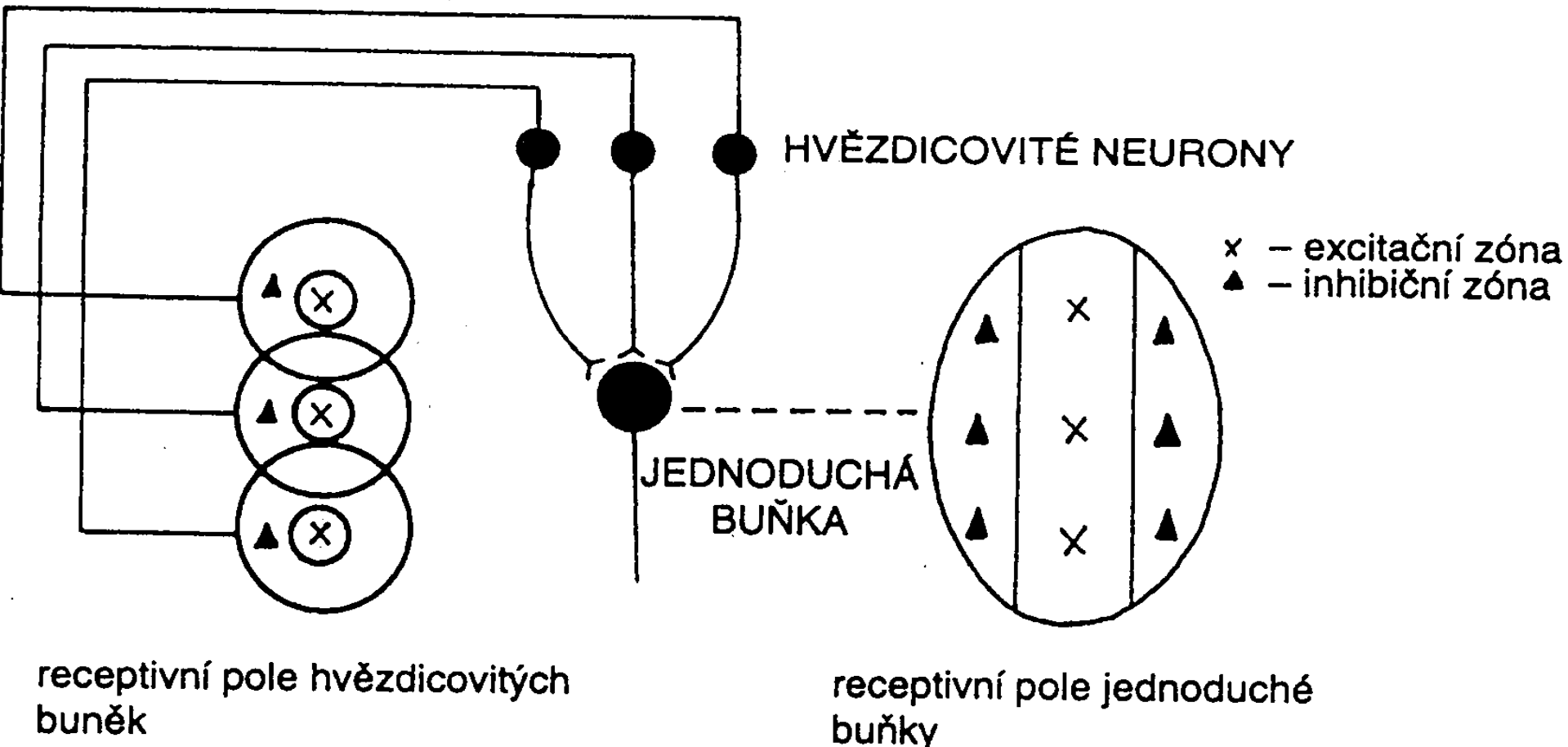


Proč ty šedé flíčky?
Vysvětlení přes recepční pole gangliových buněk.

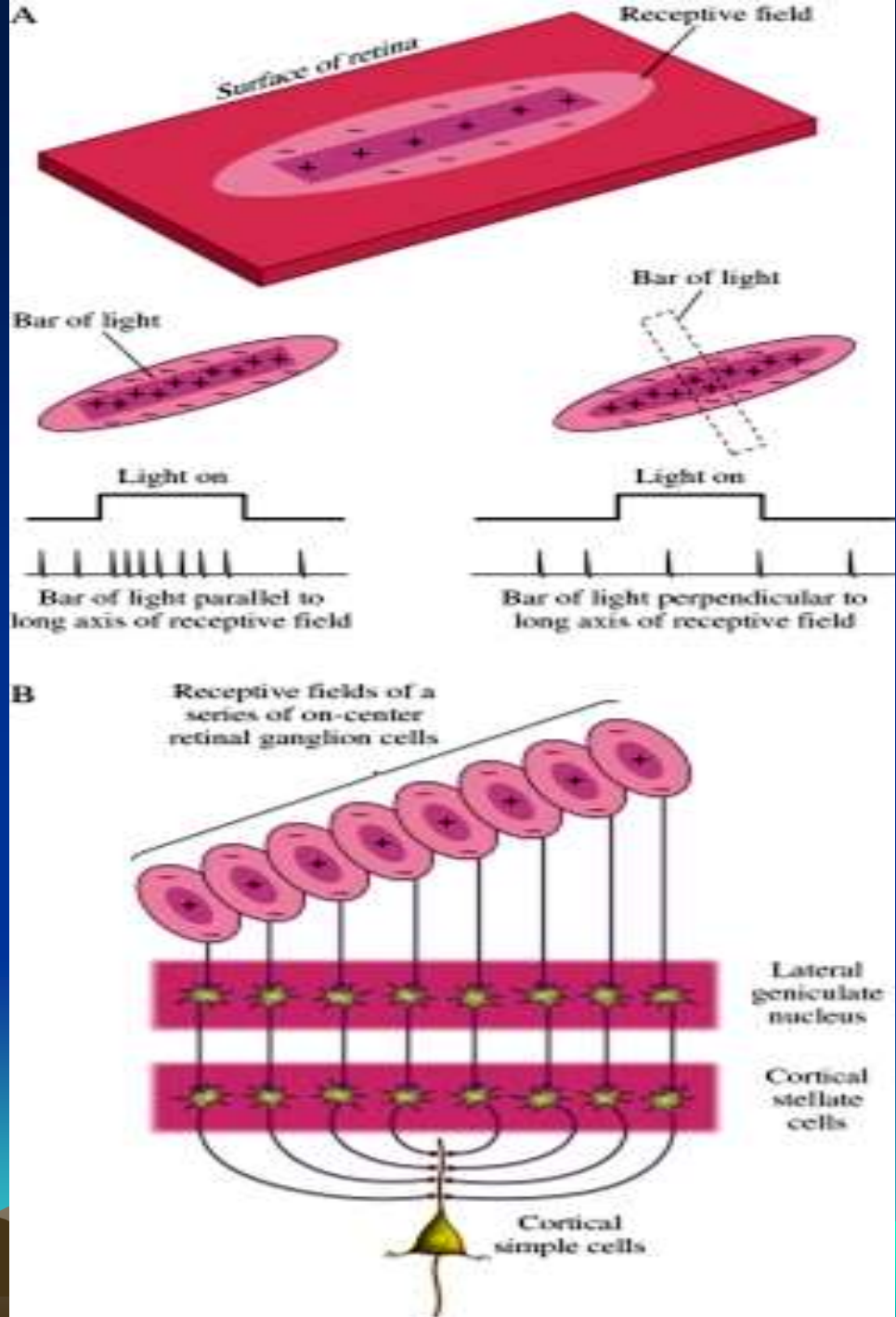


C. Kontrast pomocí recepčního pole (on-centrum)

Skládání recepčních polí. Hvězdicové a jednoduché buňky IV. korové vrstvy primární zrakové oblasti.



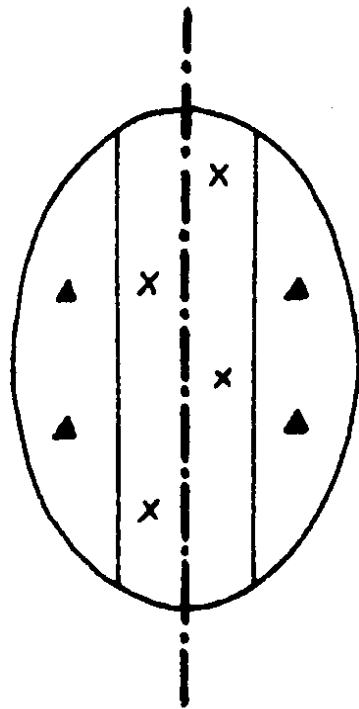
Jednoduchá buňka „měří“
sklon svého kontrastního pruhu



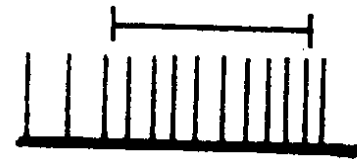
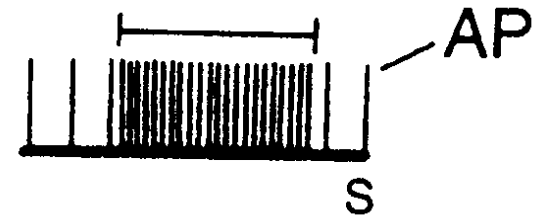
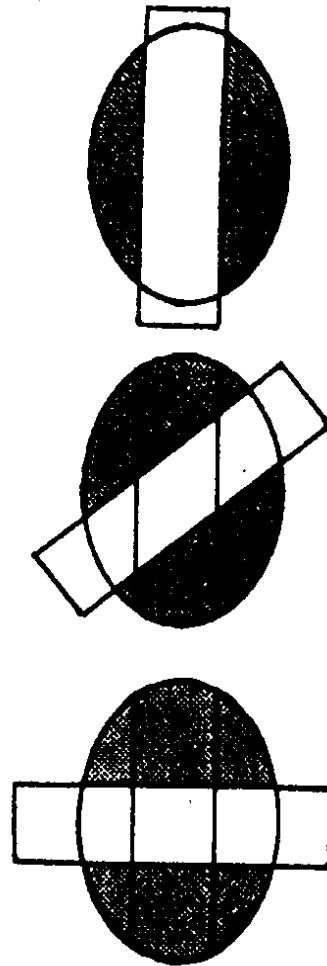
Jednoduchá buňka „měří“ pozici a sklon svého kontrastního pruhu

<http://sites.sinauer.com/wolfe3e/chap3/striaterfF.htm>

Receptivní pole
jednoduché buňky



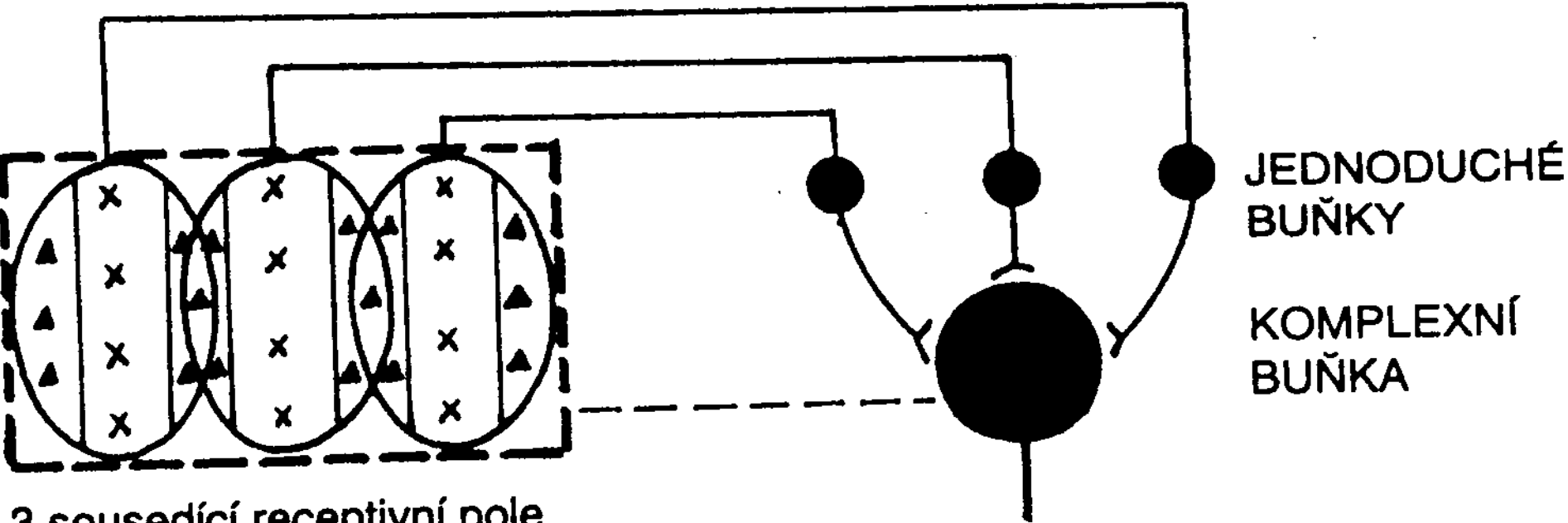
světelný
pruh



Vliv orientace vizuálního podnětu na elektrickou aktivitu jednoduché buňky. Úsečka nad záznamem elektrické aktivity značí trvání osvětlení v sekundách. AP – akční potenciál.

x – excitační zóna ▲ – inhibiční zóna

Komplexní buňka nemá jasně vyhraněnou excitační a inhibiční oblast - „měří“ sklon kontrastního pruhu bez ohledu na pozici na sítnici.



3 sousedící receptivní pole jednoduchých buněk. V rámečku zformované receptivní pole komplexní buňky.

⊗ – excitační zóna ⊕ – inhibiční zóna

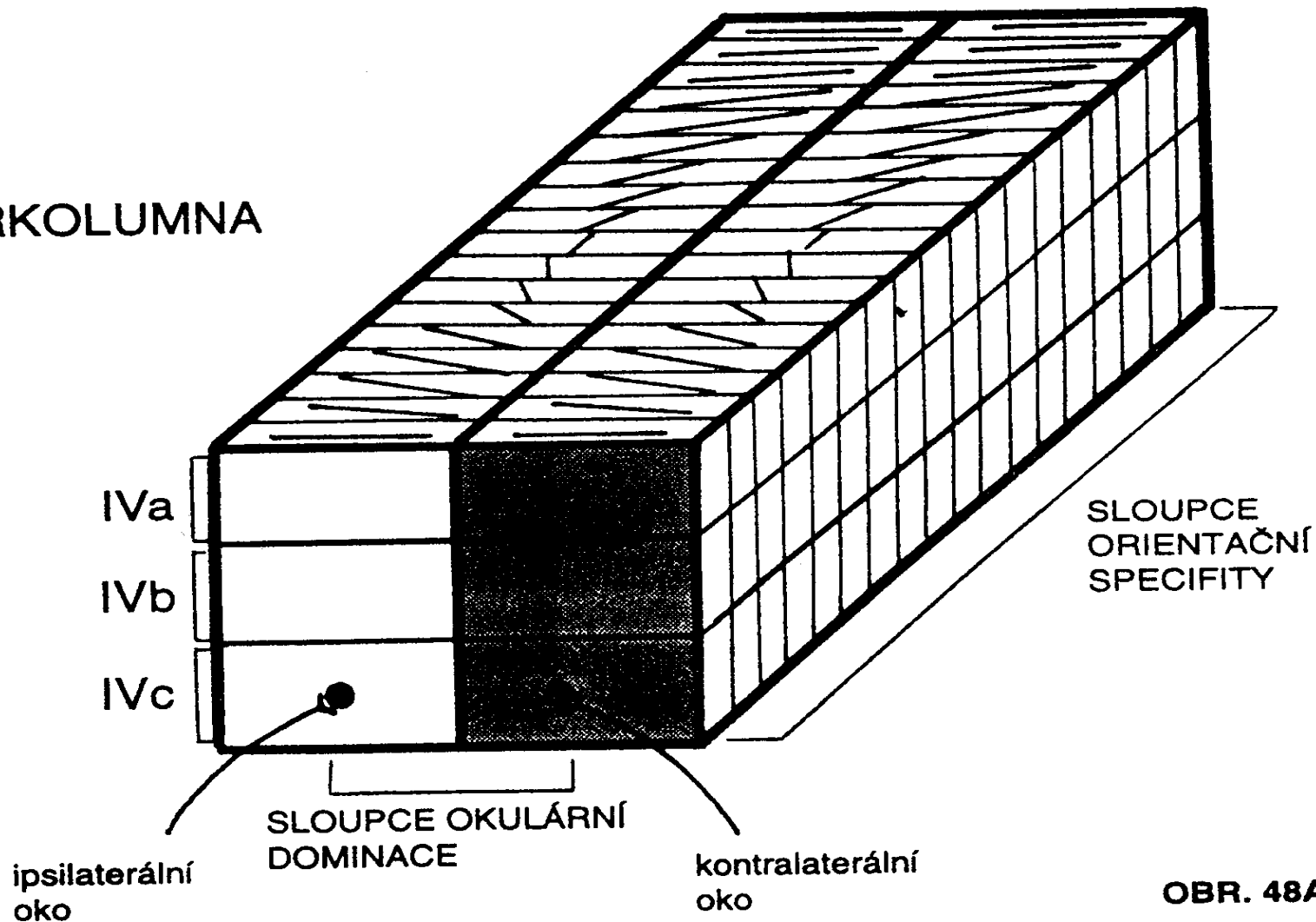
JEDNODUCHÉ
BUŇKY

KOMPLEXNÍ
BUŇKA



Komplexní orientačně selektivní buňky primární kůry tvoří mozaiku nebo „klávesnici“ podobnou tonotopické.

HYPERKOLUMNA



OBR. 48A

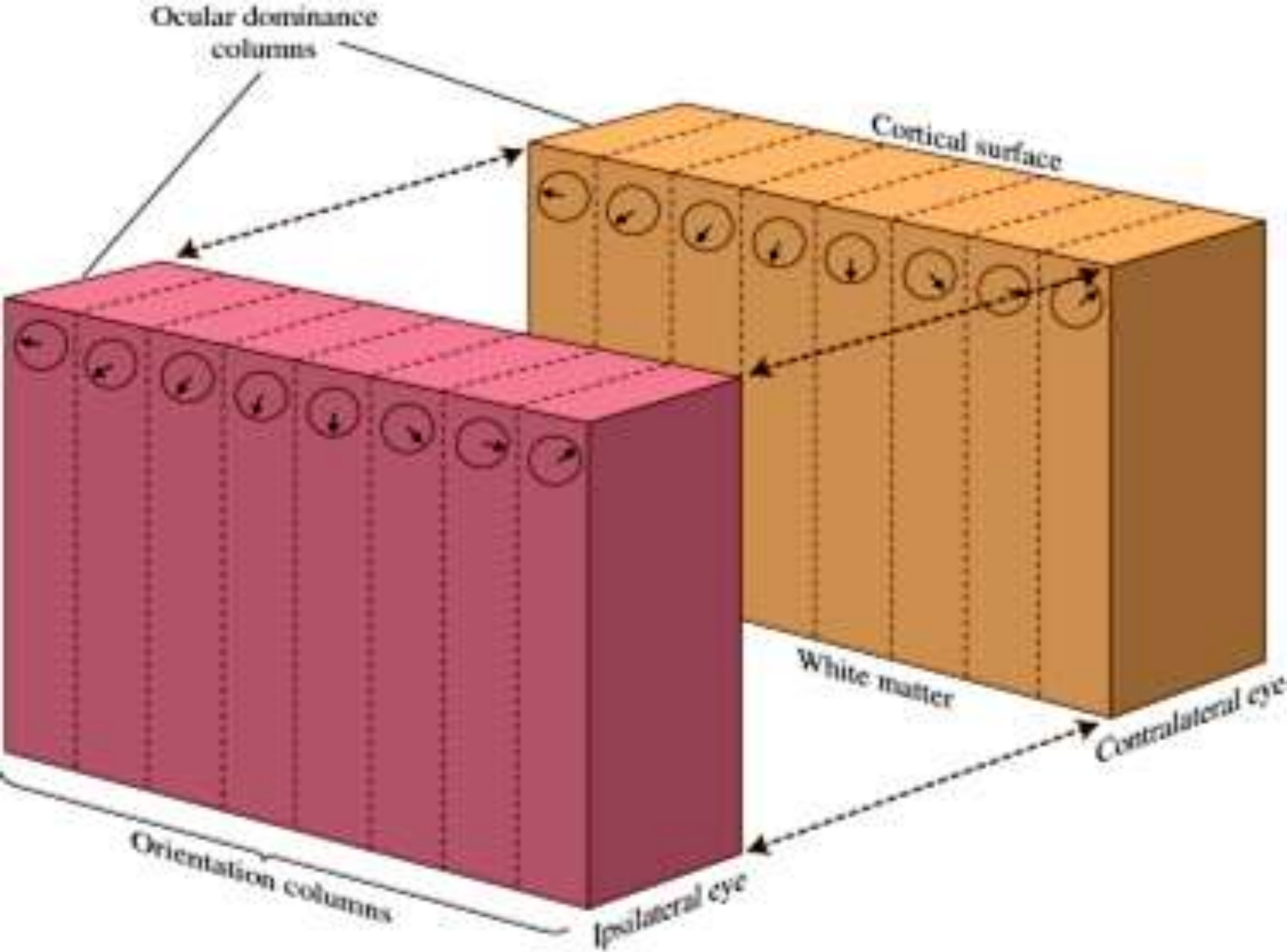
Sloupce okulární dominance charakteristicky organizovány jako sloupečky kolmé k povrchu kůry. Sousedící proužky obsahují neurony, jejichž receptivní pole jsou lokalizována v identických místech sítnic.

Sloupce orientační specifity jsou seskupeny tak, že v každém sousedním sloupečku je funkční orientace receptivního pole stočena o 10° .

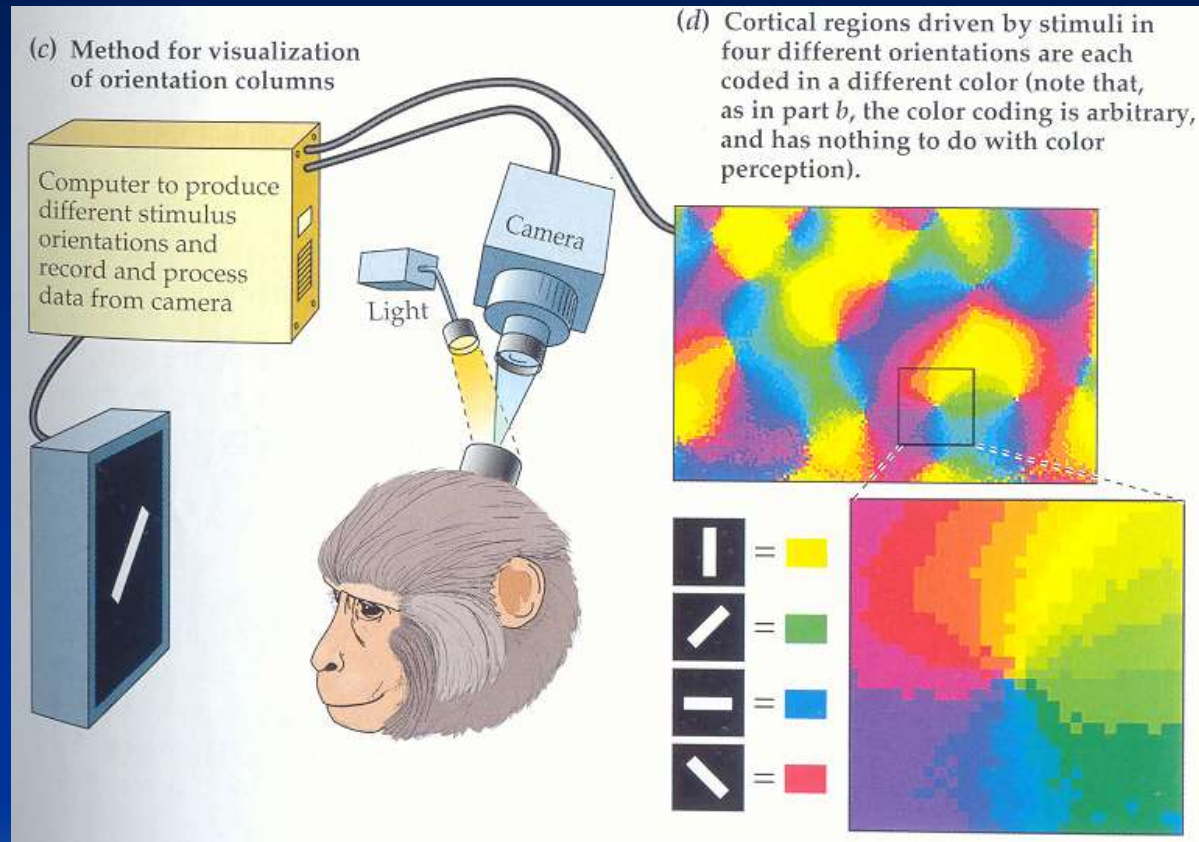
Hyperkolumna je elementární funkční modul primární z.k.

Separátní analyzátory pro barvu, tloušťku a orientaci kontrastního pruhu z každého oka zvlášť.





Komplexní orientačně selektivní buňky primární zrkové kůry makaka.

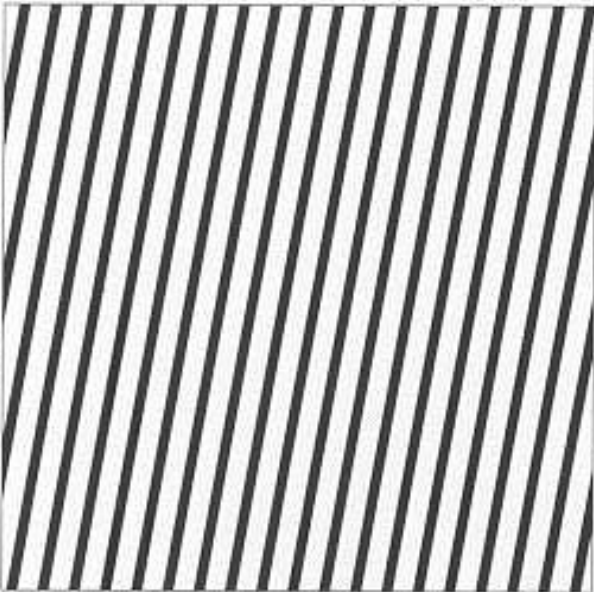
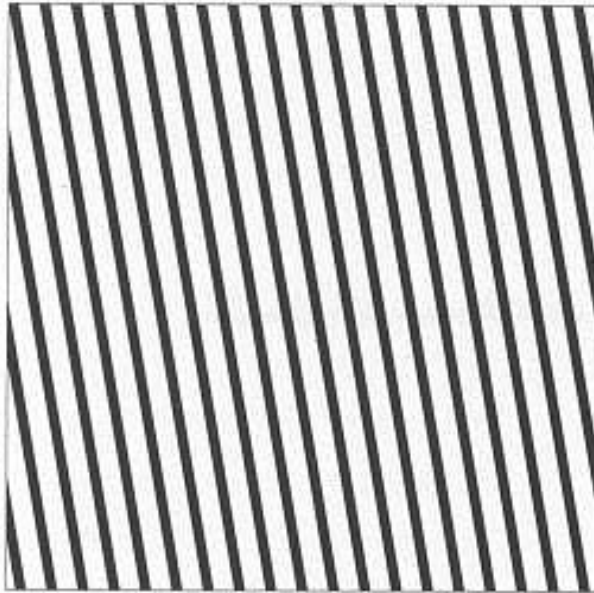


<http://sites.sinauer.com/wolfe3e/chap3/hypercolumnsF.htm>

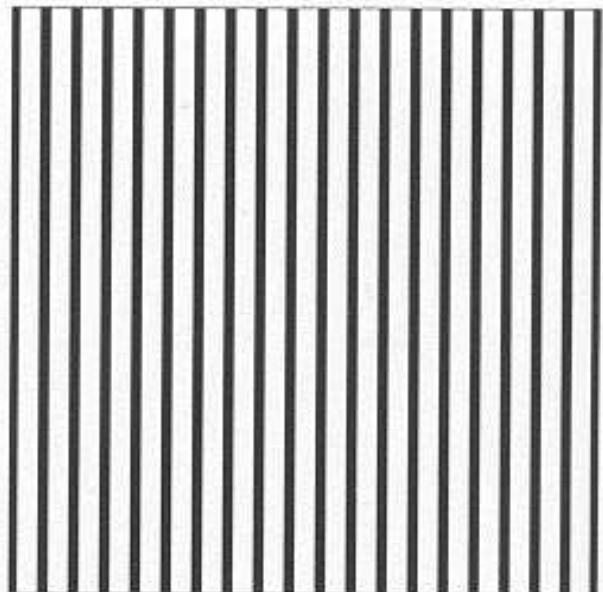
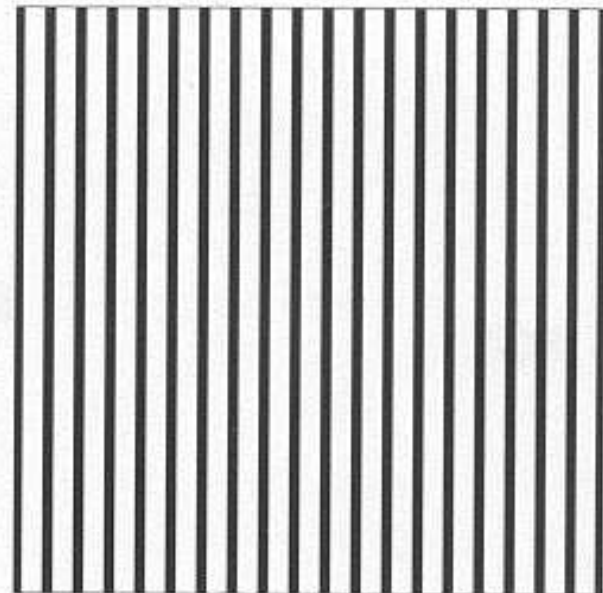
Selektivní adaptace a
orientačně
selektivní buňky.

Selektivní adaptace:
cesta do lidského
mozku

(a)

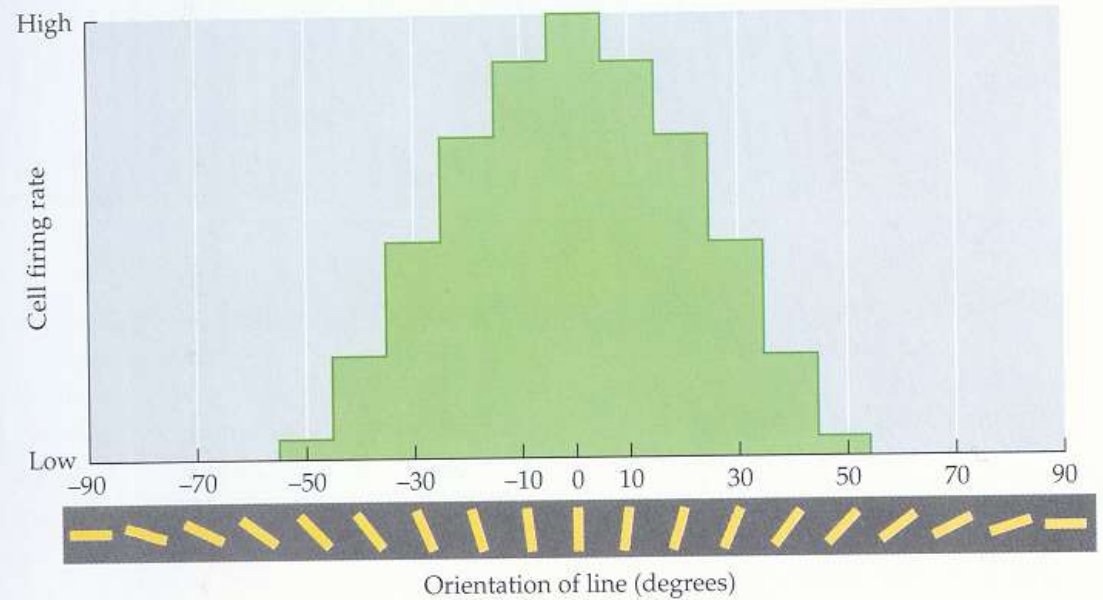


(b)



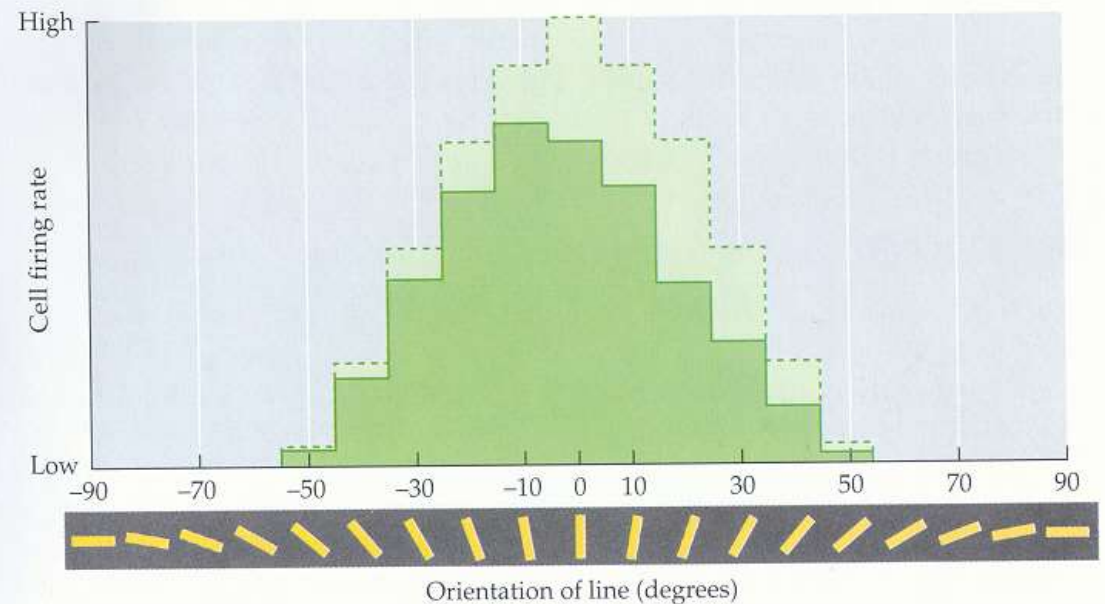
Vysvětlení:
20° buňky jsou po 1 min
adaptovány, unaveny
a přestávají přispívat
do vjemu vertikál.
Ve výsledku se vertikální
linie kácí.

(a) Before adaptation



Adapt to 20° stripes

(b) After adaptation



Selektivní adaptace a
kontrastně
selektivní buňky

Po adaptaci na
Konkrétní „frekvenci“,
je právě tato utlumena

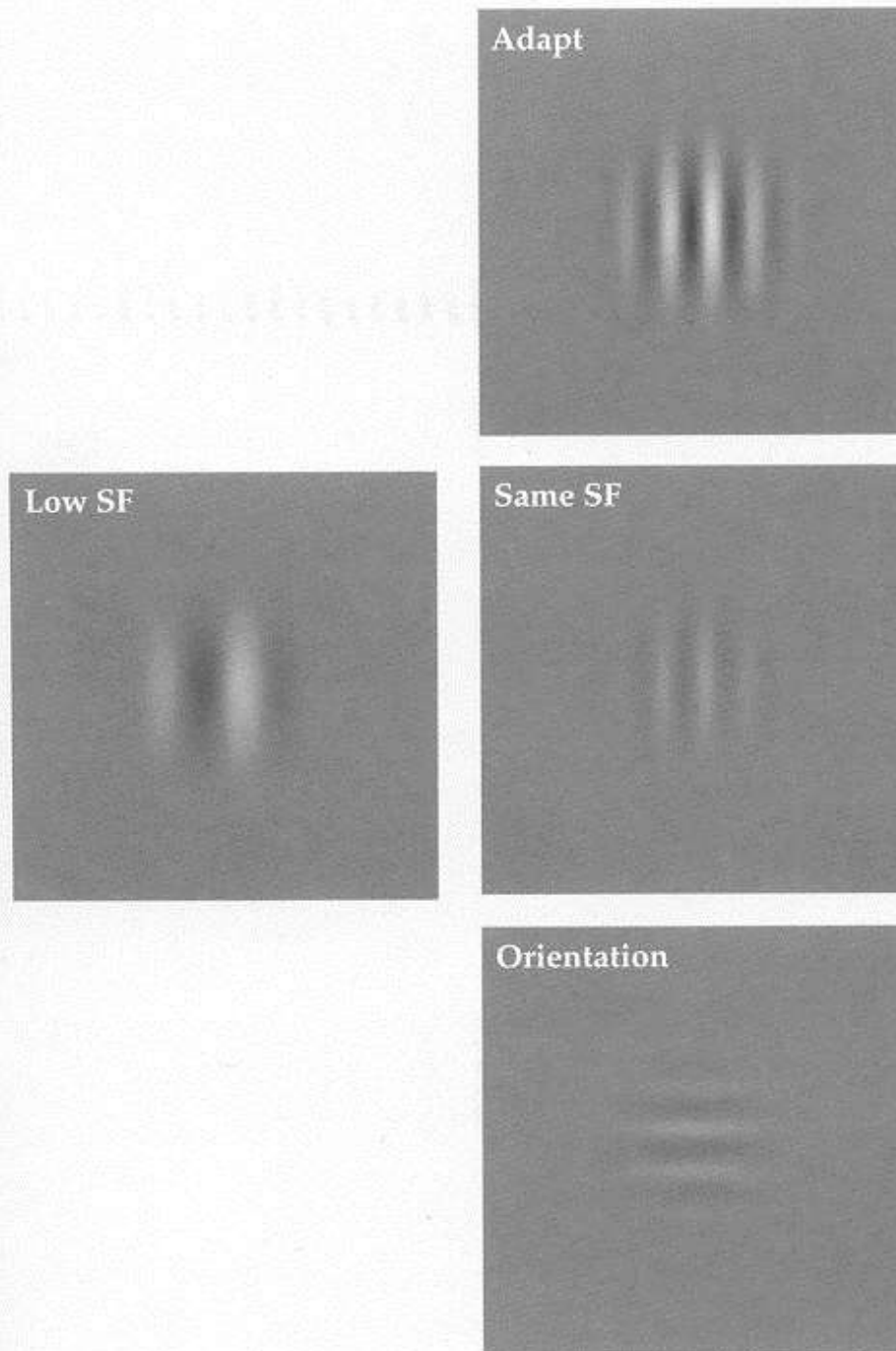


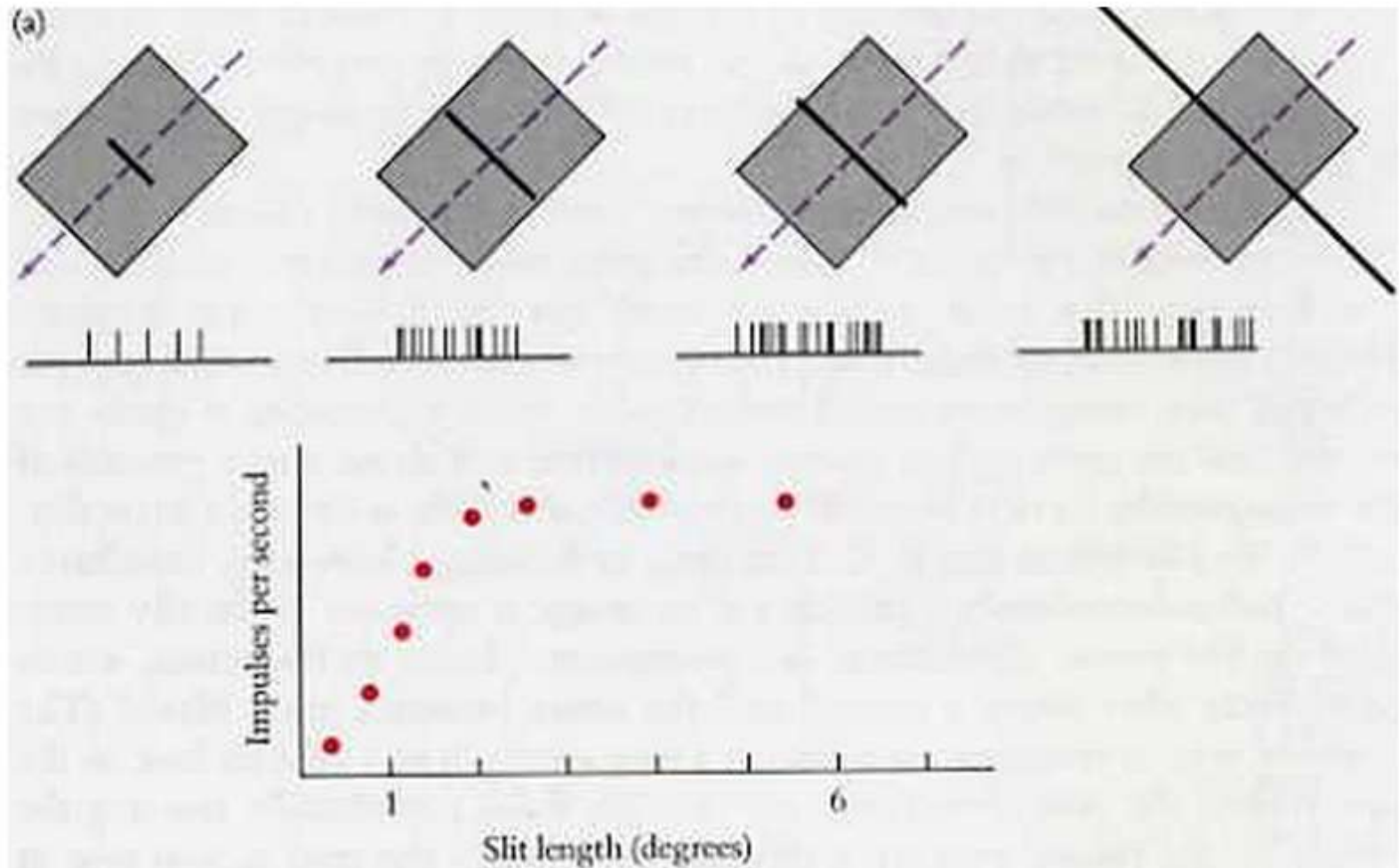
FIGURE 3.26 Demonstration of selective adaptation to spatial frequency (SF) and orientation (from Hubel and Campbell, 1969.)

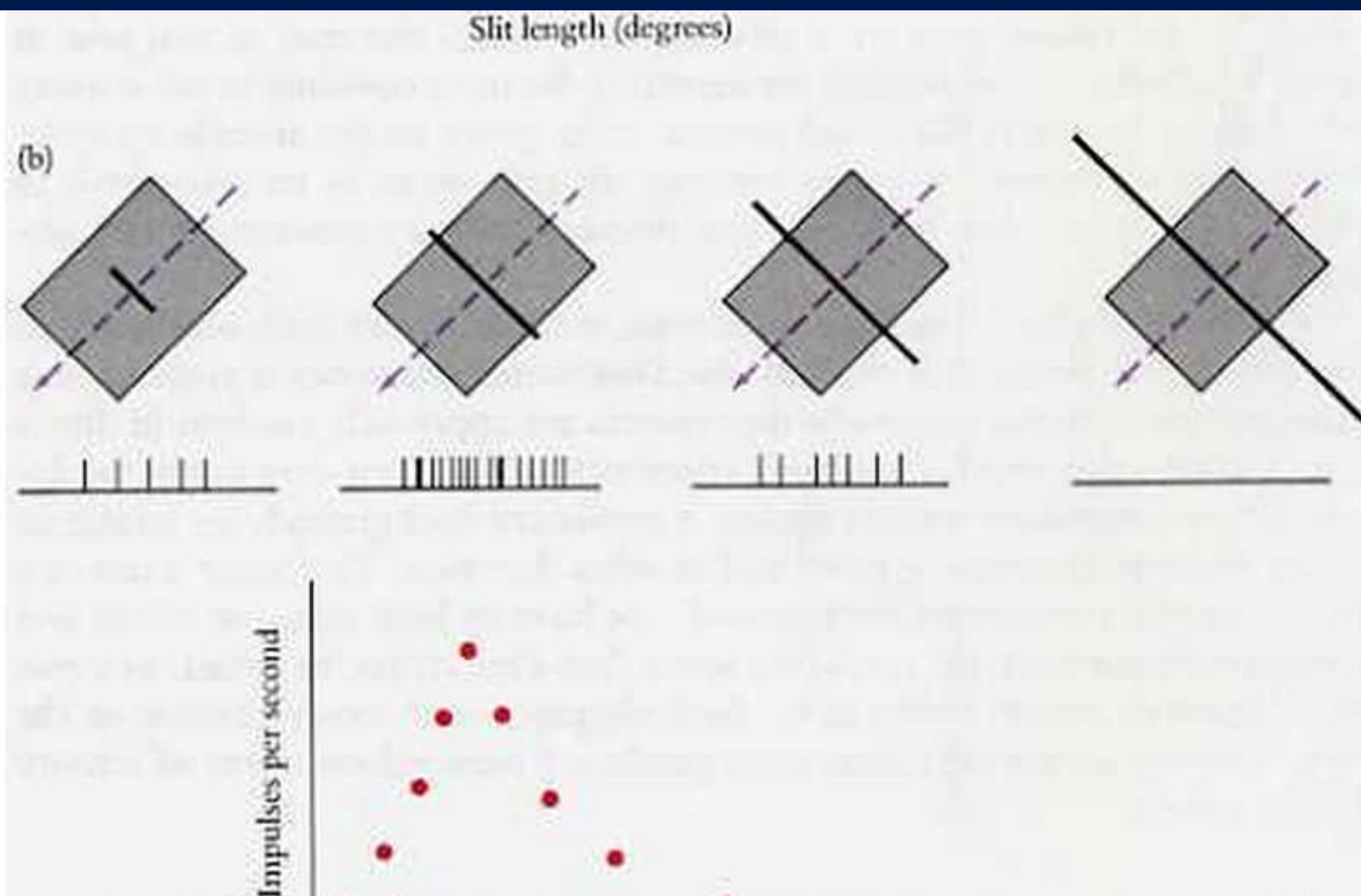
- Některé buňky odpovídají nejlépe když pruh světla končí ještě uvnitř receptivního pole. End-stopped cells
- <http://sites.sinauer.com/wolfe3e/chap3/straterfF.htm>



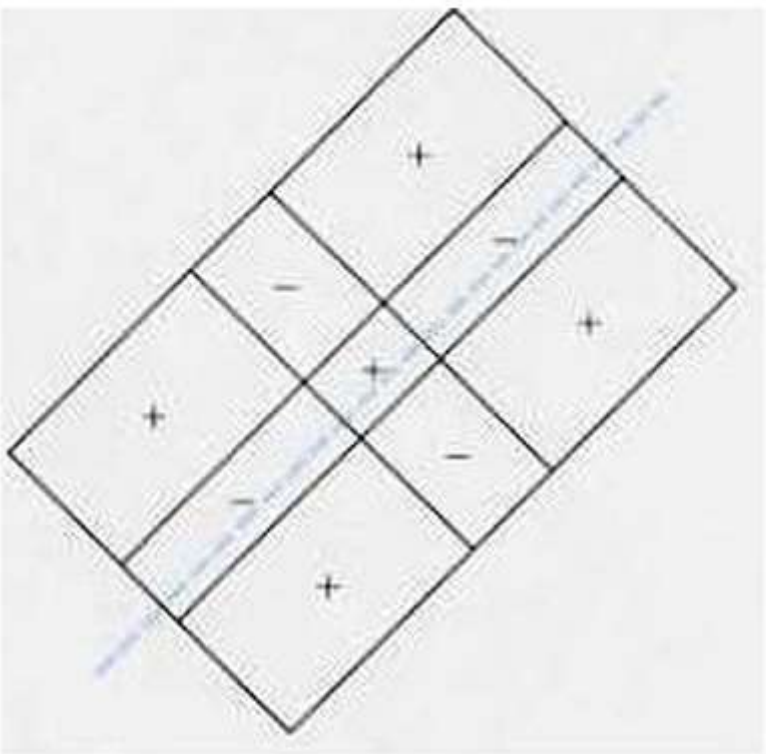
END STOPPING

One additional kind of specificity occurs prominently in the striate cortex. An ordinary simple or complex cell usually shows length summation: the longer the stimulus line, the better is the response, until the line is as long as the receptive field; making the line still longer has no effect. For an end

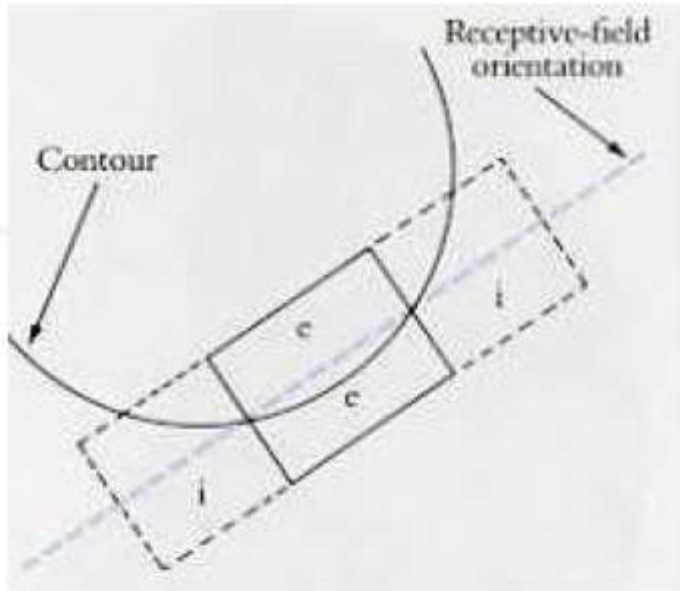




stopped cell, lengthening the line improves the response up to some limit, but exceeding that limit in one or both directions results in a weaker response, as shown in the bottom diagram on the facing page. Some cells, which we call completely end stopped, do not respond at all to a long line. We call the region

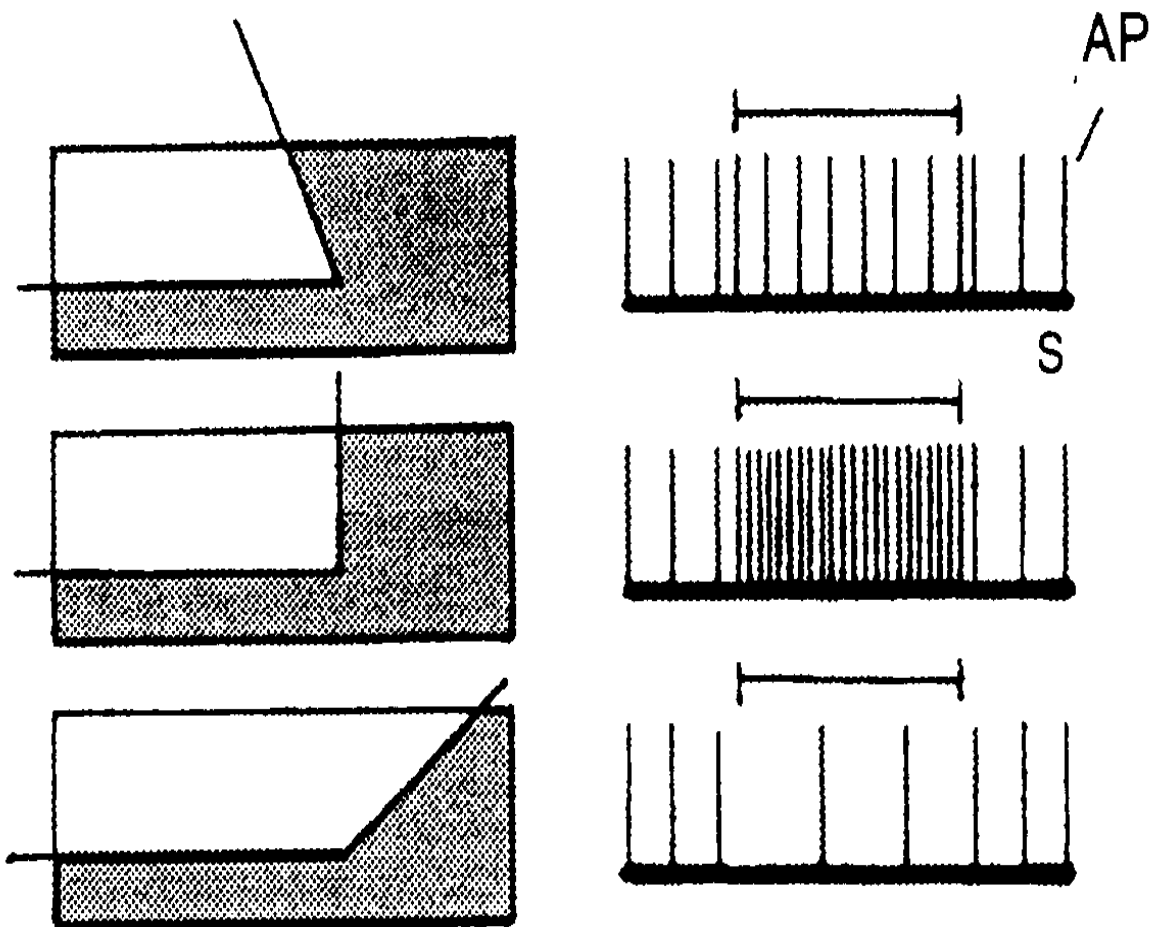


This end-stopped simple cell is assumed to result from convergent input from three ordinary simple cells. (One cell, with the middle on-center field, could excite the cell in question; the two others could be off center and also excite or be on center and inhibit.) Alternatively, the input to this cell



For an end-stopped cell such as the one shown on the previous page, a curved border should be an effective stimulus.

Sekundární kůra, hyperkomplexní buňky



Vliv různého úhlu kontrastního vizuálního podnětu na elektrickou aktivitu hyperkomplexní buňky. Úsečka nad záznamem elektrické aktivity značí trvání osvětlení v sekundách.

AP – akční potenciál.

OBR. 49A



10.21 Complex Stimuli Evoke Strong Responses in Visual Cortex

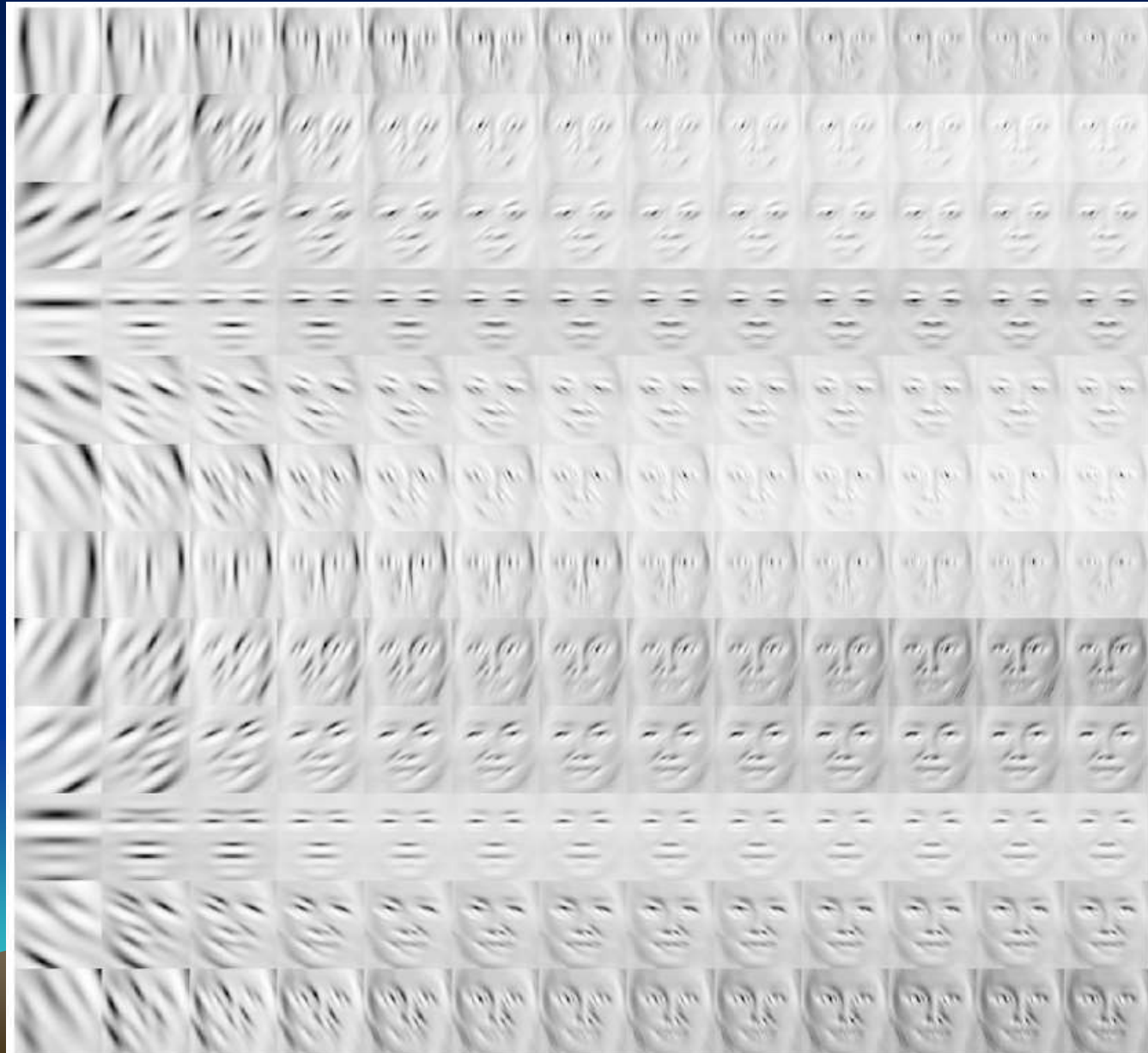
(a) These concentric and radial stimuli evoke maximal responses from some cells in visual cortical area V4. The stimuli that evoked the highest response rates (see scale bar) are shown in red and orange. (b) These 12 examples illustrate the critical features of stimuli that evoke maximal responses from cells in the anterior inferior temporal area. (Part a from Gallant et al., 1993, courtesy of Jack Gallant; b from K. Tanaka, 1993, courtesy of Keiji Tanaka.)



„Grandmother’s cells“ Na tvář selektivní buňky

FIGURE 4.33 Cells in the inferotemporal cortex of macaque monkeys are interested in very specific stimuli. In this case, the cell responds vigorously to a monkey face and to some other stimuli that seem related. (After Gross, Rocha-Miranda, and Bender, 1972.)

„Skládání“ tváří z jednodušších rysů.



Hierarchické skládání rysů a jejich paralelní zpracování

- <http://sites.sinauer.com/wolfe3e/chap4/pandemoniumF.htm>

4.2 Pandemonium

Decision Demon



Cognitive Demons



Feature Demons



A A H T X X O G R Ъ Я

- **Iluze osvětlení – světelná stálost**

Hnědá čokoláda za jasného dne odráží méně světla než papír za šera, ale stejně ji vnímáme jako tmavou.

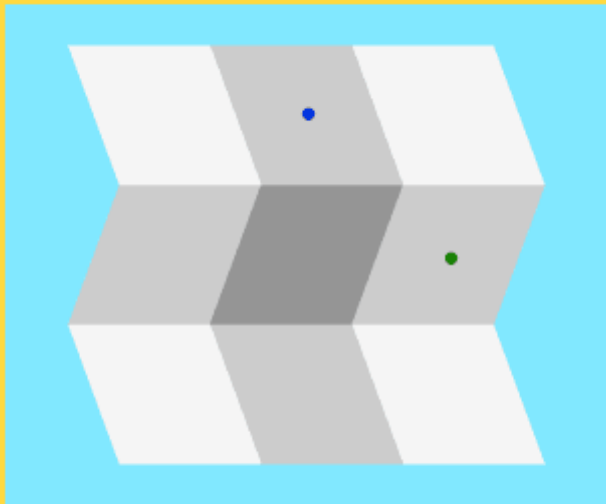
Automatické předpoklady našeho vnímání

<http://sites.sinauer.com/wolfe3e/chap5/illusionsF.htm>



5.5 Illusions of Lighting

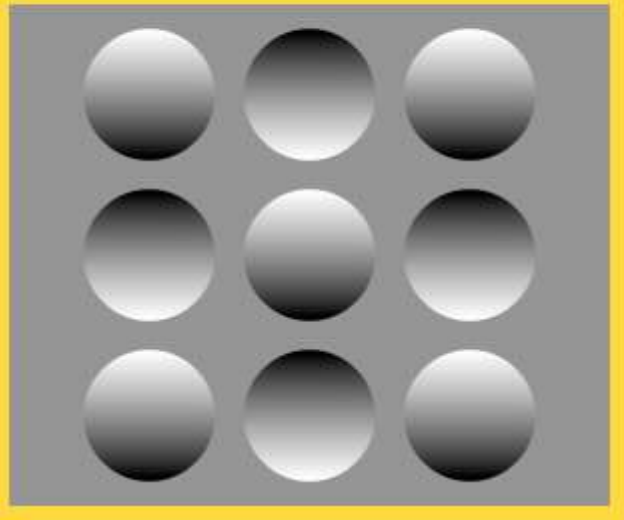
1



- Introduction
- Folded Card Illusion
- Bumps and Dimples Illusion
- Checkerboard Shadow Illusion

The visual system makes the assumption that there is a dark vertical stripe printed on the card, and that changes in luminance from left to right in the image are due to changes in the surface reflectance of the card. The visual system assumes that the changes in luminance are due to lighting shifts caused by the folds in the card, not to changes in surface reflectance. The middle section of the card probably appears to be in a shadow, which means that the light source is above the card. This is a reasonable assumption to make: the card clearly seems to be folded, and it is unlikely that the folds occur exactly at points where the surface reflectance changes abruptly.



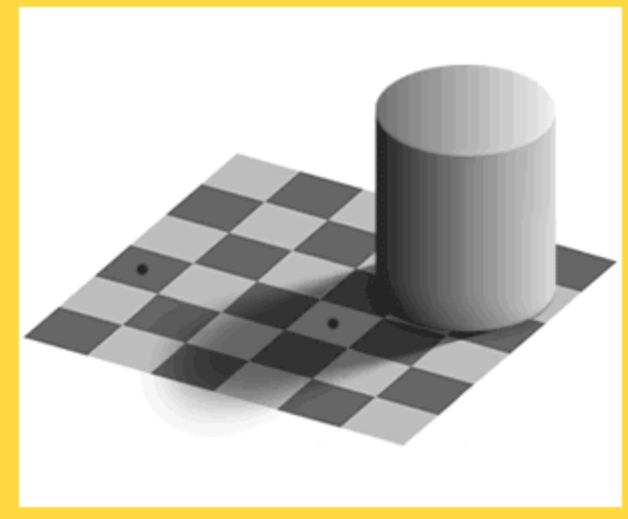


As with the folded card illusion, this illusion happens because your visual system cannot disregard its interpretation of the light sources in scenes when making judgments about the brightness of surfaces. The marked square near the center of the image falls in the shadow of the cylinder. Since we assume that shadows make surfaces less bright, we boost our estimate of the reflectance of this square accordingly. We also assume that the checkerboard pattern is regular, so that the lighter squares in the pattern are all the same lightness and the darker squares are all the same darkness. These assumptions lead us to strongly believe that the more central marked square in the shadow is lighter than the marked square on the edge of the board, so we are tricked into thinking that the former is brighter than the latter, too.

As the creator of this image, Edward Adelson at MIT, says, “The visual system is not very good at being a physical light meter, but that is not its purpose.” The assumptions used by our visual systems are designed to help us determine the qualities of surfaces in the world, not the light reflecting off the surfaces. It is the surfaces themselves that we want to know about, not the particular happen to be they are illuminated.

5.5 Illusions of Lighting

1



The visual system makes the assumption that there is a dark vertical stripe printed on the card, and that changes in luminance from left to right in the image are due to changes in the surface reflectance of the card. The visual system assumes that the changes in luminance are due to lighting shifts caused by the folds in the card, not to changes in surface reflectance. The middle section of the card probably appears to be in a shadow, which means that the light source is above the card. This is a reasonable assumption to make: the card clearly seems to be folded, and it is unlikely that the folds occur exactly at points where the surface reflectance changes abruptly.

Barevné vidění

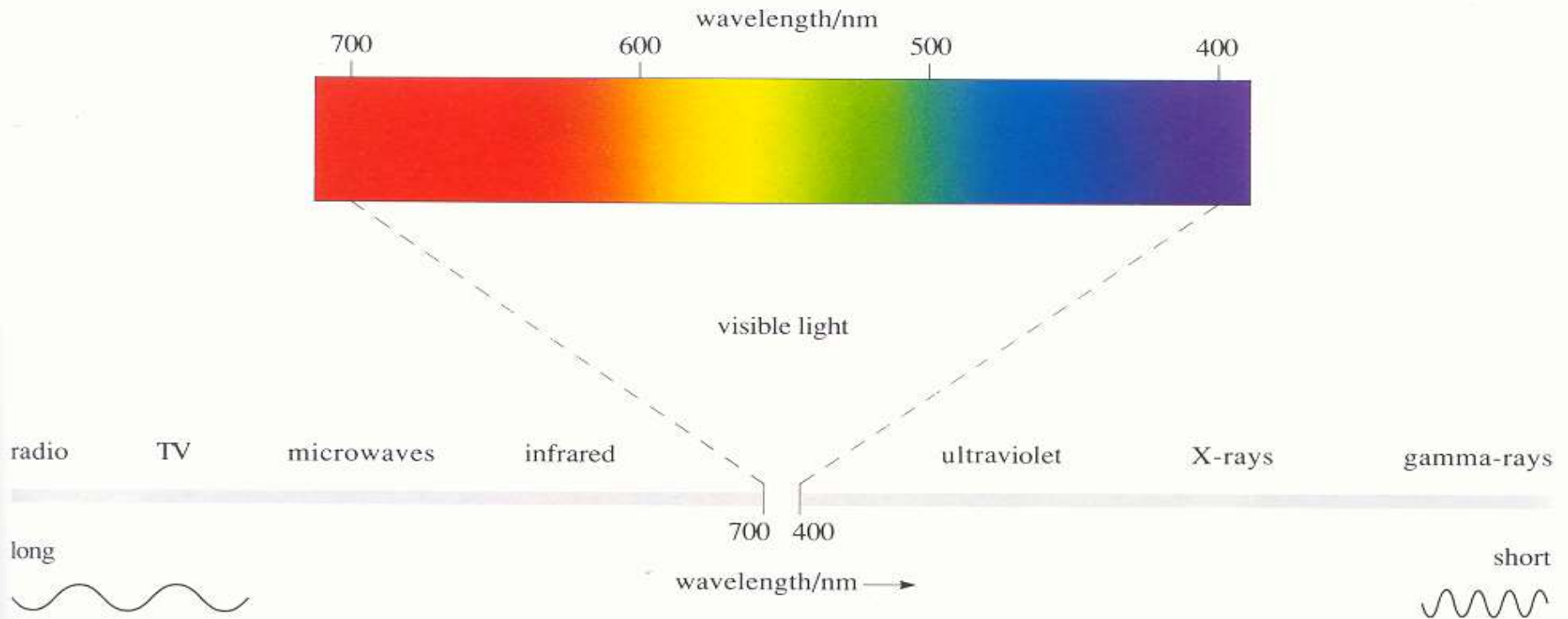
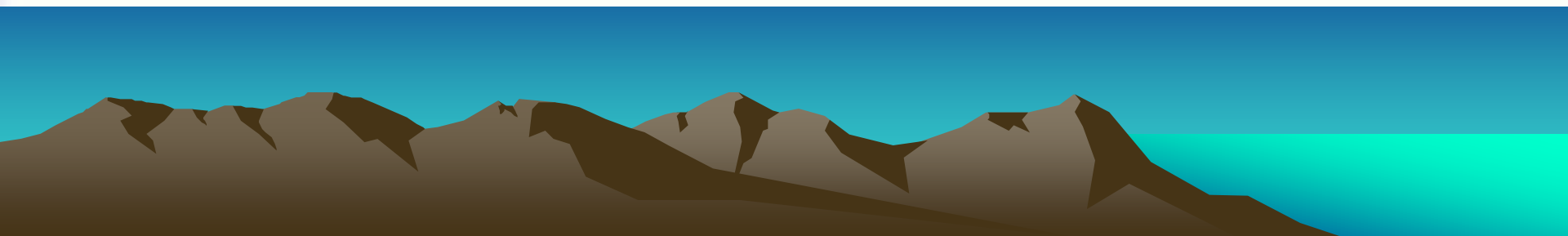


Plate 1 The electromagnetic spectrum. The visible spectrum is shown in colour.



Posunutá spektrální
citlivost = jiný pohled.

Neznamená nutně barevné
vidění

The ability to detect ultraviolet light



Human's view.



**Insect's view (simulated
through UV film.**

Barevné vidění:

Další kvalita zraku

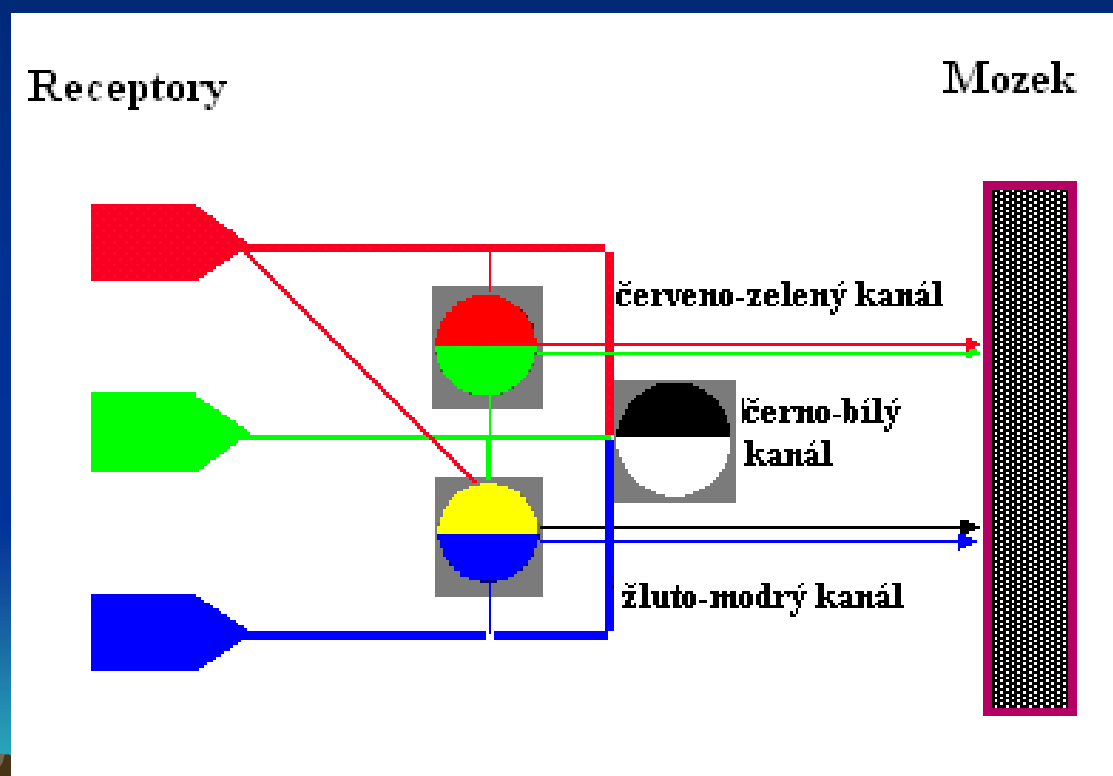
Jeden receptor barvu nerozezná, je potřeba nejméně dva druhy barevně selektivních fotoreceptorů



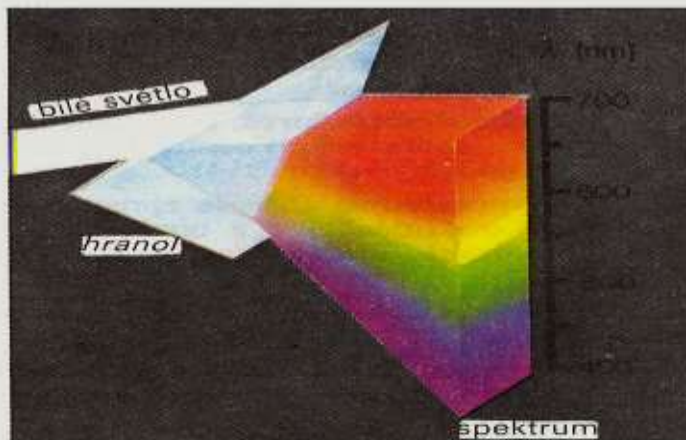
Rozlišujeme: tón, sytost, jas

Trichromatické teorie, Young-Helmholtz Oponentní kódování, Hering

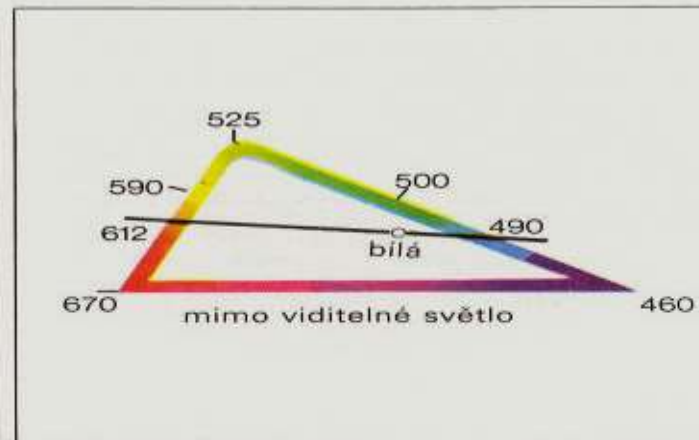
Why trade one three-dimensional color space (red, green, blue) for another three-dimensional color space (R/G, B/Y, BI/Wh)?



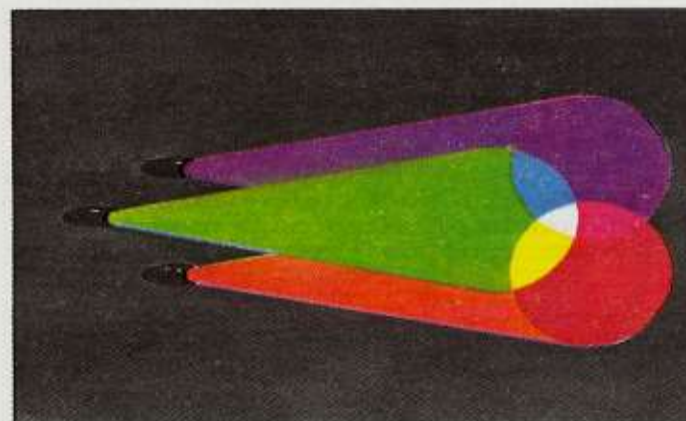
Trichromatické skládání



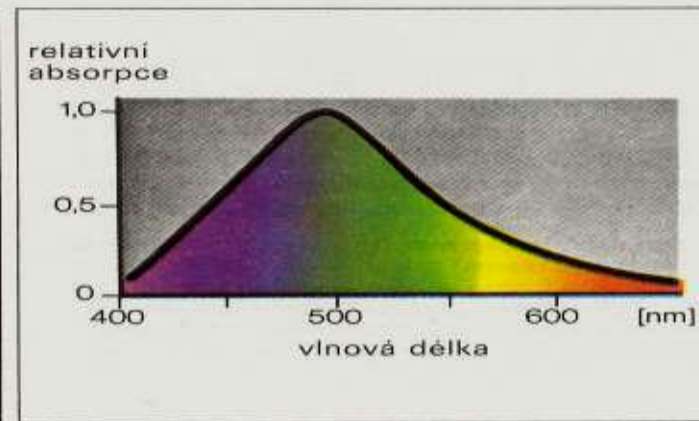
A. Složení slunečního světla



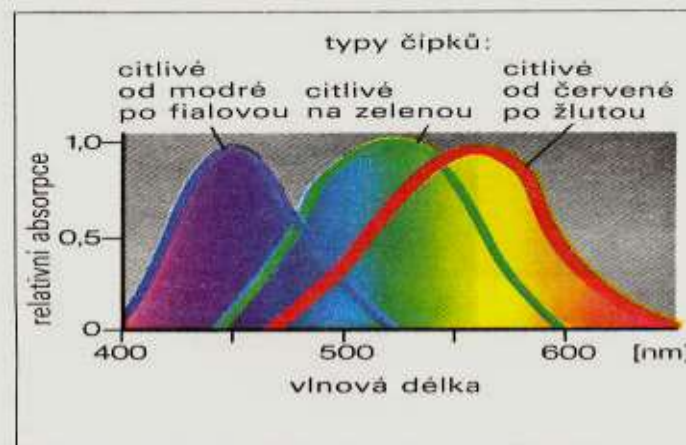
B. Barevný trojúhelník (podle Kriesa)



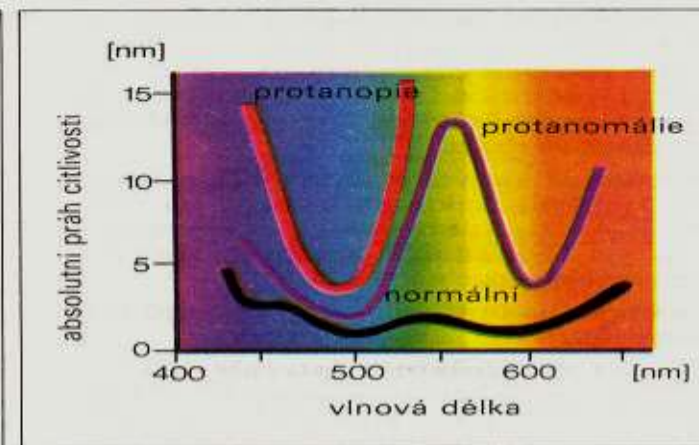
C. Aditivní míšení barev



D. Absorpce světla rodopsinem



E. Absorpce světla třemi typy čípků



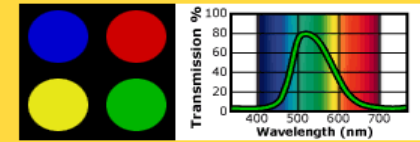
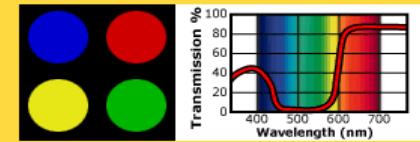
F. Práh citlivosti pro vlnové délky

Oponentní kódování, Hering
Neexistuje červenozelená nebo modrožlutá

<http://sites.sinauer.com/wolfe3e/chap5/mixingF.htm>

5.3 Color Mixing

Filter Color #1

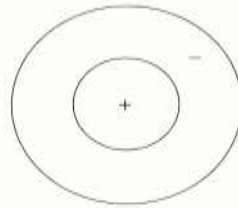


Filter Color #2

Barevná oponence

Neexistuje červenozelená
nebo modrožlutá

luminance sensitive
retinal ganglion cell



double opponent
cortical cell

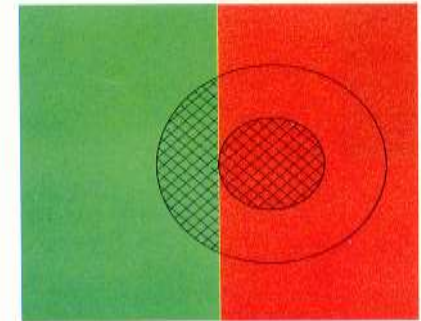
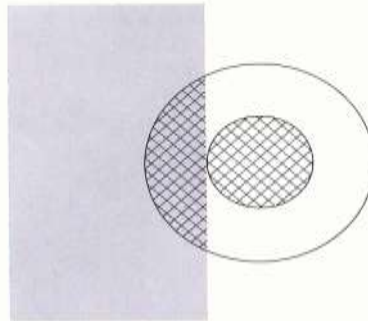
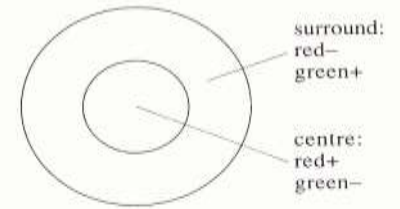


Plate 4 Double opponent receptive fields.

Simultánní barevný kontrast
– zbarvení šedého
obdélníčku

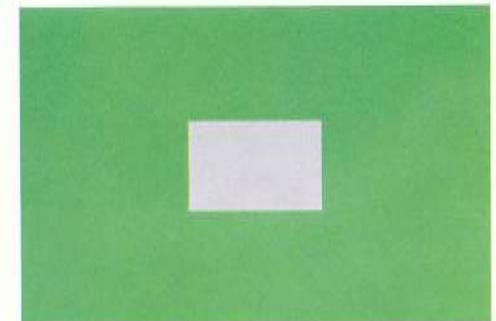
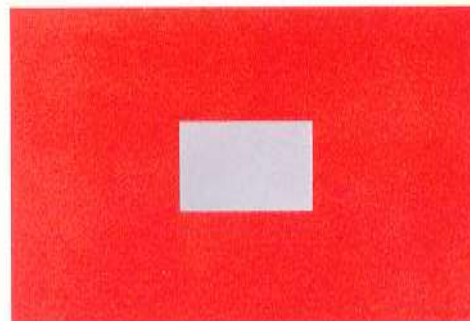
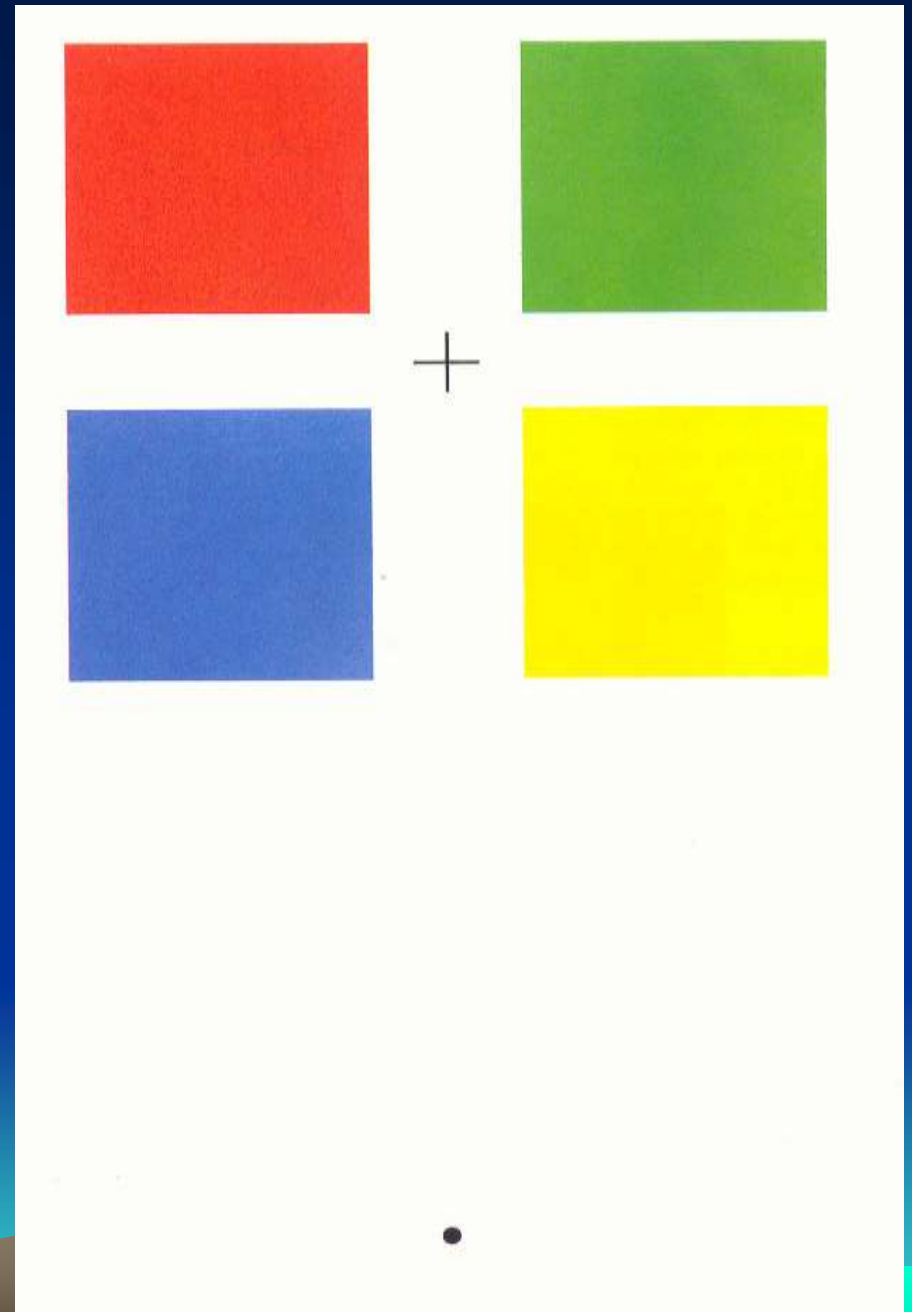
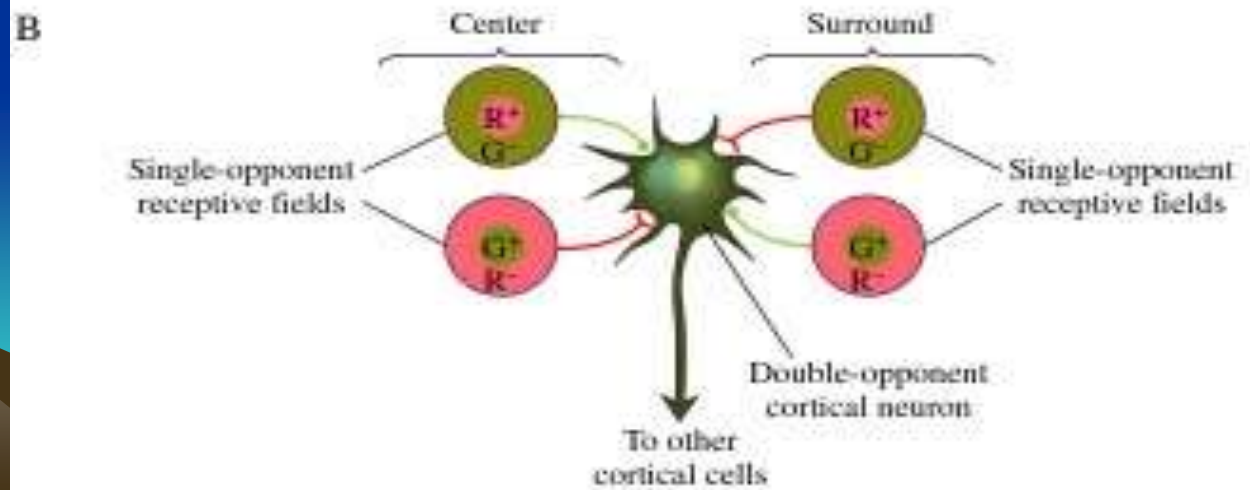
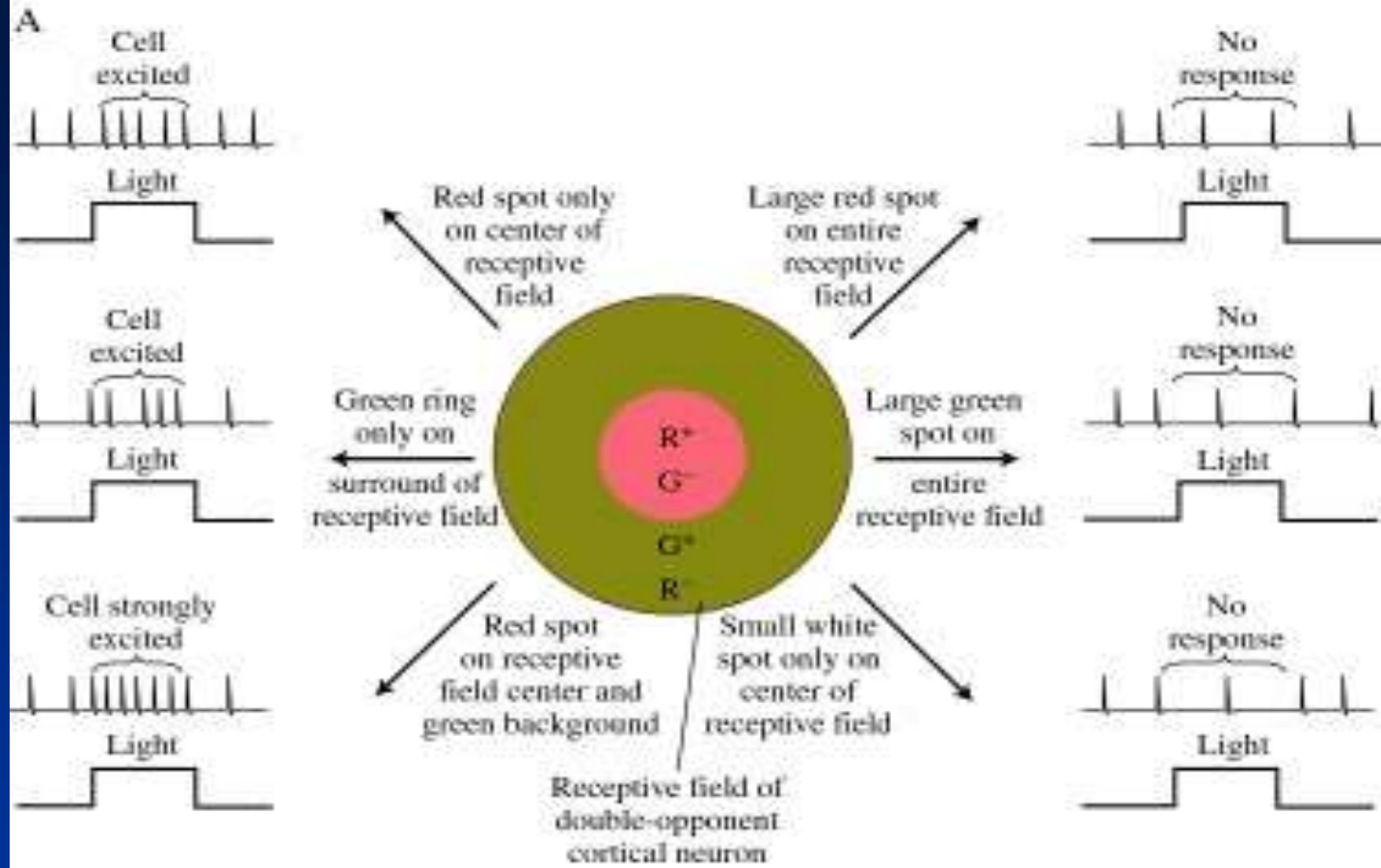


Plate 5 Simultaneous colour contrast.

Negative afterimages
Selektivní adaptace a
barevně
selektivní buňky

<http://sites.sinauer.com/wolfe/3e/chap5/afterimagesF.htm>





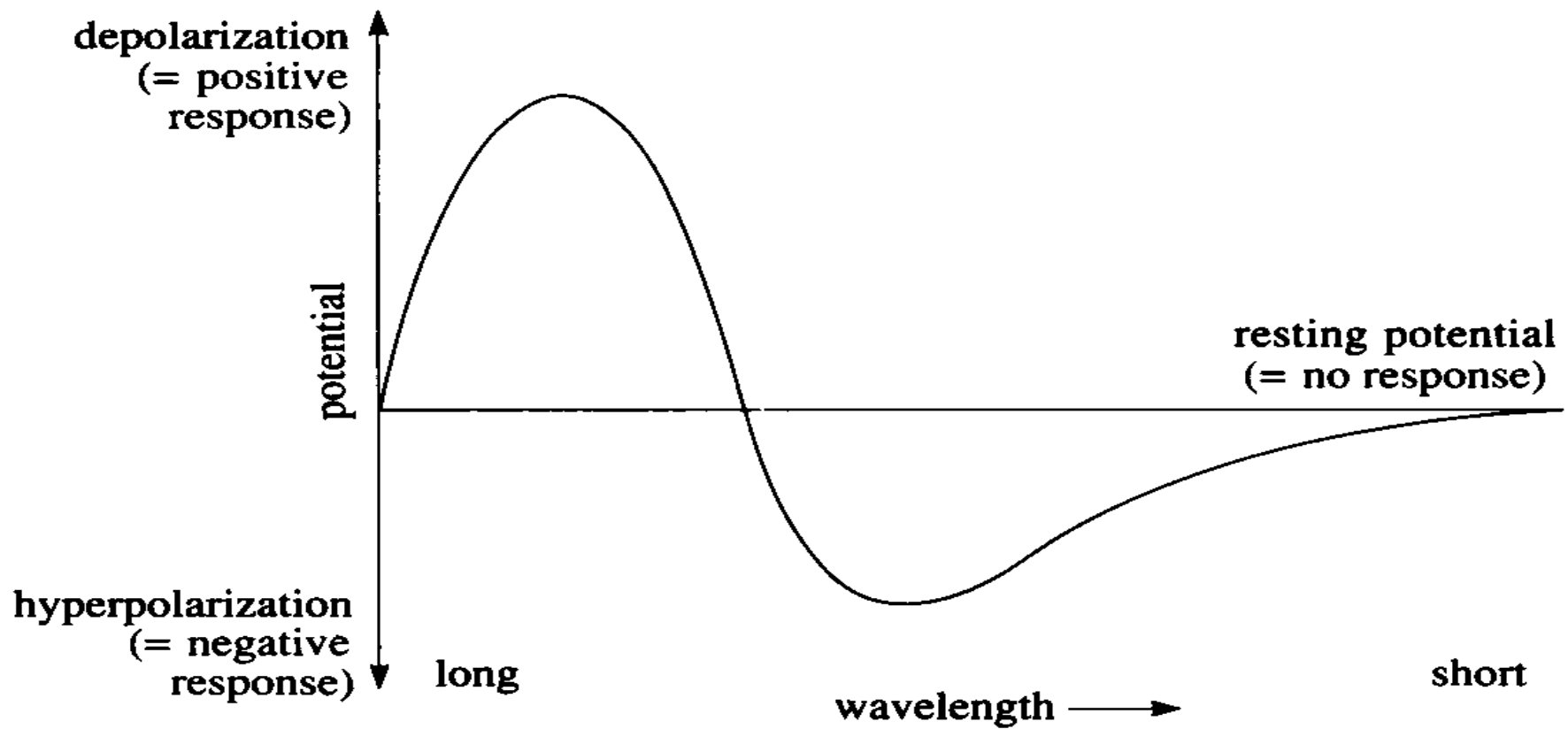


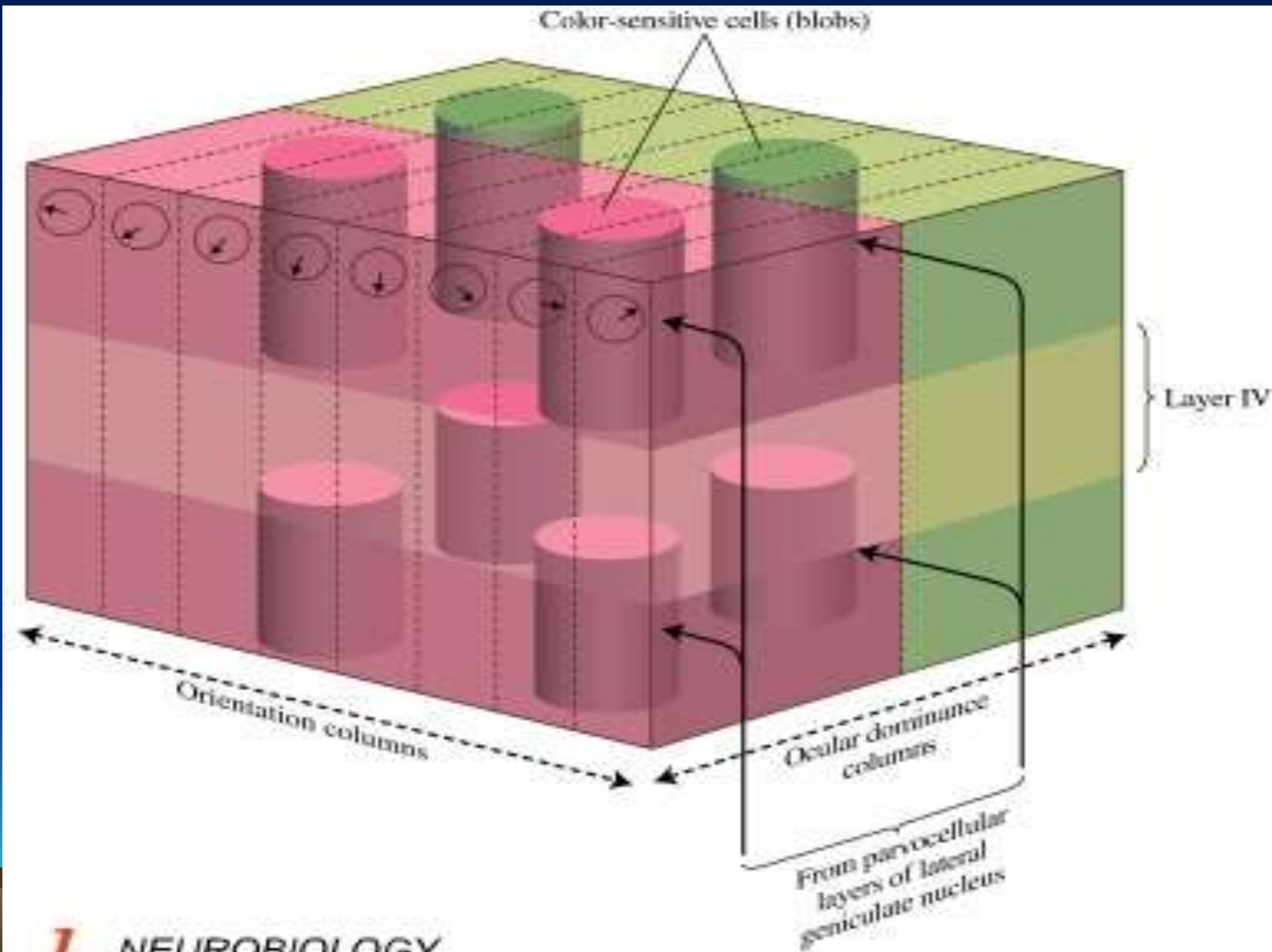
Figure 4.35 Response of a typical colour opponent bipolar cell.

Dopad zeleného světla na periferii receptivního pole buněk s dvojitou oponencí s červeným excitačním centrem a zelenou excitační periferií vyvolá jejich aktivaci. Stejnou odezvu ale vyvolá dopad červeného světla na centrum tohoto r.p. Výsledkem stimulace periferie zeleným světlem tedy je současný vznik načervenalého vjemu v té části zorného prostoru, která odpovídá centru receptivního pole.

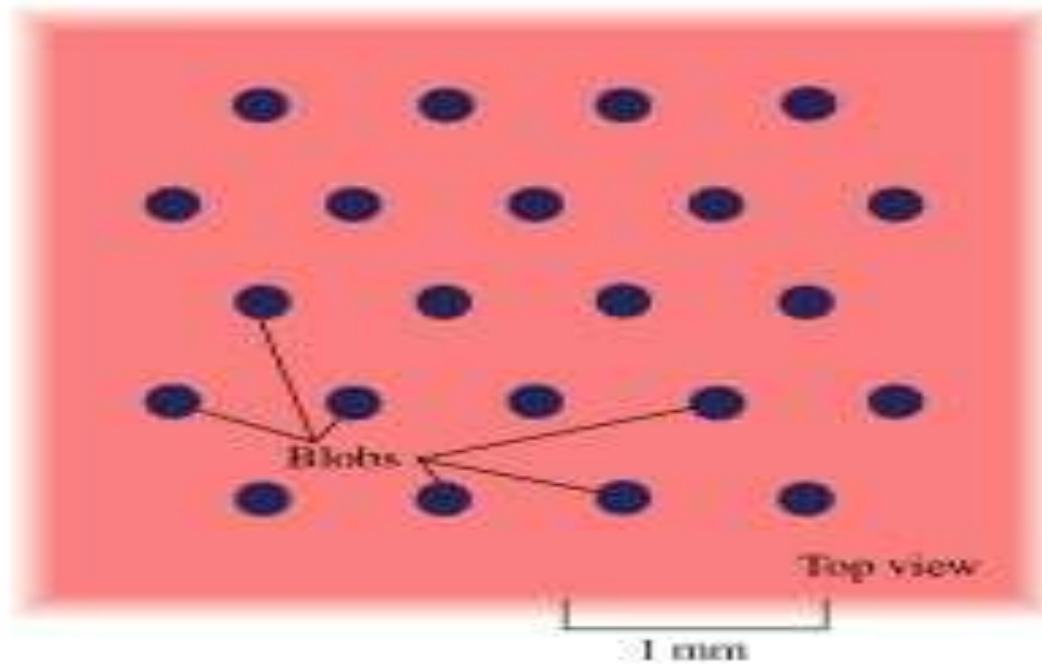
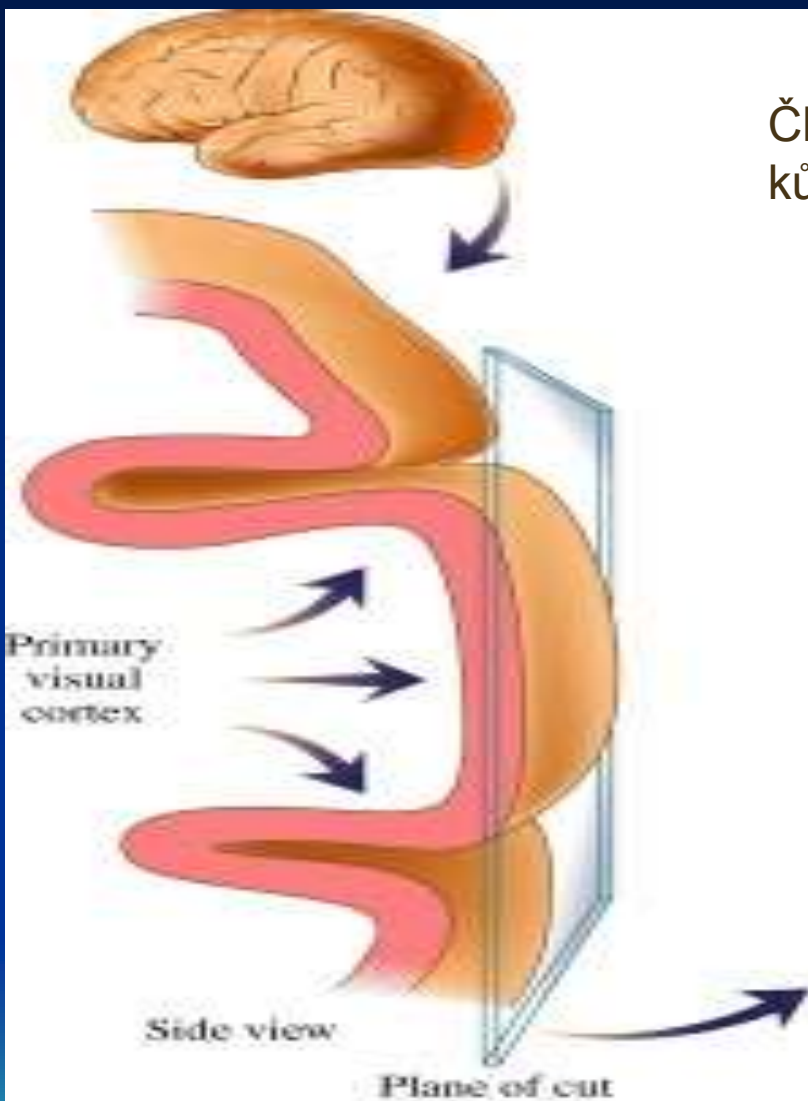
Neurony s dvojitou oponencí jsou v primární z.k. seskupeny do kolíčkovitých struktur kolmých k povrchu kůry, které jsou roztroušeny mezi sloupci orientační specifity. Označují se jako barevné sloupce (blobs).

I buňky s dvojitou oponencí projikují do sekundární zr. kůry, na buňky, které můžeme hierarchicky rozdělit na jednoduché, komplexní a hyperkomplexní.





Členění primární zrakové kůry – barevné sloupce (blobs)



3.5 Hypercolumns



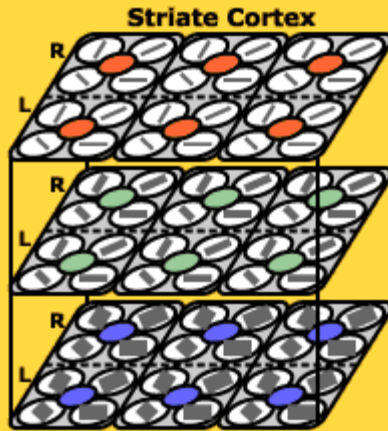
Bar Control

Bar Shown In
Left Right

Orientation

Width

Color

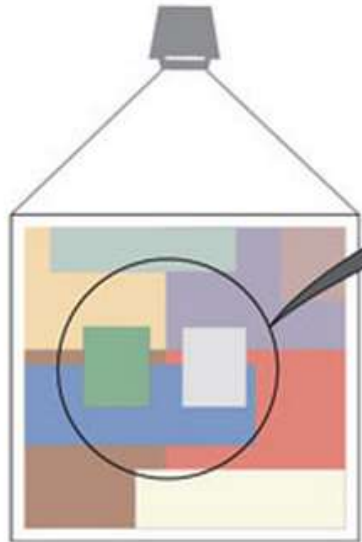


<http://sites.sinauer.com/wolfe3e/chap3/hypercolumnsF.htm>

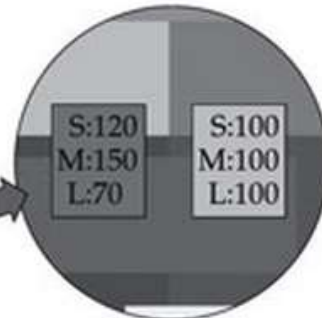


- Barevná stálost: ačkoliv osvětlené různými zdroji světla, barvy předmětů se jeví stále

1. Take a collection of color patches under a "white" light.



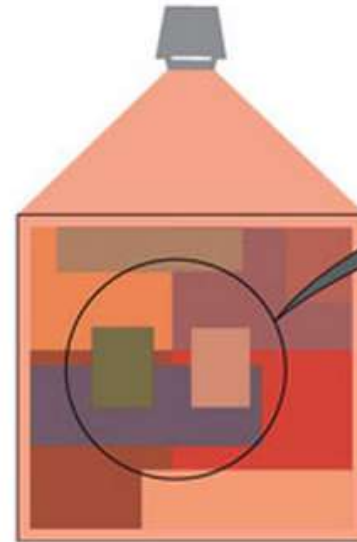
2. The "gray" patch excites S-, M-, and L-cones equally.



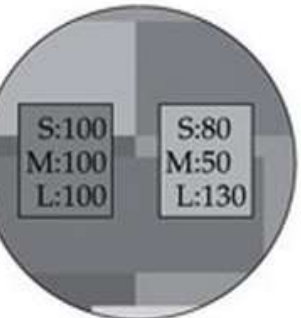
3. The gray patch looks gray, and the green patch looks green.



4. Change the illuminant to a reddish light.



5. Now, what was the "green" patch excites S-, M-, and L-cones equally.



6. The gray patch still looks gray, and the green patch still looks green.



Figure 1

Užitečná deformace: většinou jsou kontrasty mezi povrchy ne mezi zdroji světla.

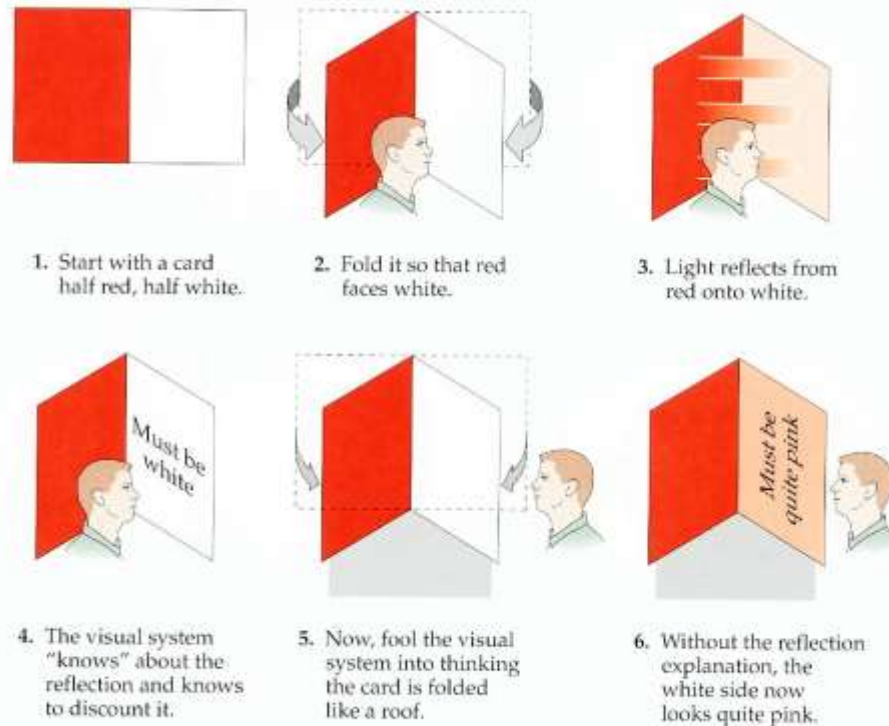
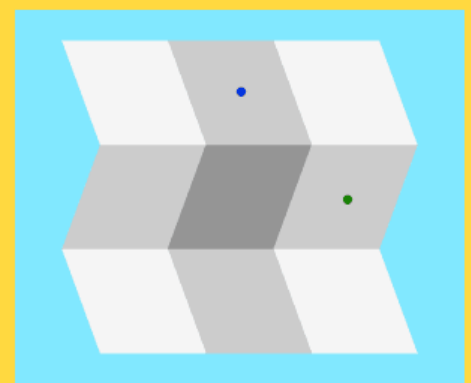


FIGURE 5.21 The experiment of Bloj, Kersten, and Hurlbert (1999) shows us how assumptions about the physics of the world influence the psychophysics of color perception.

Předpoklady a srovnávání deformují skutečný vjem.

5.5 Illusions of Lighting 1



- Introduction
- Folded Card Illusion
- Bumps and Dimples Illusion
- Checkerboard Shadow Illusion

The shadows in Figure 1 (left) produce exactly the same outputs as their backgrounds in the R/G and B/Y “channels” of the opponent process system. The orange square, for example, activates R+G⁻ and Y+B⁻ cells (because orange can be described as reddish yellow). Since the shadow of the small rectangle is the same hue, it also activates these same opponent process cells. The difference between the shadow and its background will only be registered in the output of the Bl/Wh opponent process: the Wh+Bl⁻ cells will respond more strongly to the brighter orange square than to the darker shadow. In Figure 1 (right), on the other hand, all five shapes are different hues, so **all five will produce different outputs in the R/G and B/Y channels.**

Although we almost never notice them, shadows—brightness differences—are scattered throughout almost every visual scene (if you look around carefully now, you will probably see them everywhere). But shadows are rarely of interest to us, whereas hue boundaries *are* important. They divide the visual scene into component surfaces which higher-level vision can then combine into objects. **Thus, recoding light wavelengths into dimensions that de-emphasize shadows and highlight surfaces is a very good thing.**

**K čemu je dobrá oponence?
Rozeznání objektů od jejich stínů
3 vs 5**

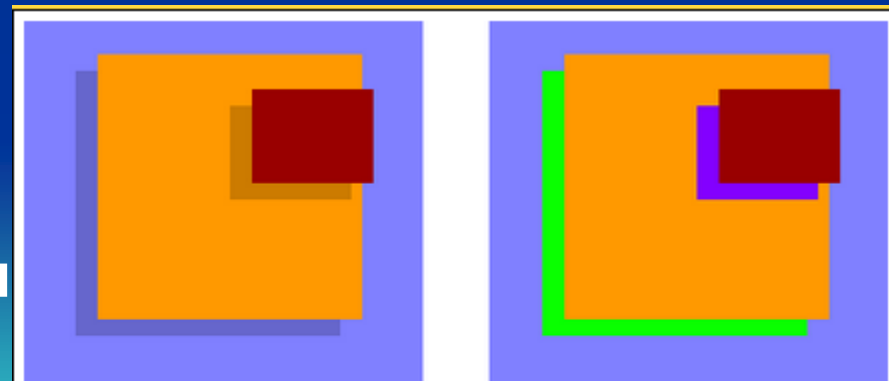
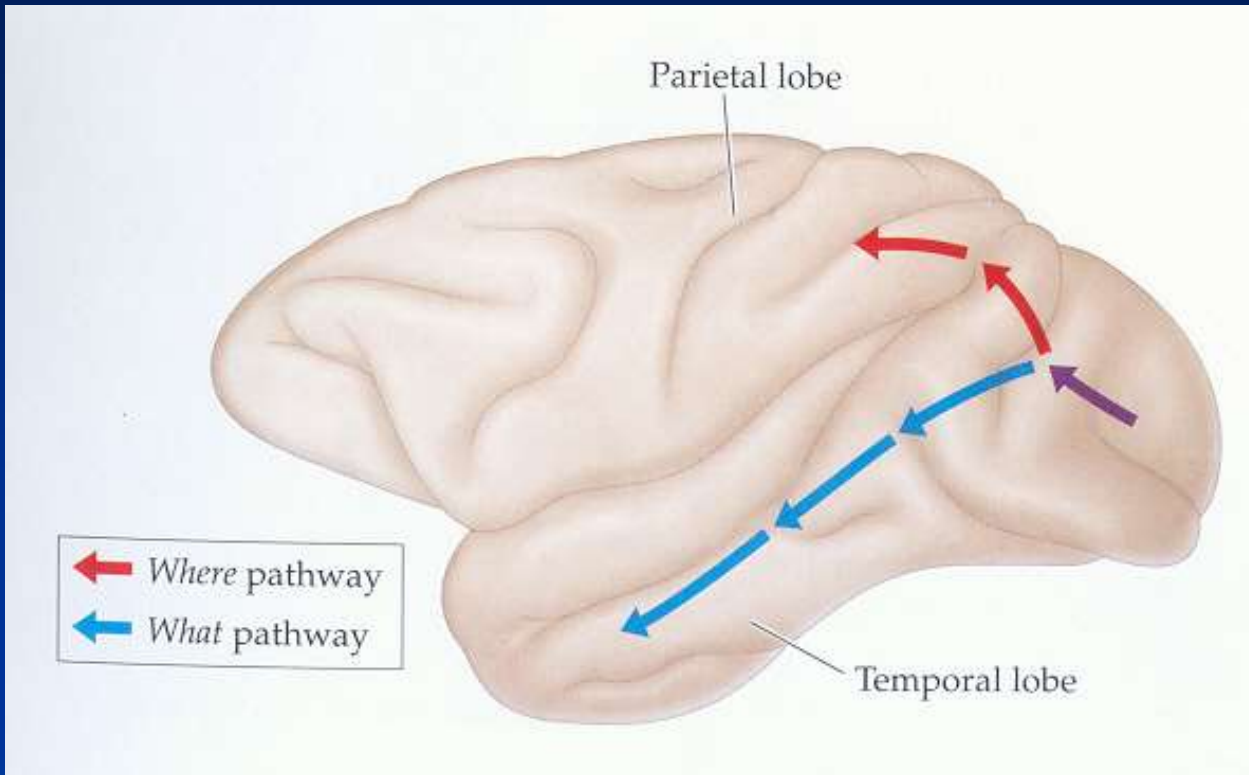


Figure 1 The image on the left is perceived as a red rectangle above an orange square on a blue background. The figure on the right is perceived as five different surfaces. These inferences are easily made on the basis of opponent-process cell outputs.

Vnímání pohybu



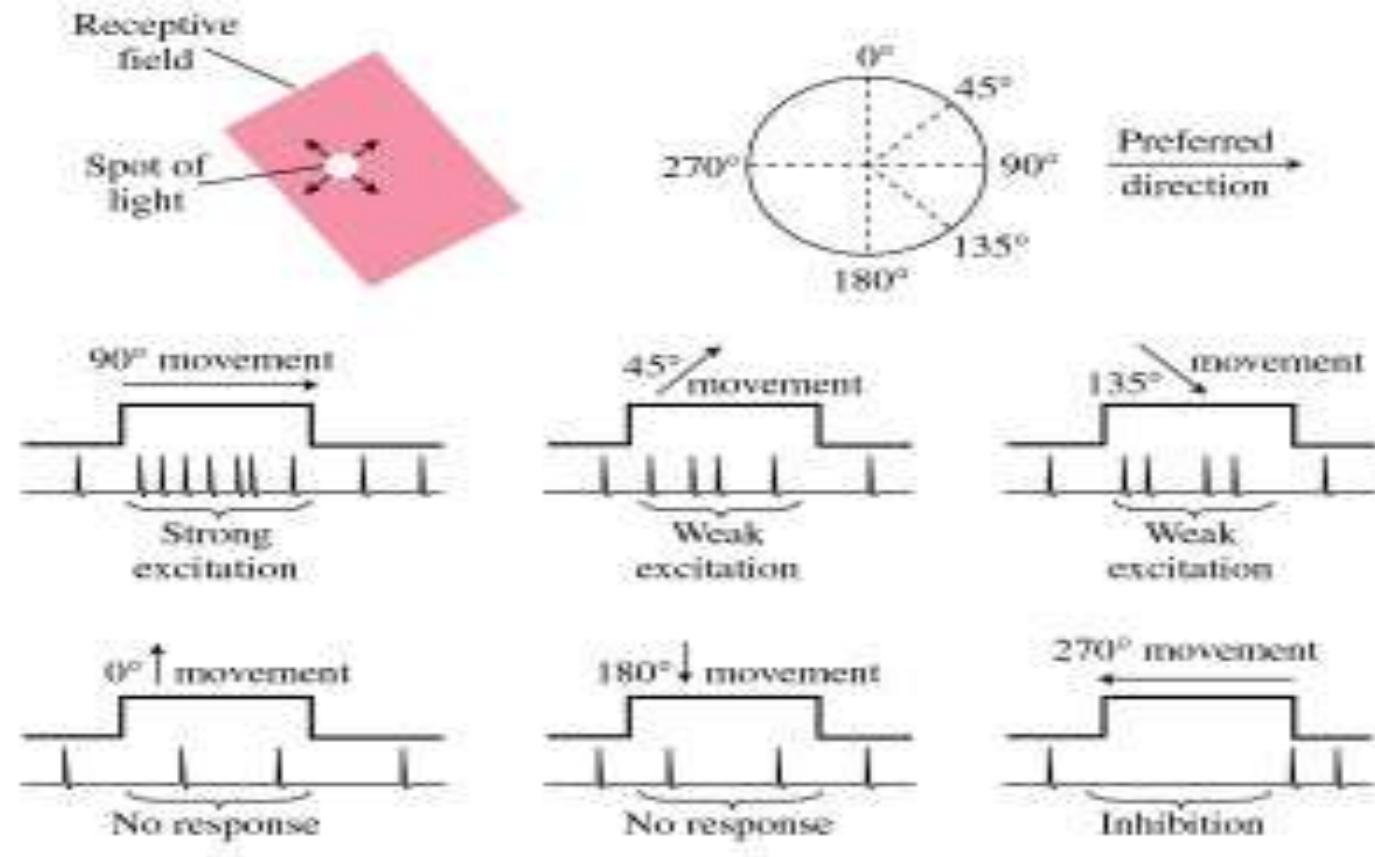
Jak je pohyb důležitý - <http://sites.sinauer.com/wolfe3e/chap8/startF.htm>

[Zdánlivé pohyby](#)

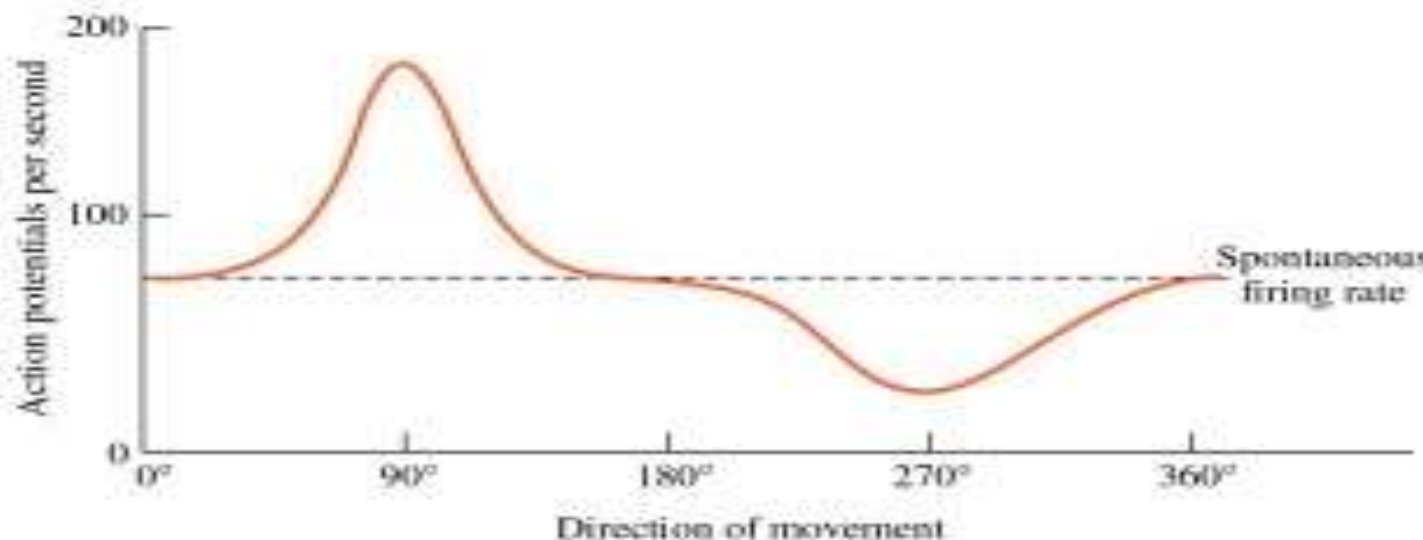
<http://sites.sinauer.com/wolfe3e/chap4/occlusionF.htm>

Specialista na směr

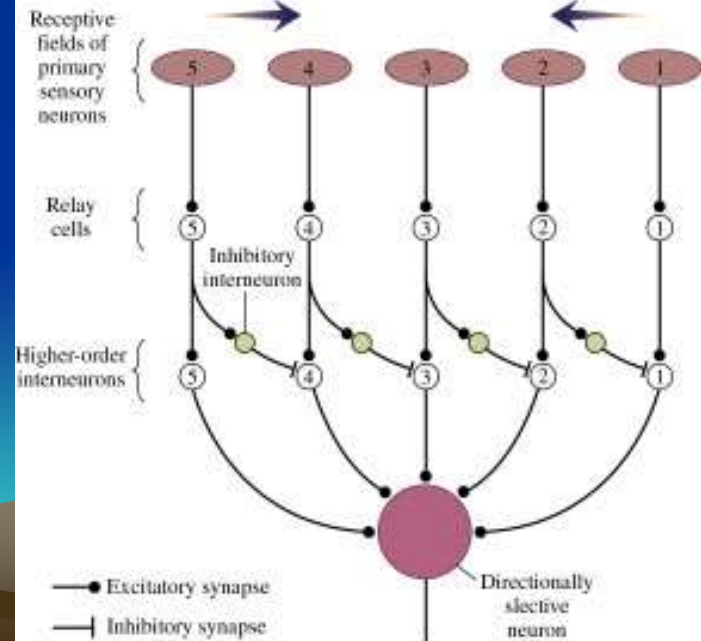
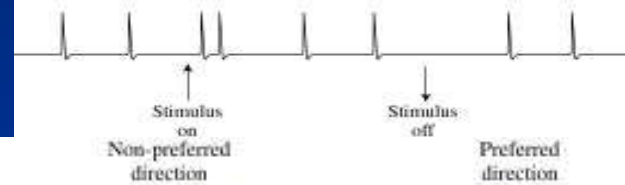
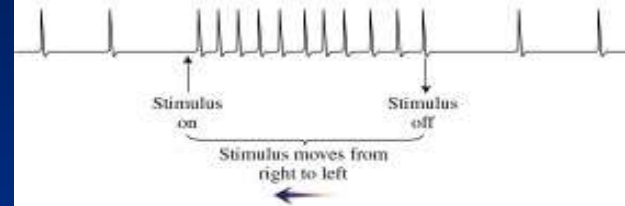
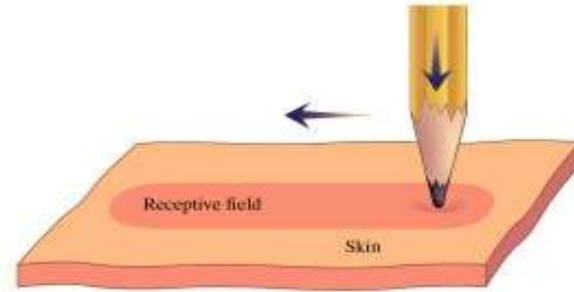
A



B

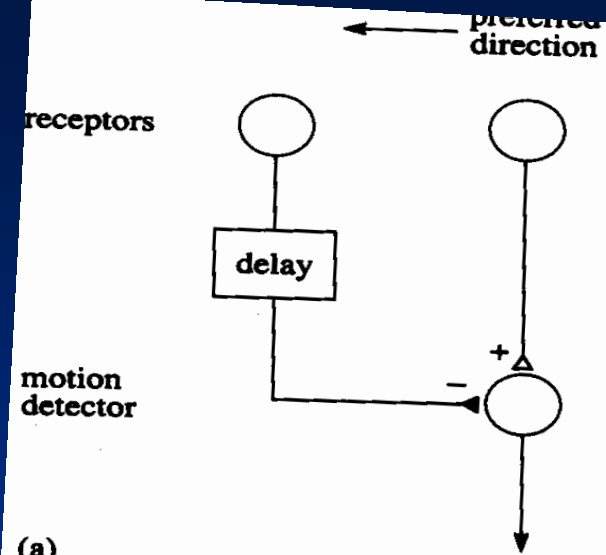


Detektor směru pohybu



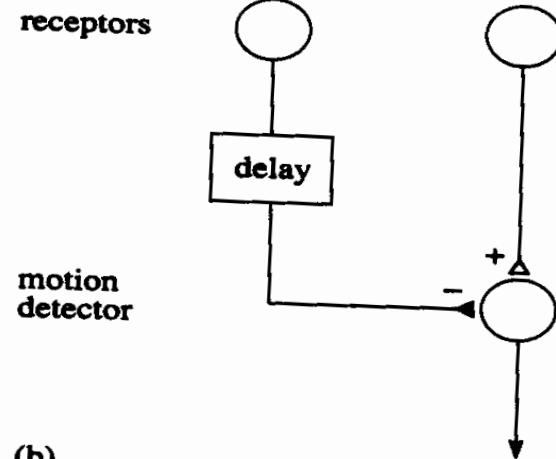
Detektor rychlosti

- <http://sites.sinauer.com/wolfe3e/chap8/motdetectorF.htm>



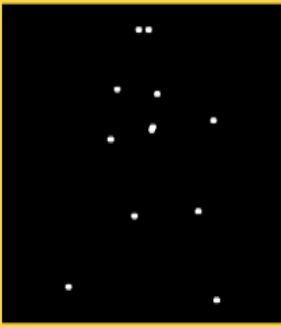
(a)

null direction →



(b)

Figure 4.36 Principles of a simple retinal motion detector. See text for explanation.



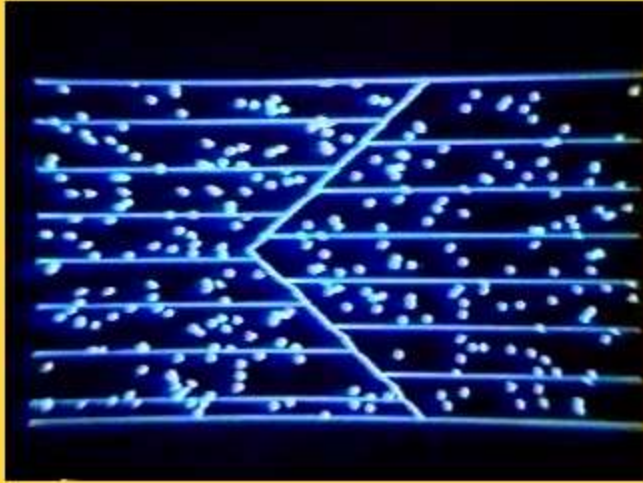
<http://sites.sinauer.com/wolfe3e/chap8/mottypesF.htm>

[Image 1](#) and [Image 2](#) of this part of the activity may at first look like random collections of white dots. But when we put a series of these images together and play them as a movie, as in [Image 3](#), you should get the immediate and compelling perception of a human being walking to the right.

Researchers have found that a great deal of information can be gathered about the activities and even identities of people featured in “dot walker” displays such as this. For example, it has been shown that observers can usually identify the gender of the walker, possibly by calculating the width of his or her shoulders and hips (males typically have broader shoulders and narrower hips than females).

Interestingly, biological motion displays are much easier to identify when the character in the movie is performing a familiar action. [Image 4](#) shows the frames of the movie in [Image 3](#) reversed, so that the person is walking backwards. Although the motion in this movie does appear vaguely familiar, it seems less “natural” than the forward walker in [Image 3](#).

8.2 Types of Motion

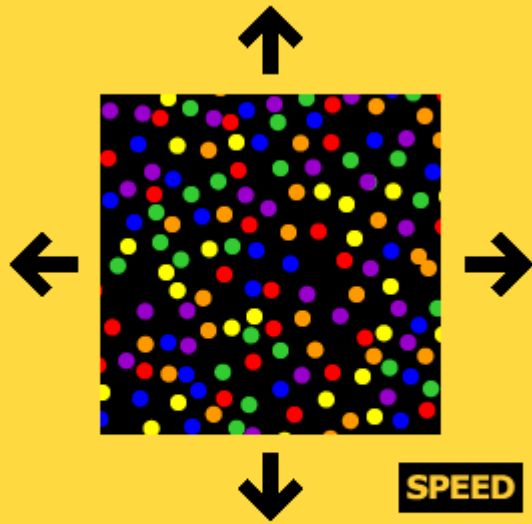


Play Stop

<http://sites.sinauer.com/wolfe3e/chap8/mottypesF.htm>

Okraj je vždy „nahore“

8.4 Motion Aftereffects



- Introduction
- Why Does the MAE Occur?
- Interocular Transfer
- More Fun with the MAE

Únava analyzátoru pohybu

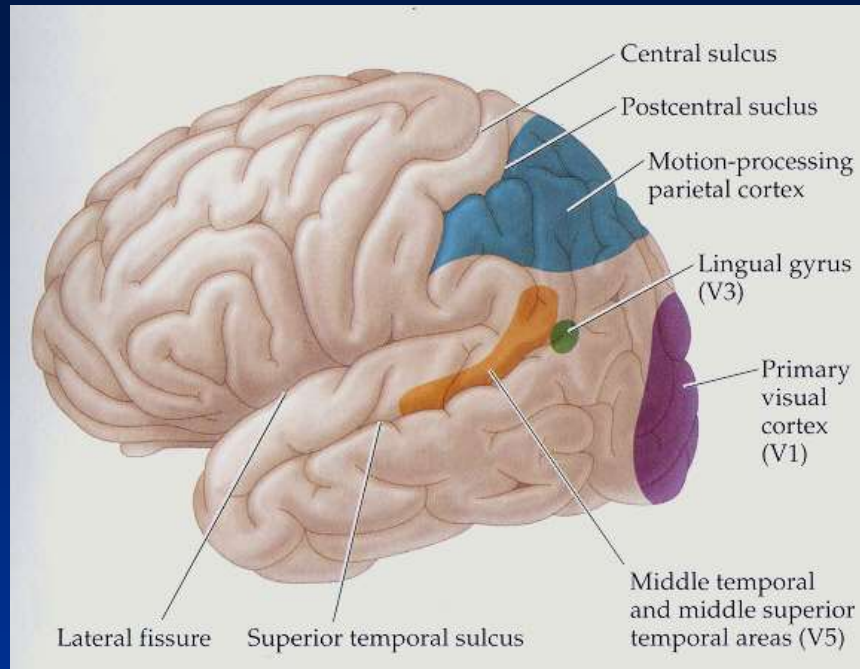
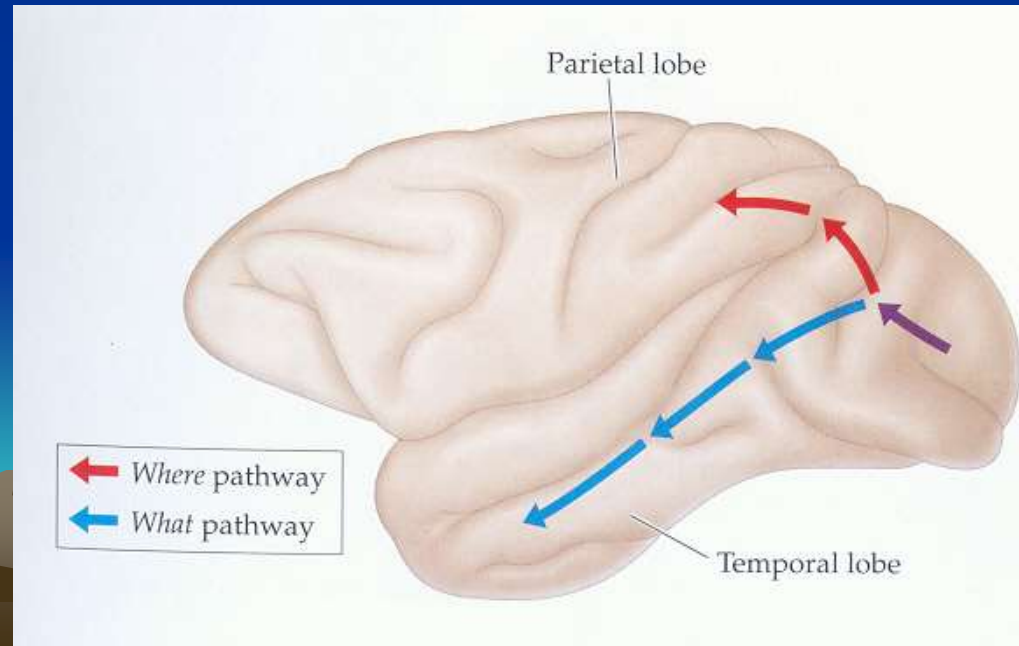
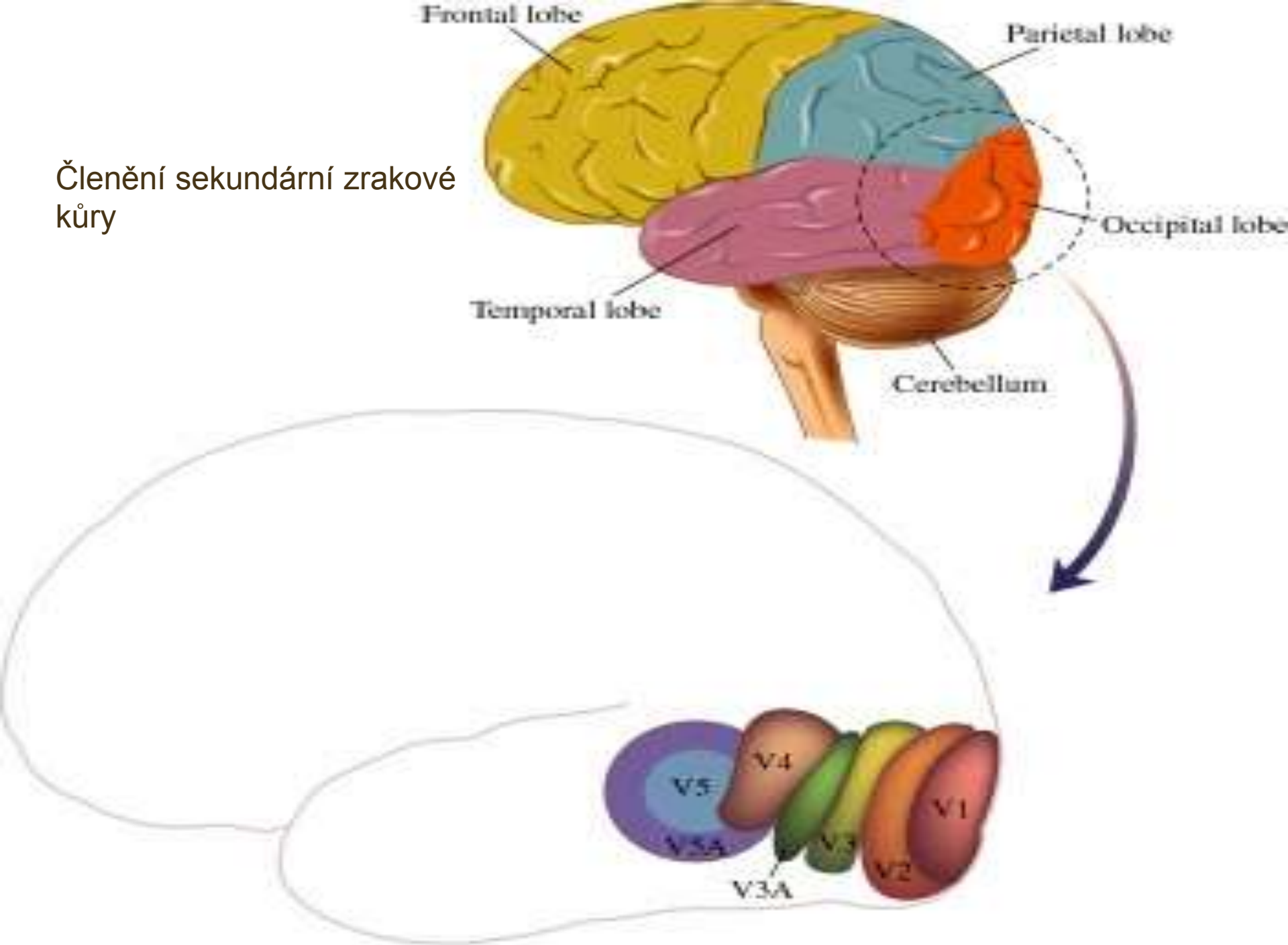
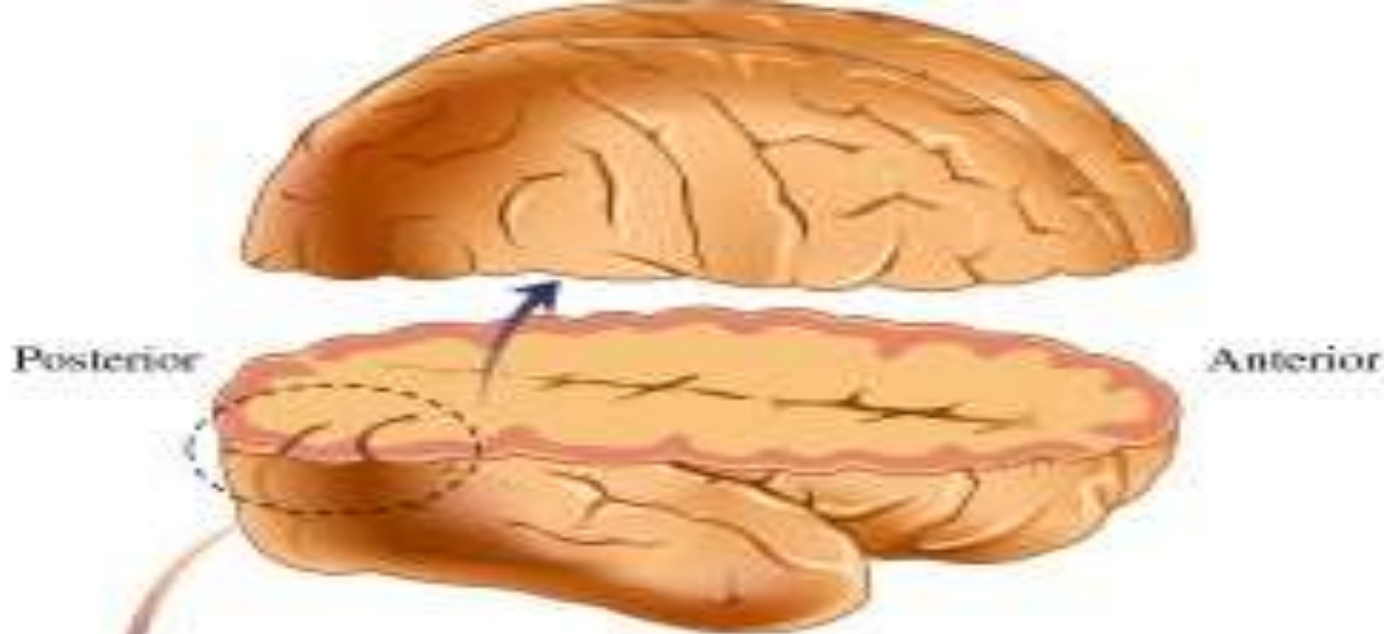


FIGURE 7.7 The middle temporal lobe and other regions of the cortex involved in motion perception.

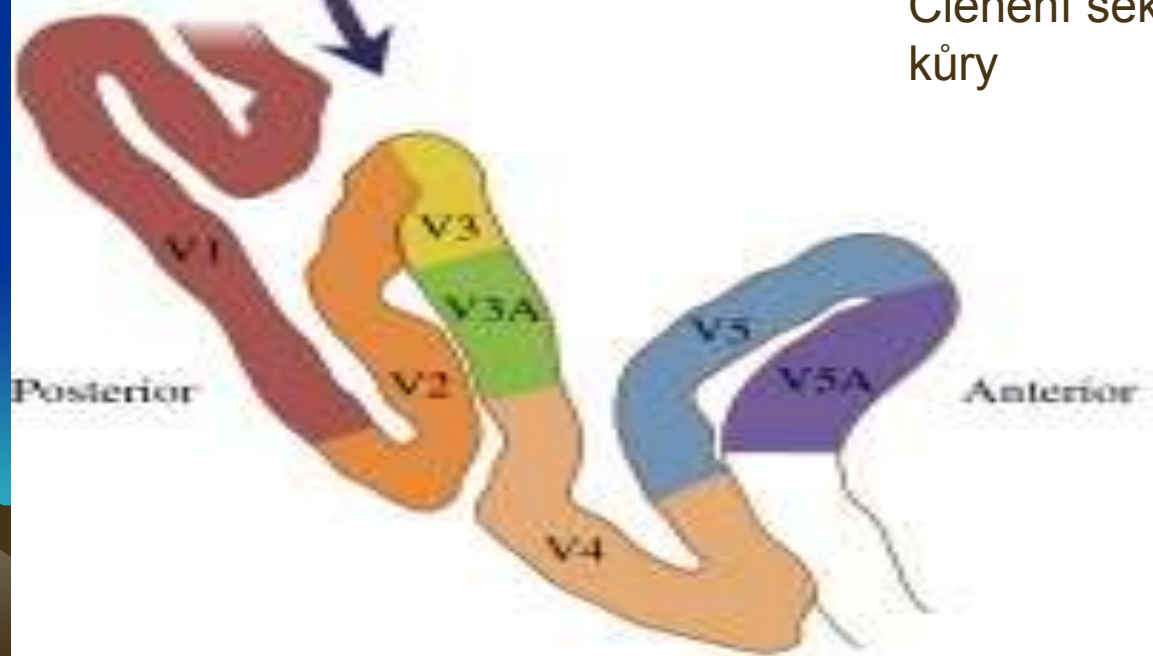


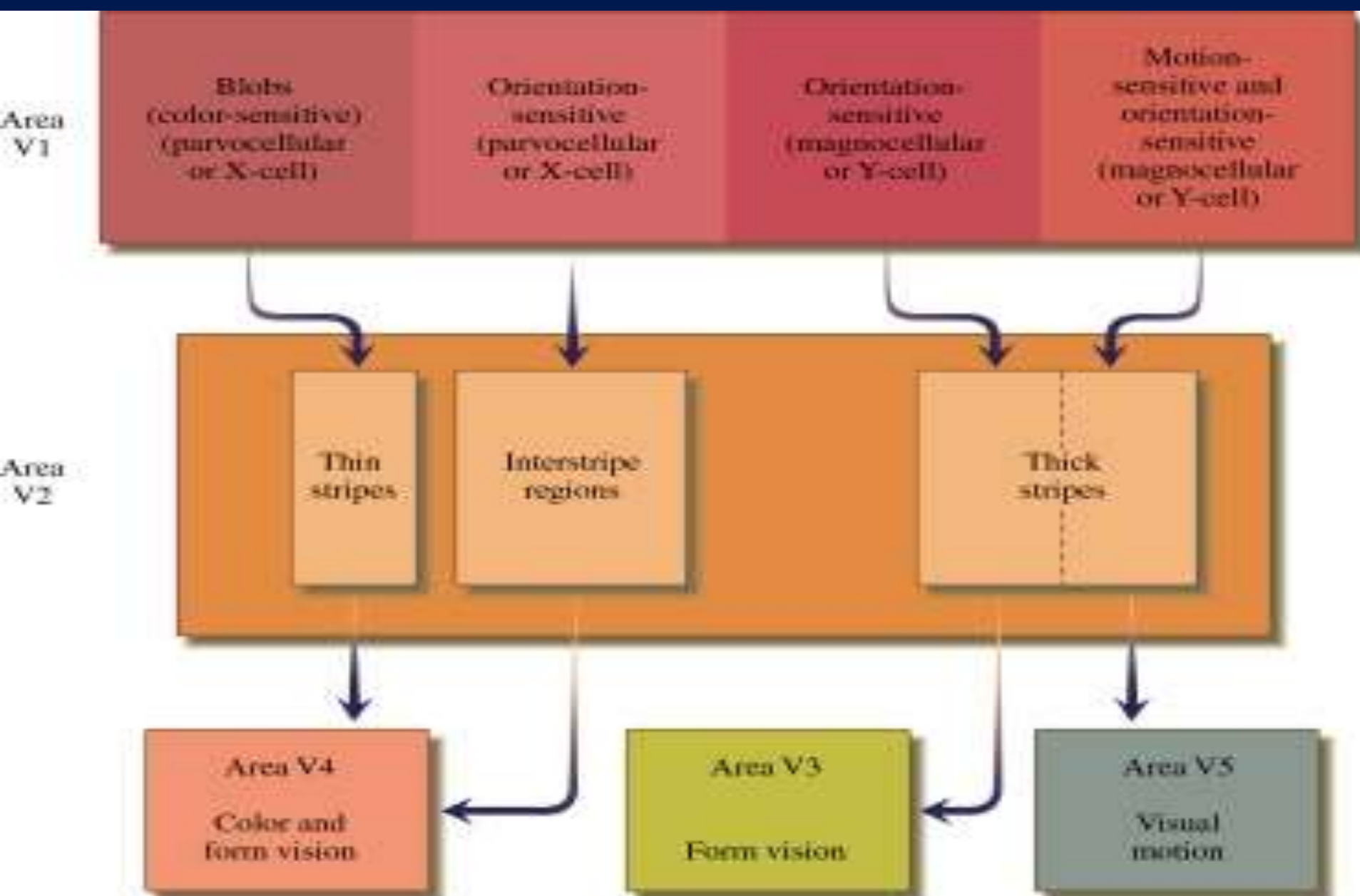
Členění sekundární zrakové kůry





Členění sekundární zrakové kůry

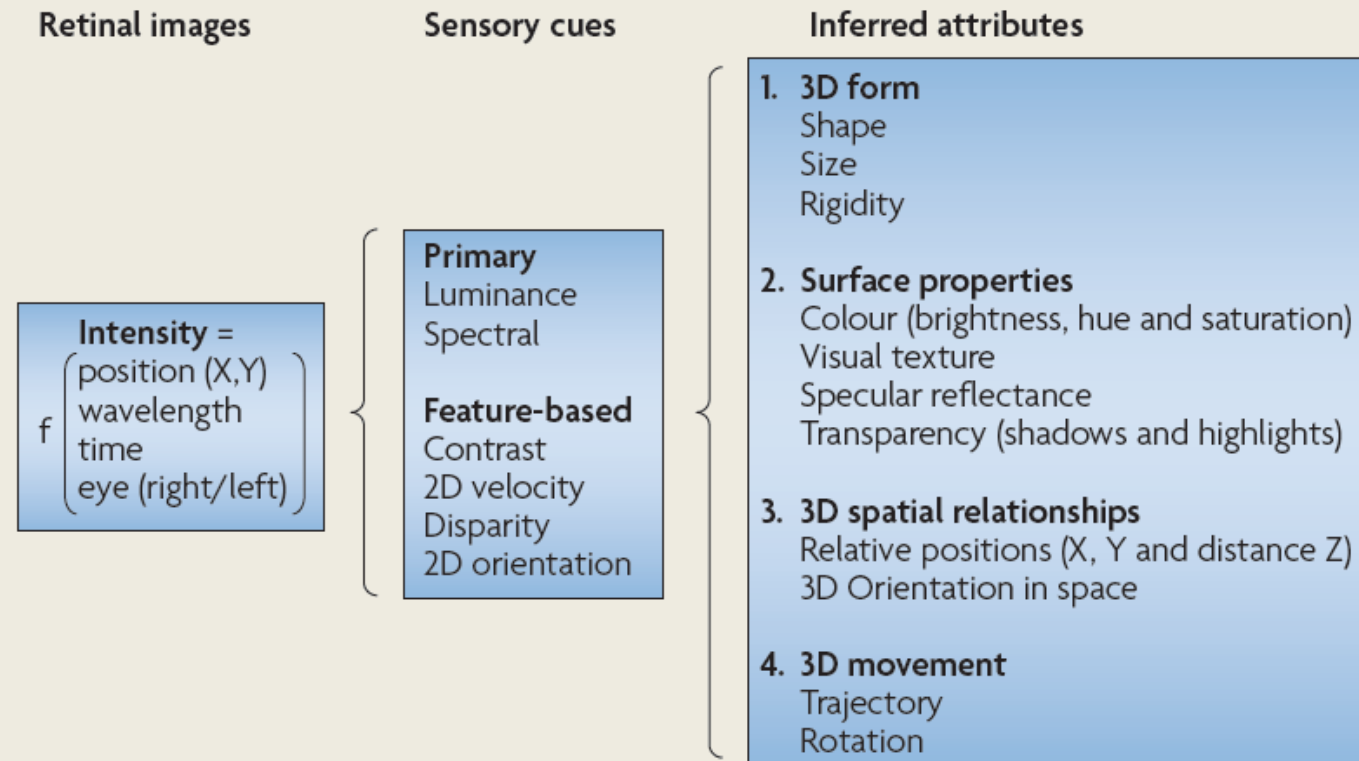




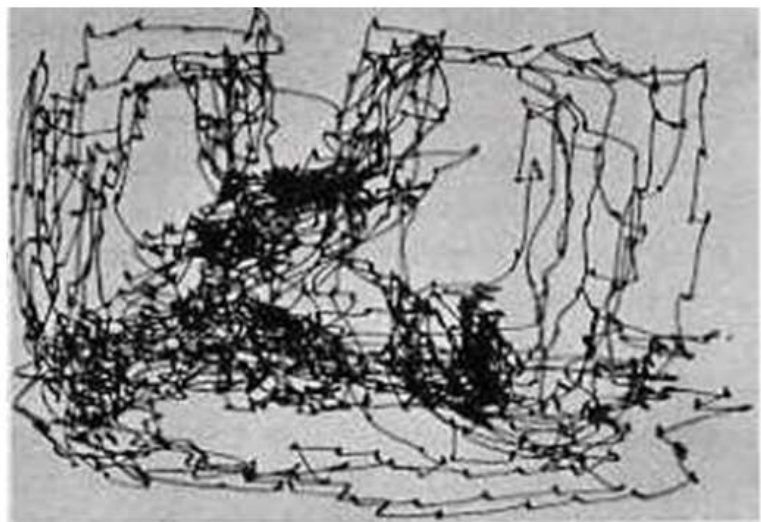
Paralelní zpracování ve zrakové dráze

Box 1 | From retinal input to cortical processing and perception

Visual input is initially encoded in the retina as a two-dimensional (2D) distribution of light intensity, expressed as a function of position, wavelength and time in each of the two eyes. This retinal image is transferred to the visual cortex, where sensory cues and, later, inferred attributes are eventually computed (see the figure). Parallel processing strategies are used from the outset to overcome the constraints of individual ganglion cells' limited bandwidth and the anatomical bottleneck of the optic nerve. Figure is modified, with permission, from REF. 9 © (1988) Elsevier.



Pohyby očí – sakkadické pohyby



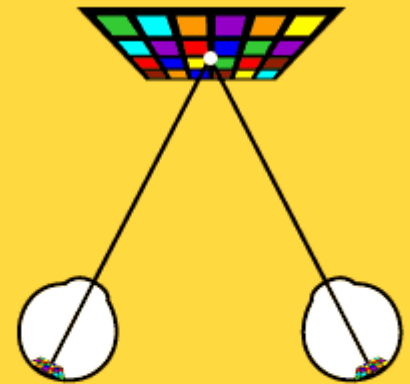
A picture is viewed by an observer while we monitor eye position and hence direction of gaze. The eyes jump, come to rest momentarily (producing a small dot on the record), then jump to a new locus of interest. It seems difficult to jump to a void - a place lacking abrupt luminance changes.



Úkol rozeznat pohyb na sítnici způsobený pohybem očí od vlastních pohybů předmětů

- http://sites.sinauer.com/wolfe3e/chap8/eye_movementsF.htm

8.5 Eye Movements



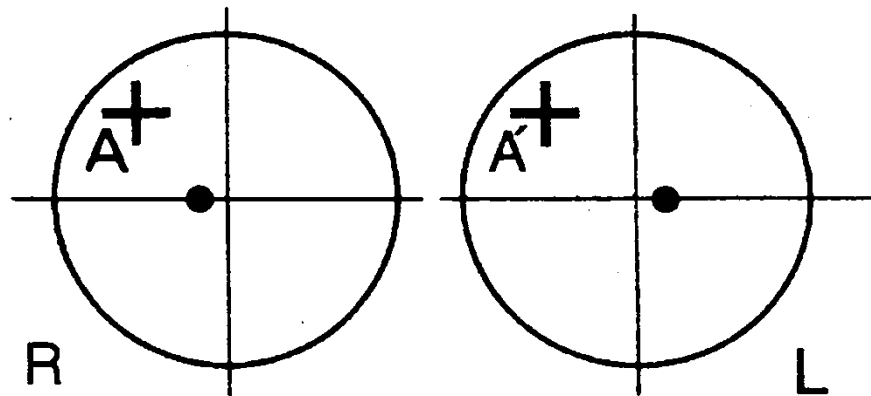
- Introduction
- Voluntary Eye Movements
- Object Movements
- Top Views
- Distinguishing Eye from Object Movements
- Involuntary Eye Movements

Vnímání prostoru

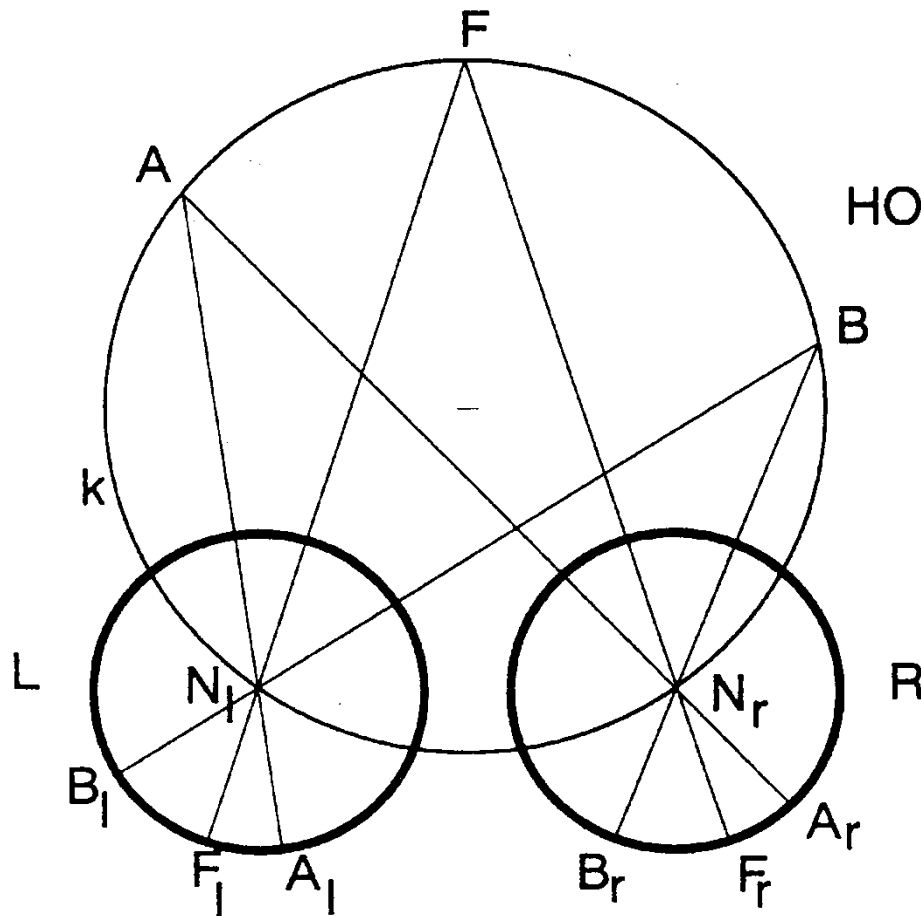


OBR. 57A

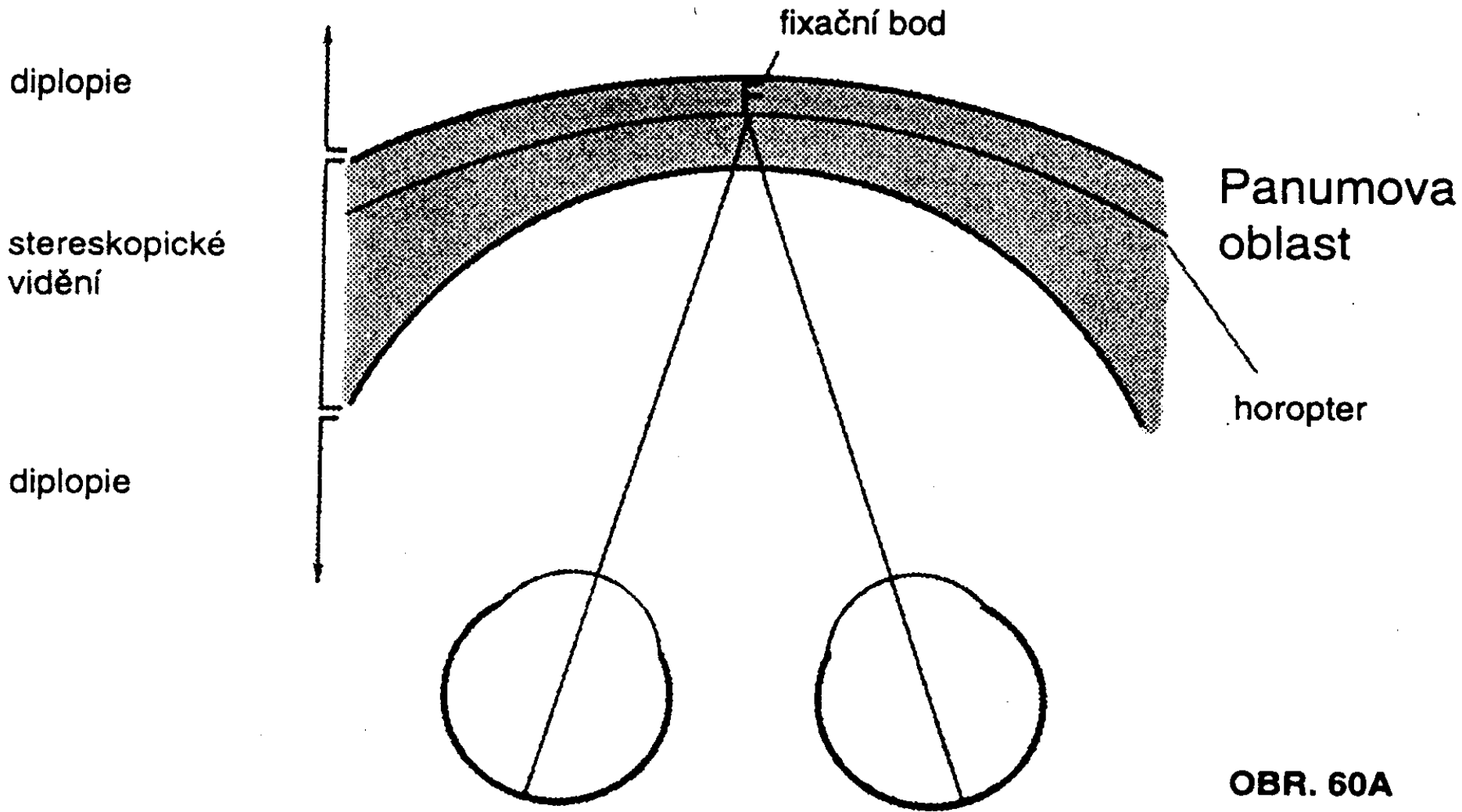
Sítnice pravého (R) a levého (L) oka. Body A a A' značí polohu identických míst. Černá skvrna znázorňuje centrální jamku.



OBR. 58A



HOROPTEROVÁ
KRUŽNICE



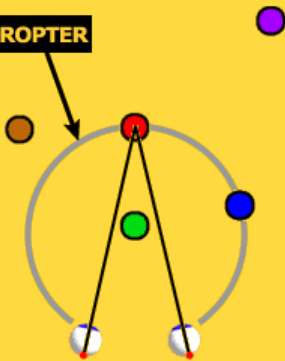
OBR. 60A

<http://sites.sinauer.com/wolfe3e/chap6/disparityF.htm>



6.2 Binocular Disparity

HOROPTER



Shifting Focus

The figures at left now show what happens if the disembodied eyeballs' gaze is shifted, so that they are focused on the green cylinder rather than the red cylinder. (Click any of the cylinders or the link below to toggle back and forth between focusing on the green and red cylinders.) As you can see, disparity information shifts as gaze direction is shifted (although the changes are made much more dramatic than normal in this scene because the objects are all placed so close to the viewer).

In particular, note that images of the blue cylinder, which fall on corresponding retinal points when the eyeballs are focused on the red cylinder, fall on disparate retinal points when gaze is shifted to the green cylinder. Indeed, the whole horopter shifts along with the shift in focus. This illustrates the fact that binocular disparity provides only relative depth information: The disparities of the various objects in the environment tell us how far away objects are relative to the horopter, but we cannot tell exactly how far away the horopter is, and furthermore the horopter changes every time we look at a new object!

This demonstration should also impress upon you the incredible amount of computation that the visual system must carry out to achieve stereopsis. Every time we shift our gaze, the system instantaneously recalculates the disparity information from every object in view, updating our sense of three-dimensional space.

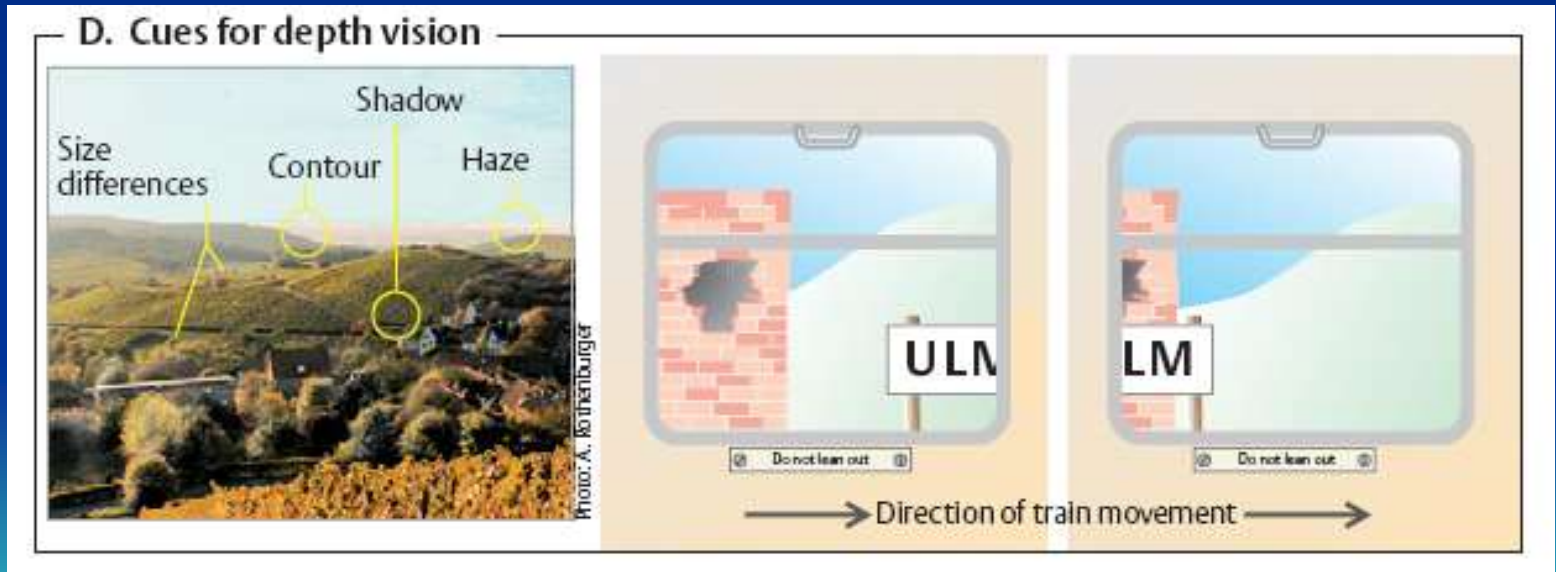
- **Toggle focus**
- **Do another disparity demonstration**
- **Return to the activity introduction**

<http://sites.sinauer.com/wolfe3e/chap6/disparityF.htm>

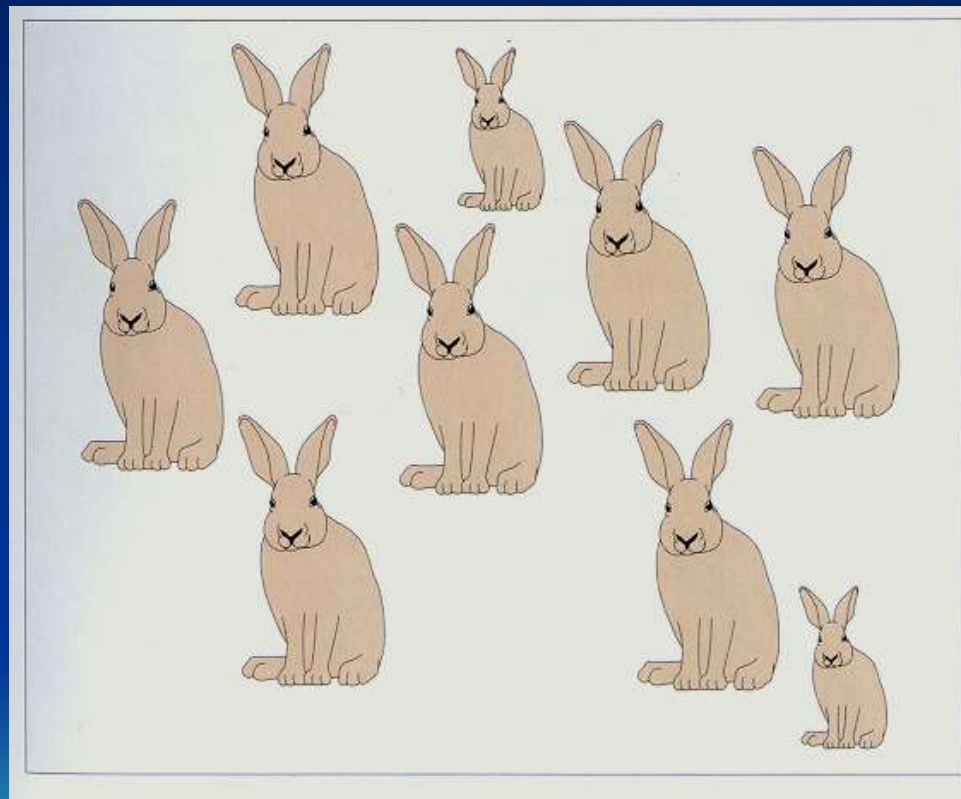
- Binokulární neurony – fúze obrazů
- Sloupečky retinální disparace



Další metody konstrukce prostoru.



Jsou stejně malí, ale nevypadají...



Interpretace viděného rozeznávání objektů



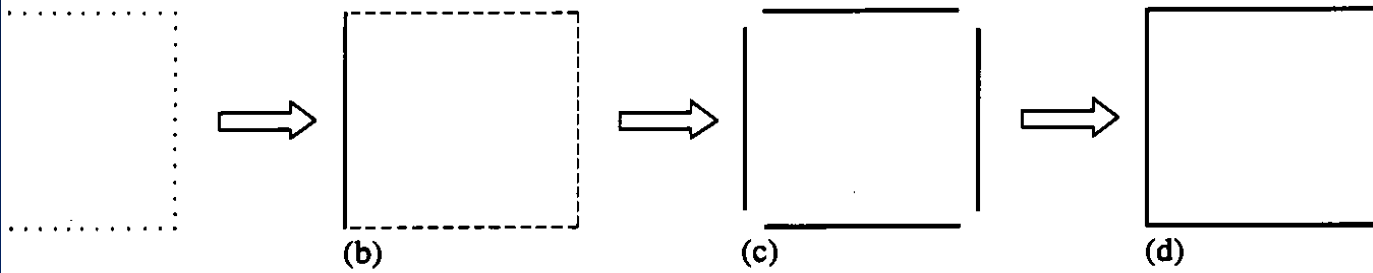


Figure 4.51 Descriptive advantages of visual grouping. See text for explanation.

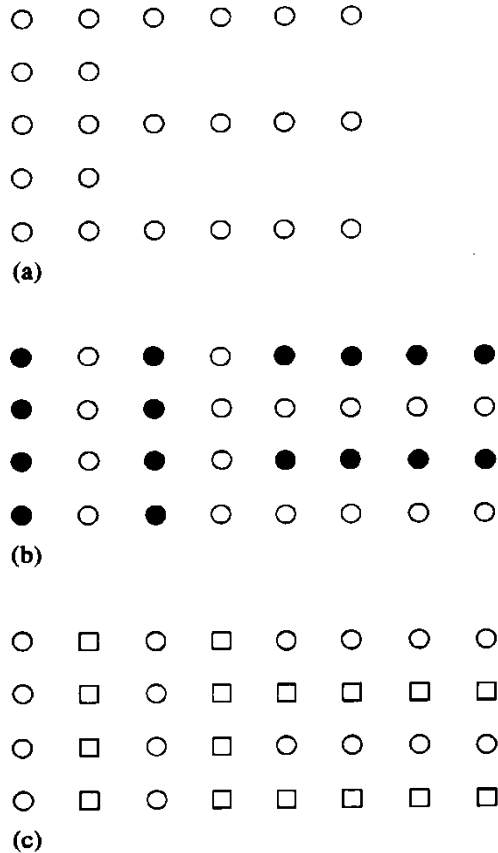
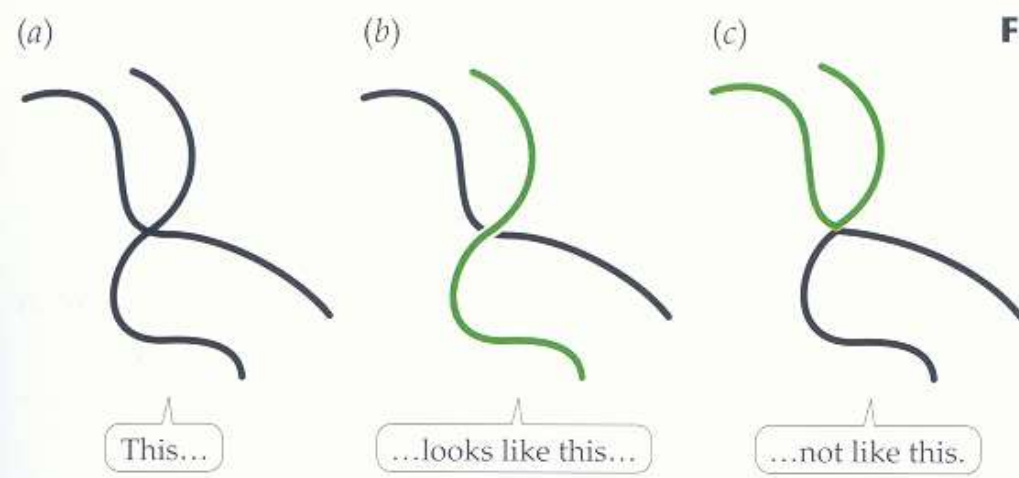


Figure 4.50 Examples of visual grouping: (a) Grouping by spacing. (b) Grouping by colour. (c) Grouping by shape.

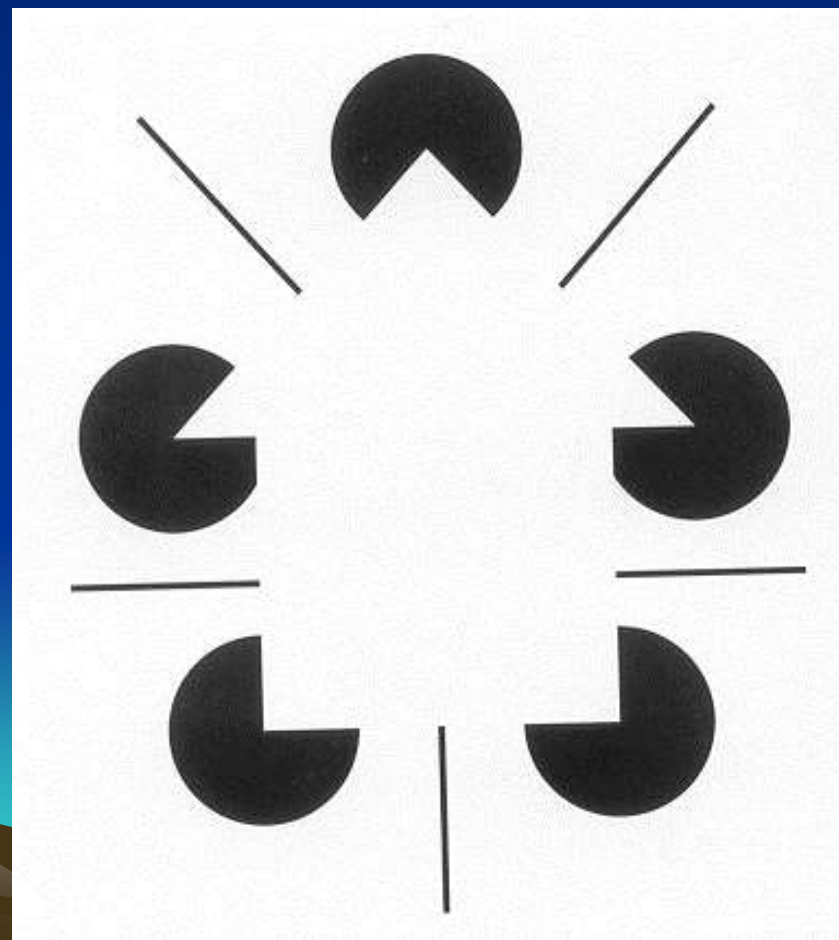
Seskupování
Podle kontrastních
linií

<http://sites.sinauer.com/wolfe3e/chap4/gestaltF.htm>

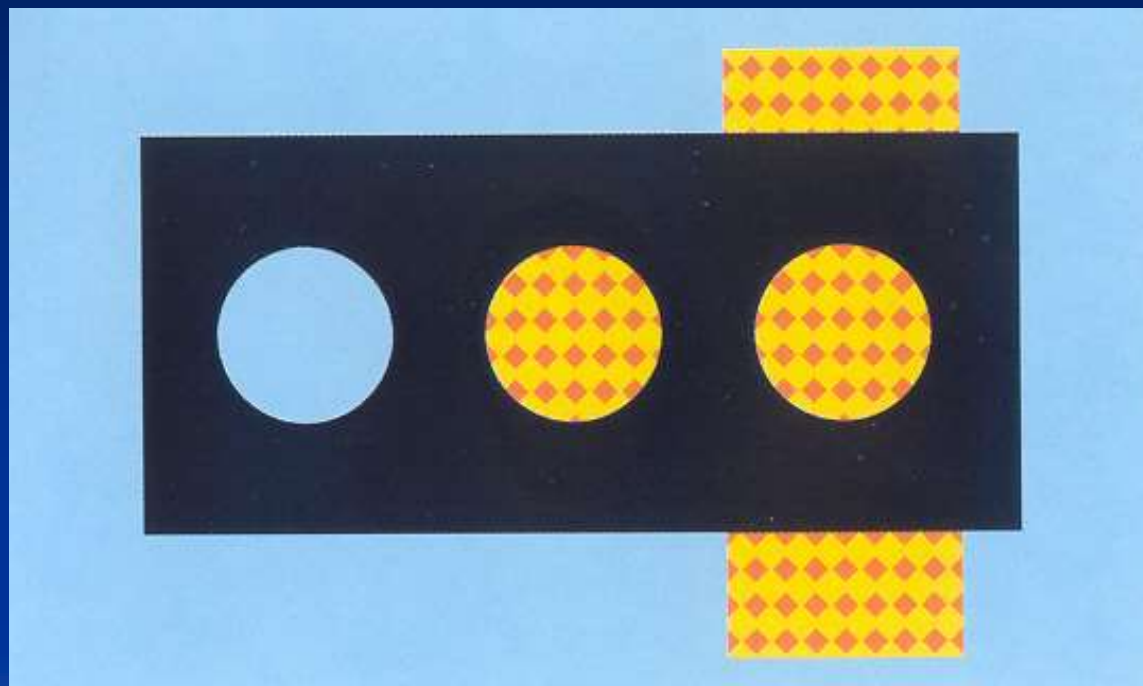
FIGURE 4.7 The Gestalt principle of good continuation.



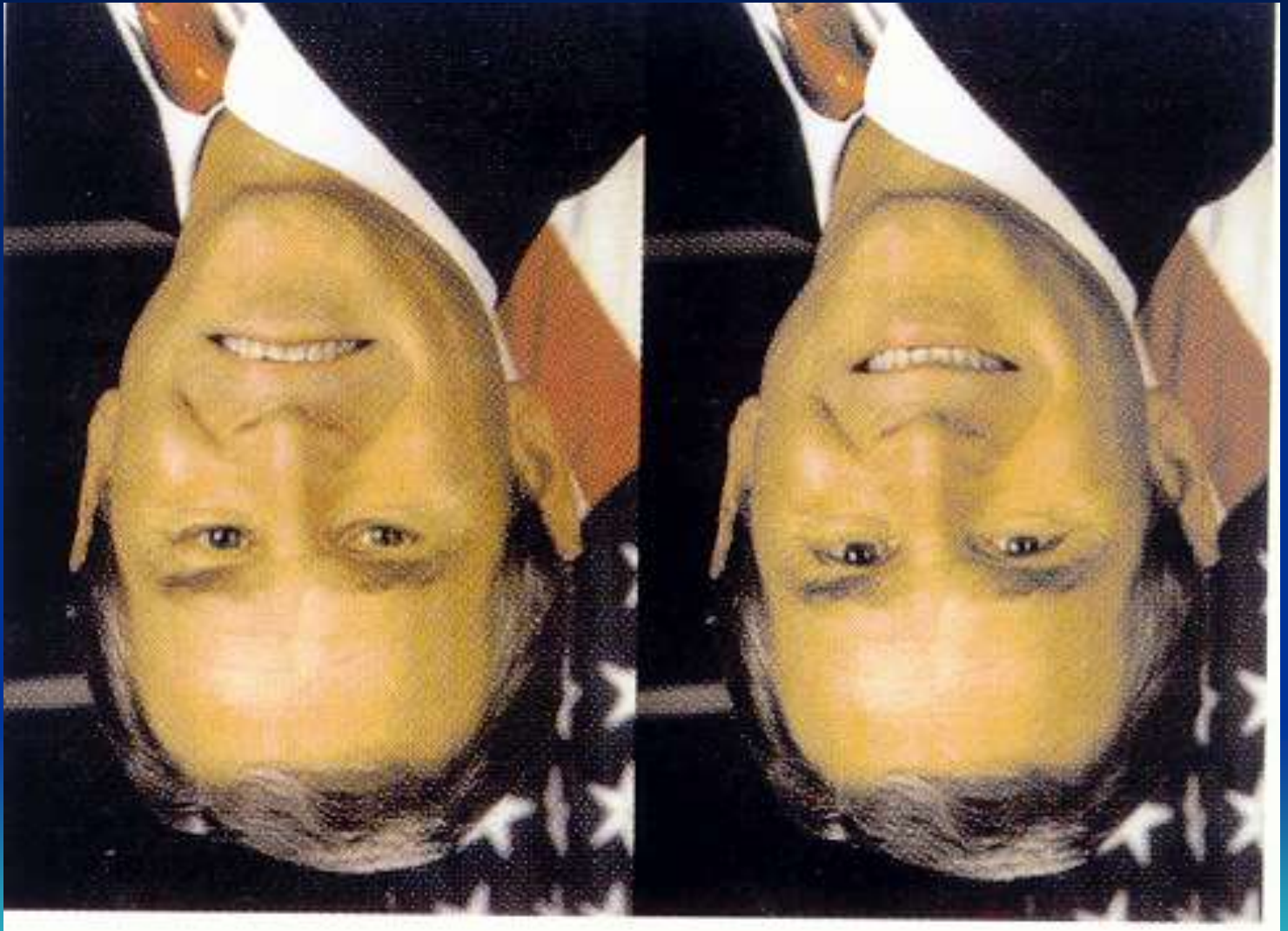
Seskupování
Podle kontrastních
Liníí
Hledání hran, kontur

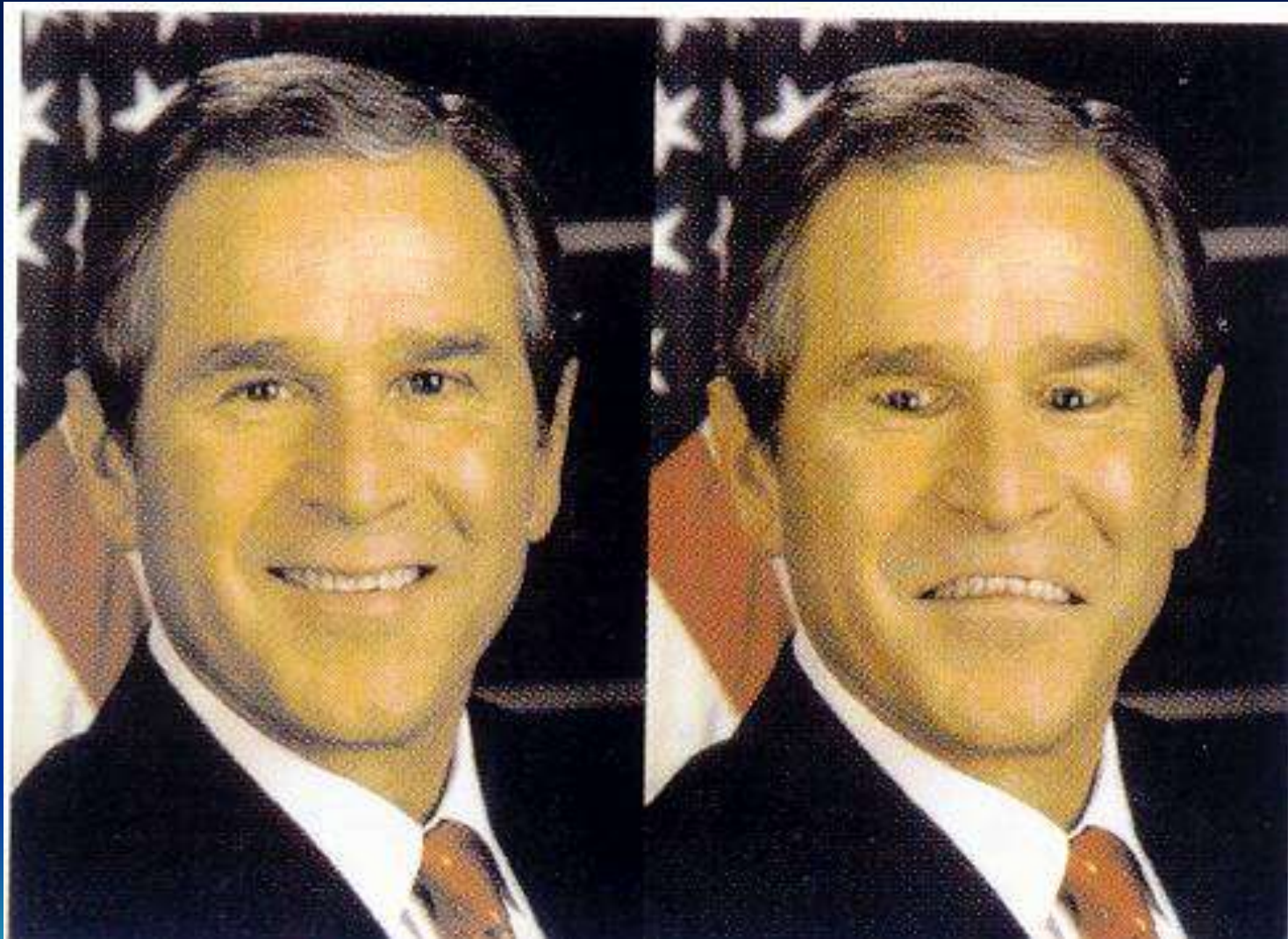


Okluze - překrývání
Co je obrázek a co díra?



Orientace v prostoru nesmí být zásadní pro interpretaci
Obrácené tváře vnímáme jinak (hůře) než normálně orientované





Zkušenost – rozeznáme tvar i z různých úhlů

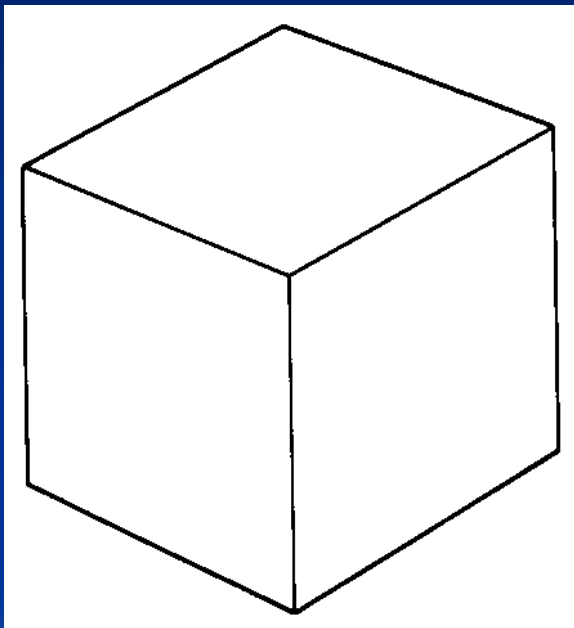


FIGURE 4.1 (a) A house. (b) Paul Cézanne's *Chateau Noir* (1902–05). (c) Even though a viewpoint shift has radically changed the retinal image, you know that this is the same house as in Figure 4.1a.



middle (midlevel) vision A loosely defined stage of visual processing come after basic features have been extracted from the image



Iluze 1

Iluze 2

Iluze 3

Zdánlivý pohyb

Jak je pohyb důležitý

Analýza biologického pohybu



Psychofyzologie

- Poznávací procesy
 - Asociační korové oblasti
 - Parasensorické
 - Prefrontální
 - Paralimbická



Parasensorické

- Unimodální – sekundární korové oblasti jednotlivých smyslů. Léze vedou k agnosiím.
 - Zrakové:
 - Pro kresby
 - Prosopagnosie – pro tváře
 - Pro pohyb
 - Pro hloubku prostoru



Parasensorické

- Unimodální – sekundární korové oblasti jednotlivých smyslů. Léze vedou k agnosiím.
 - Sluchové:
 - Čistá slovní hluchota, ale mluvení, čtení, psaní ano
 - Pro neverbální zvuky



Parasensorické

- Unimodální – sekundární korové oblasti jednotlivých smyslů. Léze vedou k agnosiím.
 - Somatosensorické:
 - Astereognosie – neschopnost poznat hmatem



Parasensorické

- Polymodální

- Hemineglect syndrom: ignorace vizuálních, somatosensorických, sluchových podnětů z jedné poloviny těla

Schopnost pravé hemisféry sdělovat a vnímat emocionální komponentu řeči.

Aprosodie- neschopnost: motorická, sensorická.



- deaf abstract thinking - téma



Polarizované světlo – mám nové články!!

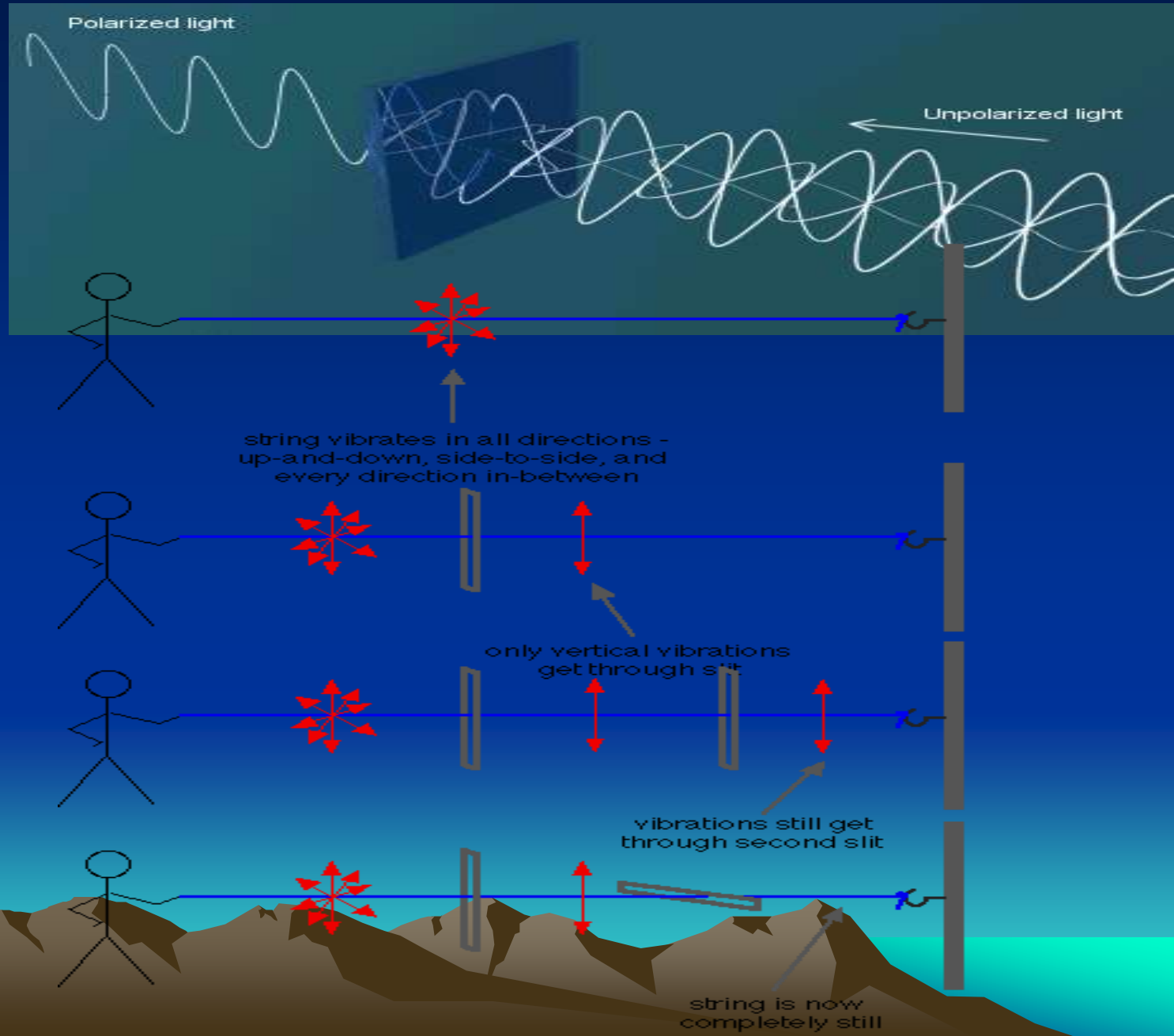


Fig. 3. Two-dimensional representations of the celestial E-vector pattern (the pattern of polarized light) depicted for two different elevations of the sun (filled circle): 25° in left figure, 60° in right figure. The orientation and size of each black bar mark the angle and degree (percentage) of polarization, respectively. The open circle indicates the zenith. The solar meridian (the line from the zenith down to the horizon) and the anti-solar meridian represent the symmetry plane of the celestial E-vector pattern. From Wehner (1994a).

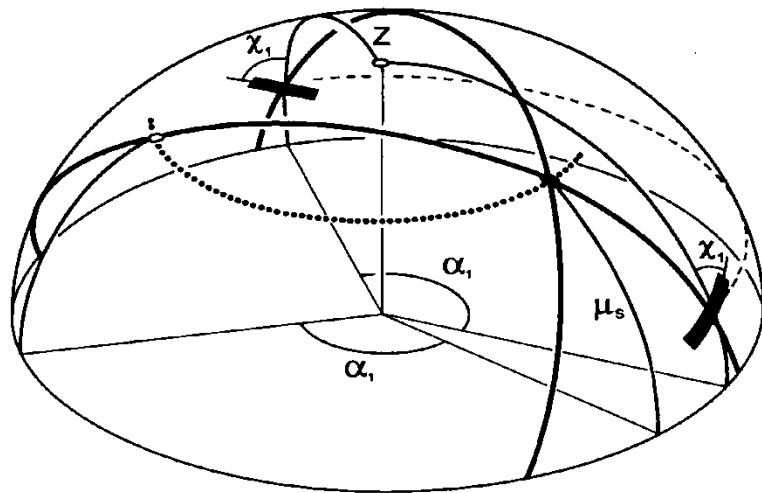
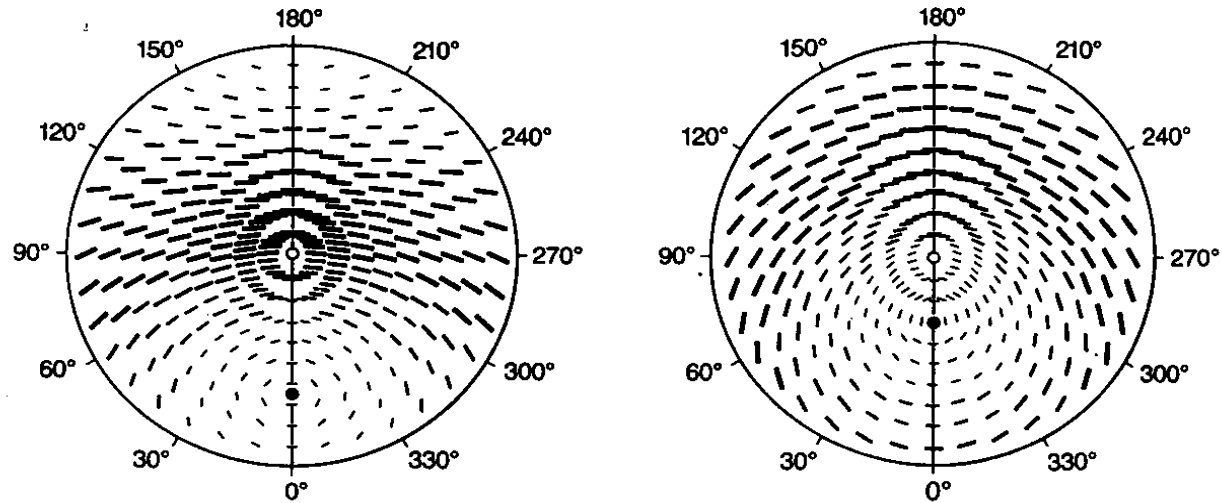
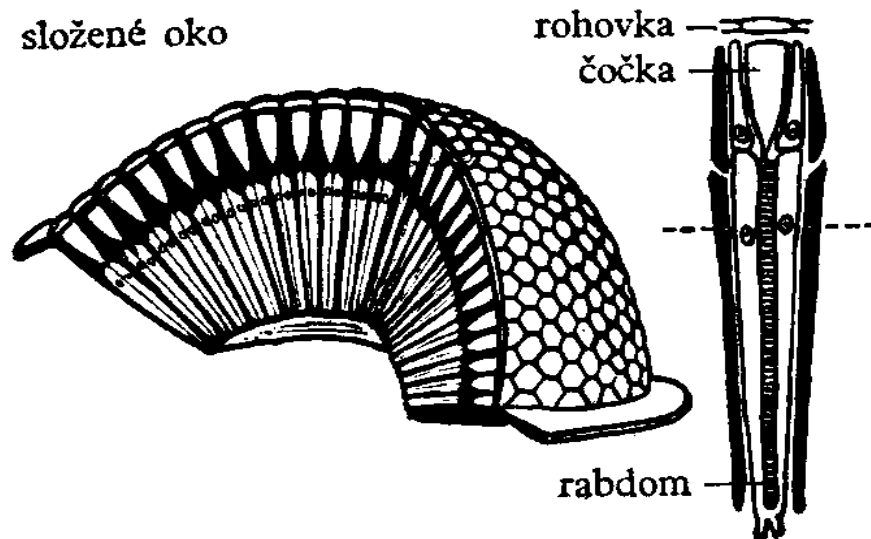
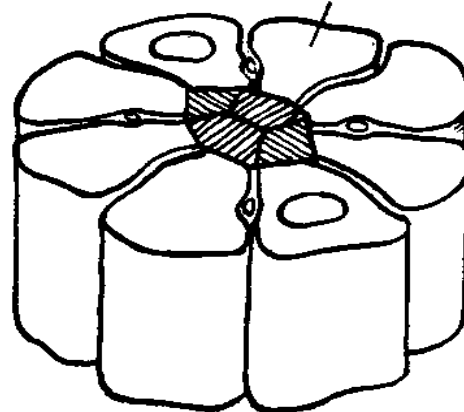


Fig. 4. Three-dimensional constructions required to infer the position of the sun – and hence the azimuthal position of the solar meridian – from at least two patches of polarized light in the sky. The black bars indicate the orientation of the E-vectors (χ) at two points in the sky. The following directives would yield an all-inclusive solution of the problem: First, determine the E-vector orientation at two points in the sky (a task not discussed here); then construct the great circles (heavy black arcs) running at right angles through the E-vectors; finally determine the position of the sun (filled circle) as the point of intersection of the two great circles. With one E-vector alone, the position of the sun cannot be determined unambiguously. If the elevation of the sun (μ_s) were known at a particular time of day, two intersection points of the great circle inclined orthogonally to χ_1 and the parallel of altitude defined by μ_s could be determined. These intersection points define the correct position of the sun (filled circle), as well as a fictive position (open circle), which is separated by the azimuthal difference α_1 from the correct one. The insect's E-vector compass does not operate this way, but is based on a set of simpler rules (see text and Fig. 5). Modified from Wehner (1981).

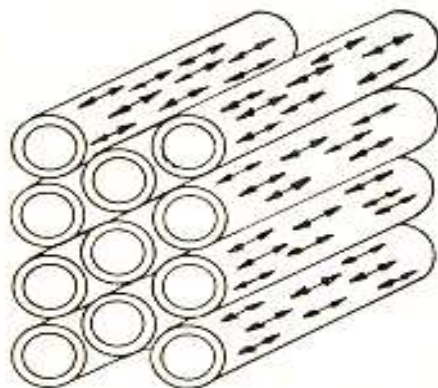
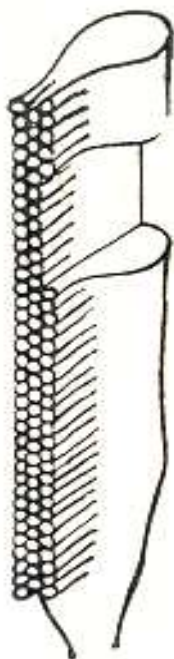
složené oko



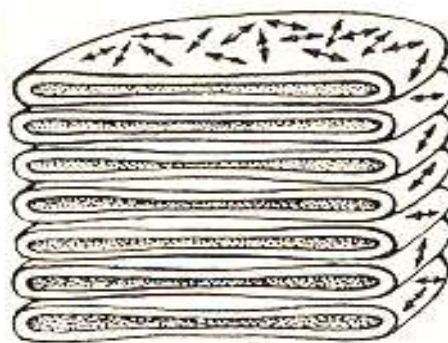
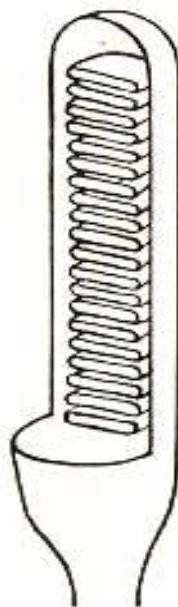
sítnicové buňky



Složené oko hmyzu se skládá z mnoha omatidií, oddělených od sebe pigmentem. Každé omatidium má vlastní rohovku, čočku a sítnicovou tyčinku (rabdom) tvořenou osmi sítnicovými buňkami, jež přecházejí v nerv.



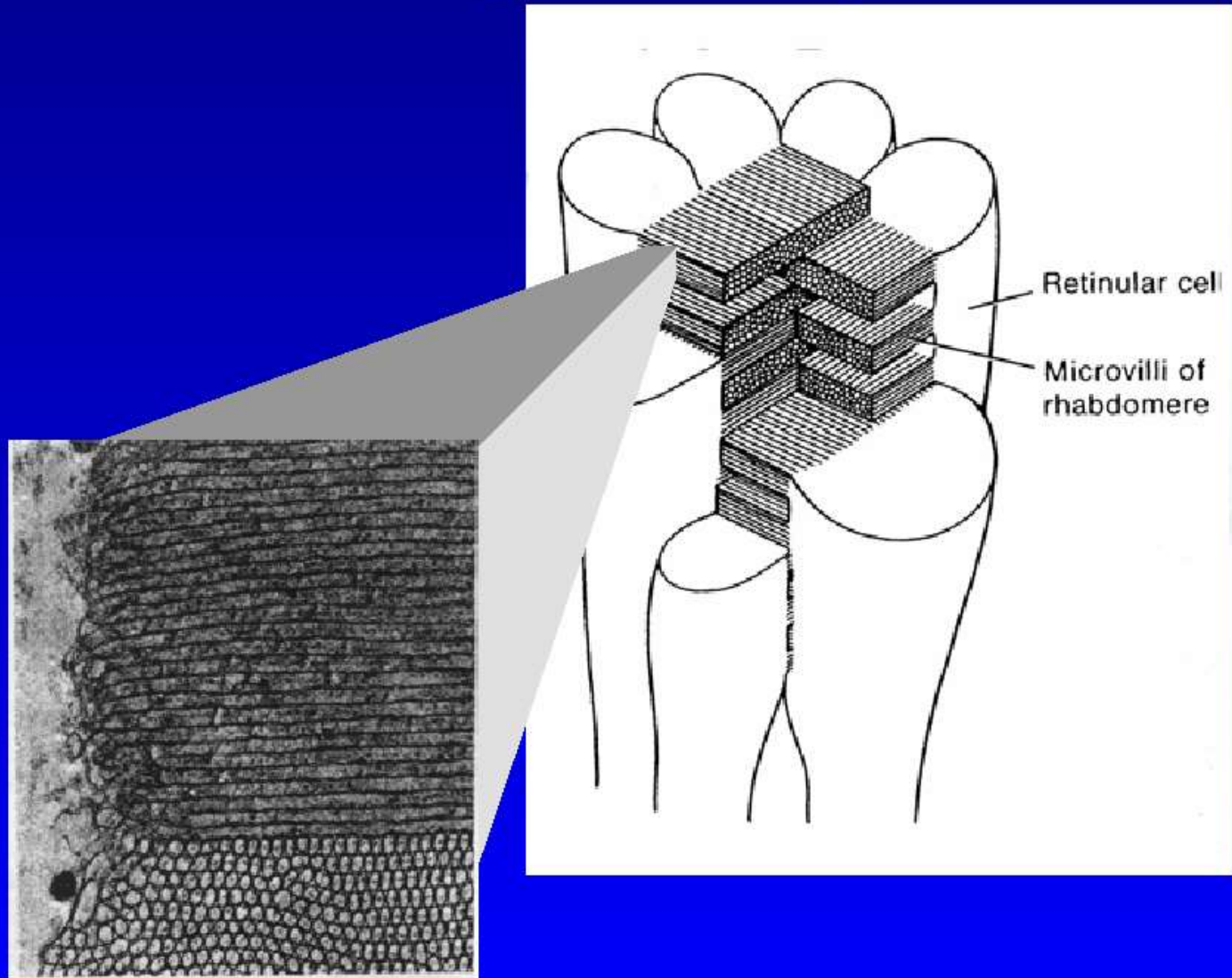
sítnicová buňka hmyzu



zraková tyčinka obratlovců

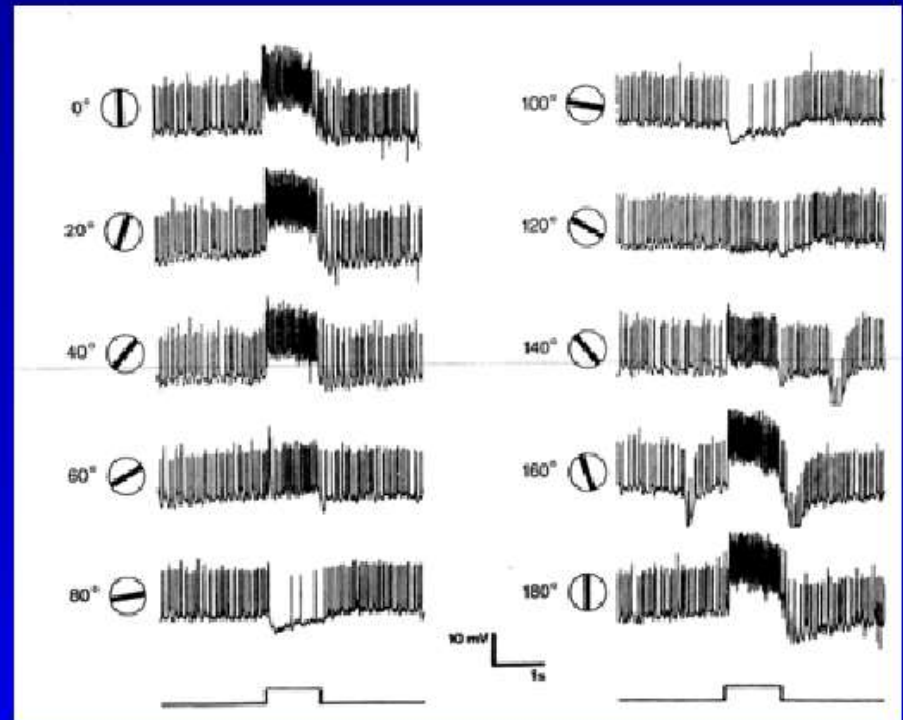
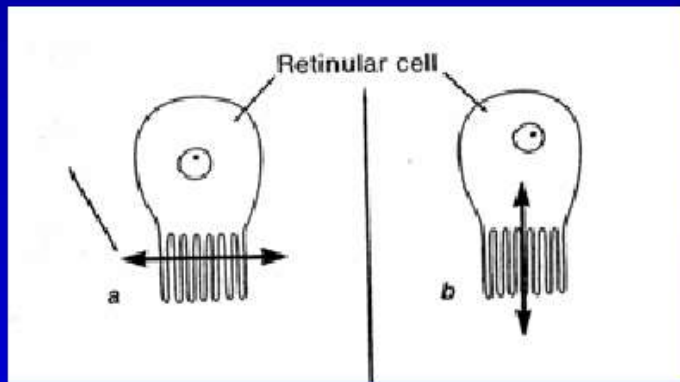
Molekuly světločivého pigmentu (radopsinu) jsou v tyčince hmyzího oka uspořádány jedním směrem, kdežto v tyčince oka obratlovce jsou neuspořádané. Vysvětluje to rozdíl ve schopnostech obou očí rozlišovat rovinu polarizovaného světla.

Organization of retinular cells allows for detection of polarized light



Arthropod visual neurons can be sensitive to specific planes of polarized light

Cricket



(Wehner 1989)

