

2021 Fall "Physiology"

Making Sense of Vision

Dong-Gen LUO

College of Life Sciences
Peking University

Escaping Behaviours

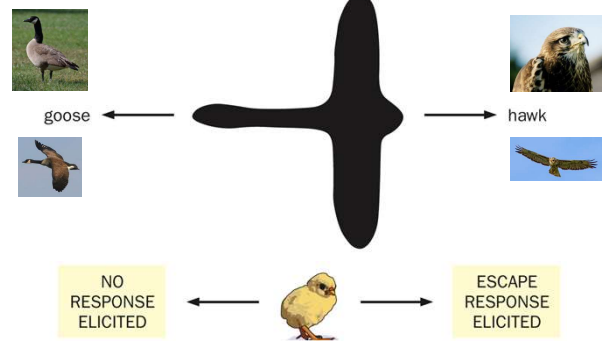
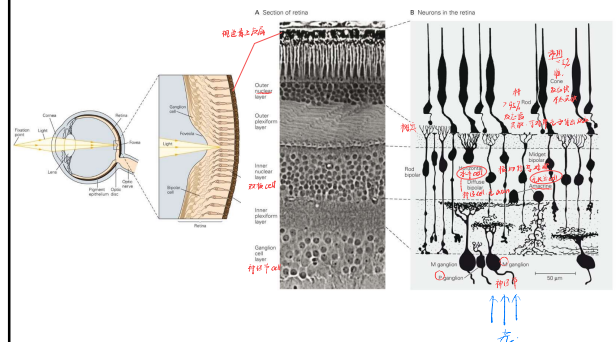


Figure 1-4 Principles of Neurobiology (© Garland Science 2016)

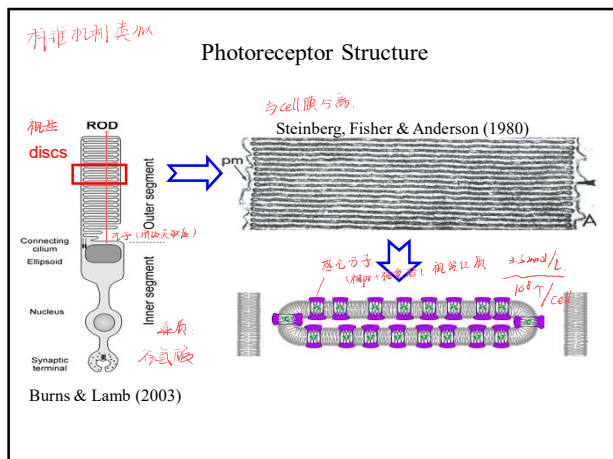
Outline of the Lecture

1. Organization of the retina;
2. Photoreceptors and phototransduction;
3. Signal transformation in the retina;
4. Visual pathways;
5. Signal processing in visual cortex.

Retina

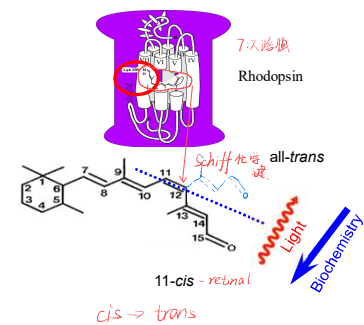
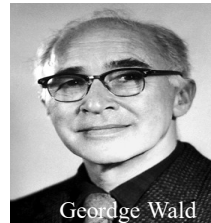


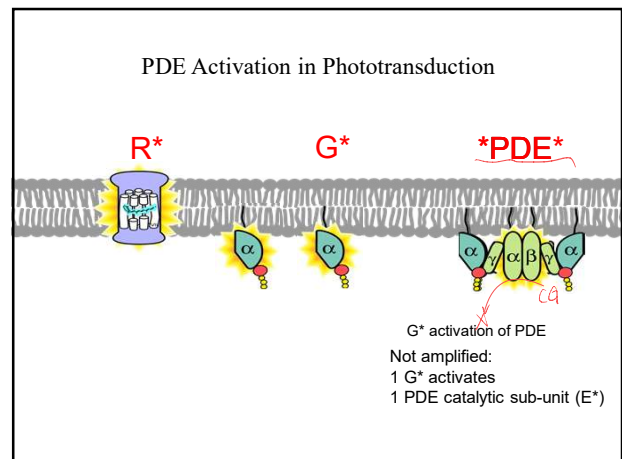
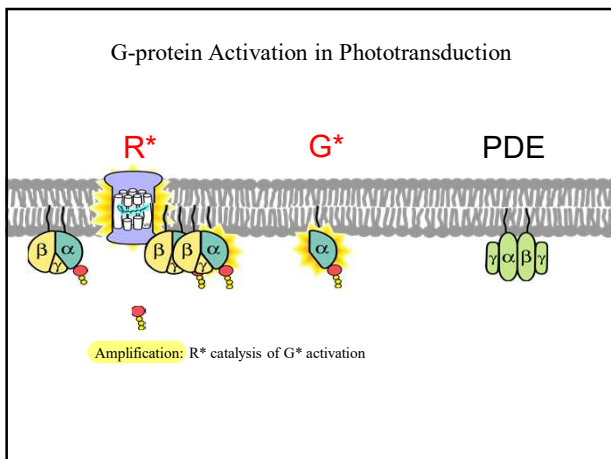
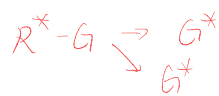
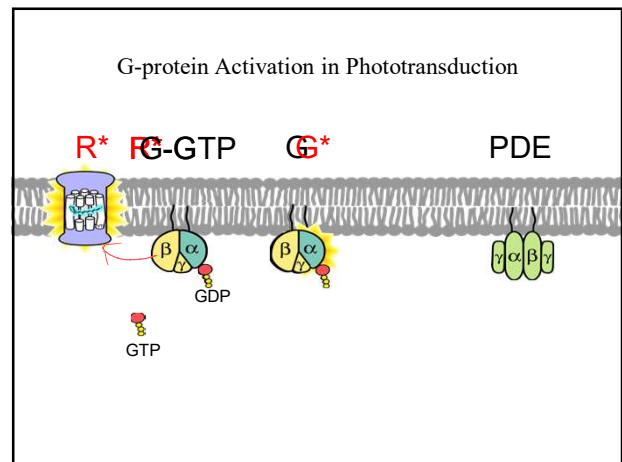
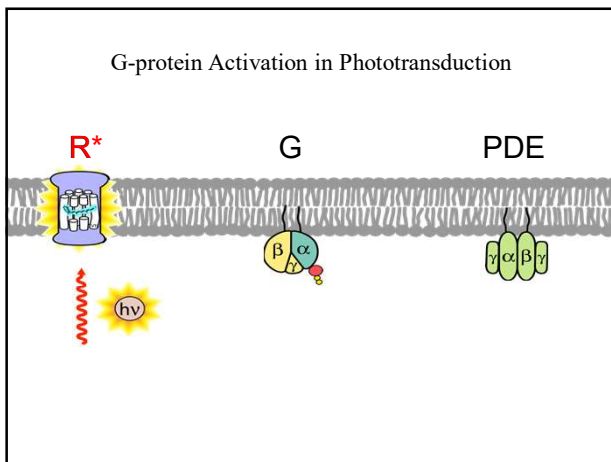
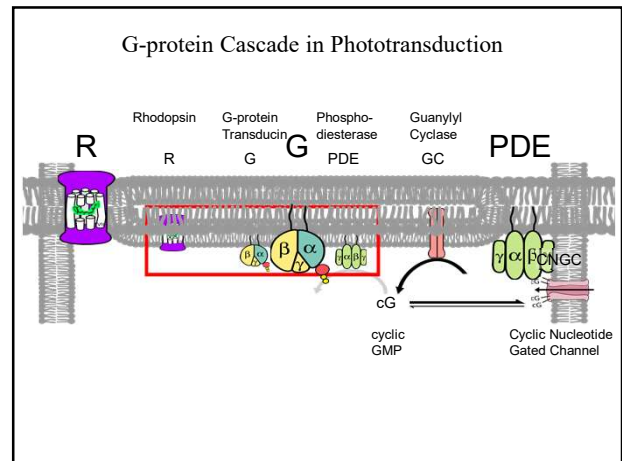
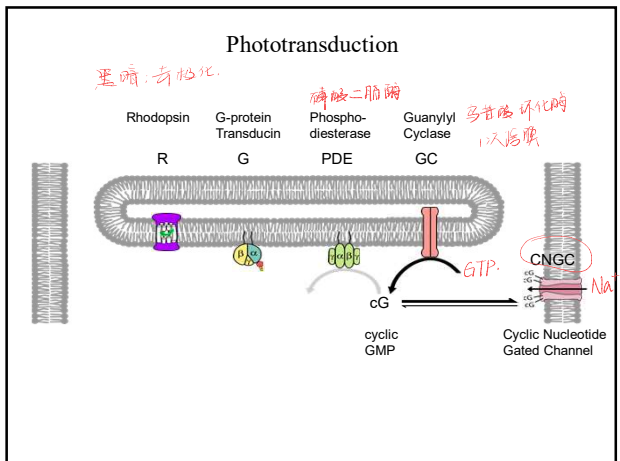
Photoreceptor Structure



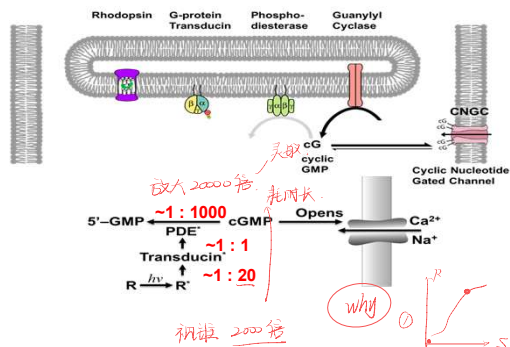
Photoisomerization

1967 Nobel Prize
in Physiology and Medicine



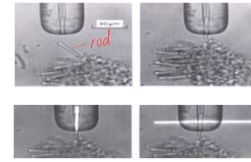


Amplification Steps in Phototransduction

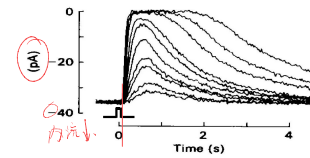


② 视网膜强度?

Phototransduction: High Amplification and Slow Kinetics



Suction-pipette Recording



Baylor, Yau, and Lamb, (1979) *J. Physiol.*

Retinal Physiology

Haldan Keffer Hartline
(1903-1983)



Nobel prize (1967)
in Physiology or Medicine

Visual Receptors and Retinal Interaction

Retinal Ganglion Cells

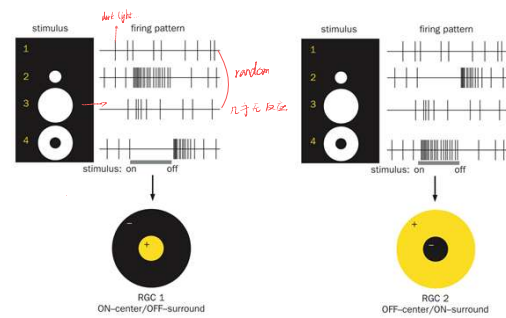
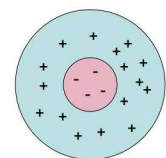
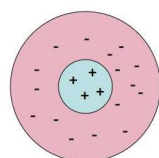


Figure 4-24 Principles of Neurobiology (© Garland Science 2016)

Center-Surround Receptive Field

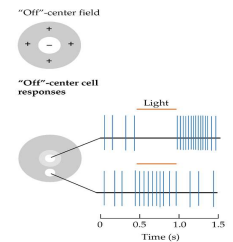
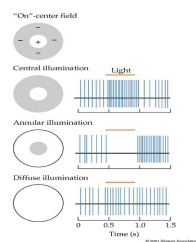


Off-center, On-surround

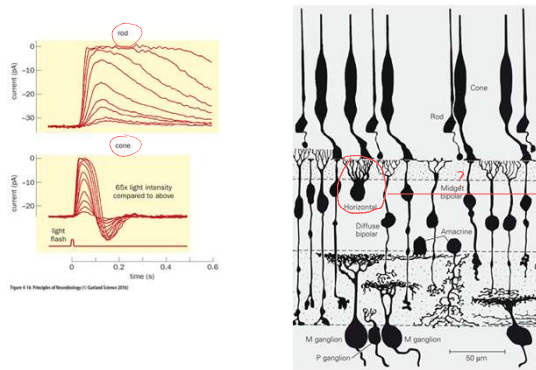


On-center, Off-surround

Center-Surround Receptive Field



Signal Transfer from Photoreceptors to RGCs



ON-OFF Channels: Bipolar Cells

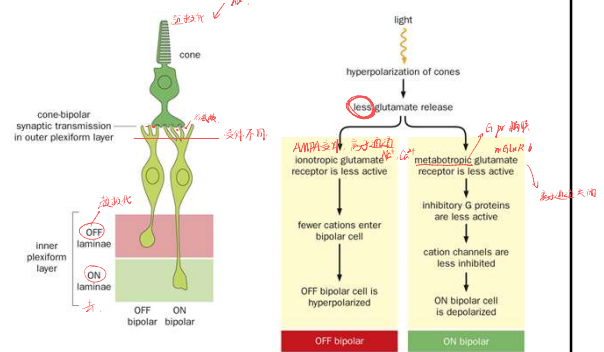
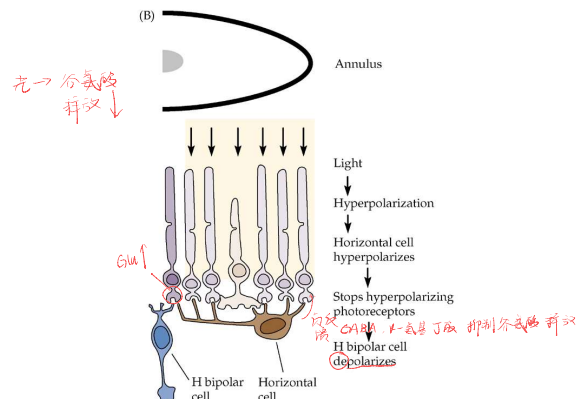
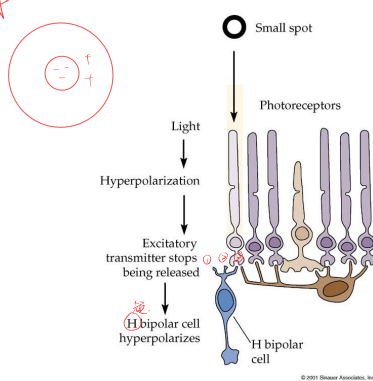
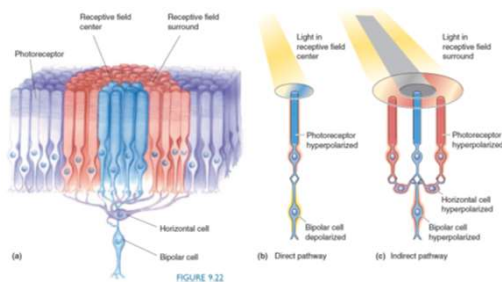


Figure 4-25 Principles of Neurobiology (© Garland Science 2016)

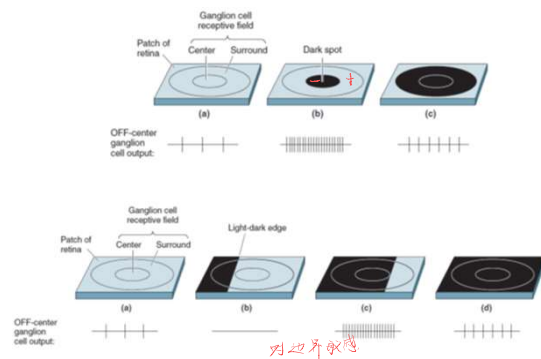
Center-Surround Receptive Field



Center-Surround Receptive Field

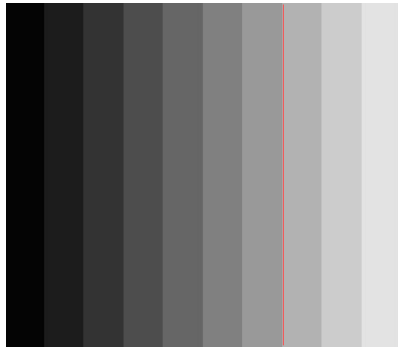


Center-Surround Receptive Field

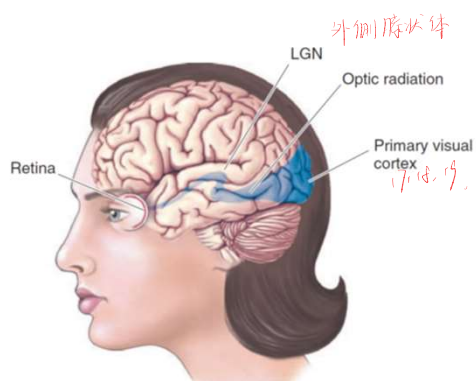
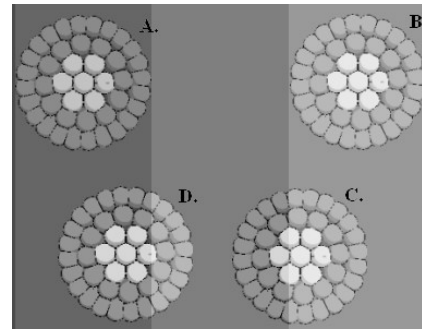


The Mach Band

马赫带



The Mach Band Explained

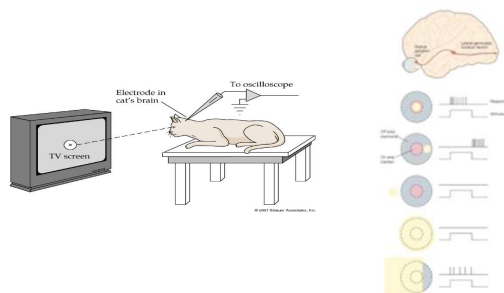


David Hunter Hubel and Torsten Wiesel

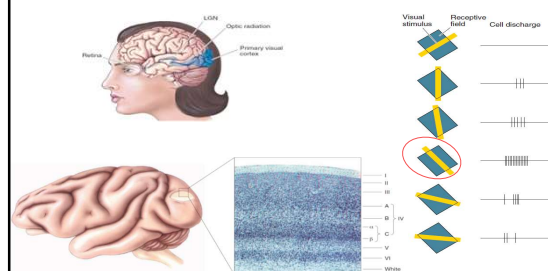


1981 Nobel Prize in Physiology or Medicine
for their discoveries concerning information processing in the visual system.

Center-Surround Receptive Field in LGN



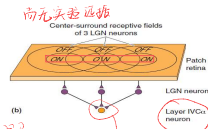
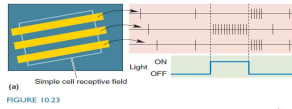
Light Responses in Visual Cortex



Simple Cells

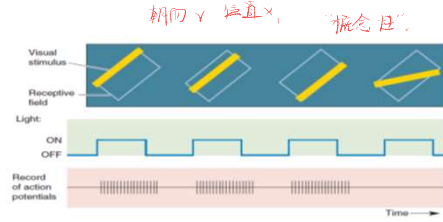
Simple Cells: V1 layers 4 and 6.

- 1: Excitatory and inhibitory regions;
- 2: **Linearity** of spatial summation;
- 3: **Antagonism** between excitatory and inhibitory regions.



大非反层：线条感受器
 脏：中心-周边
 → 脏→反层(抑制)

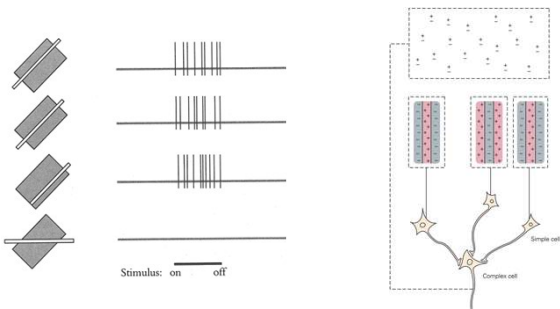
Complex Cells



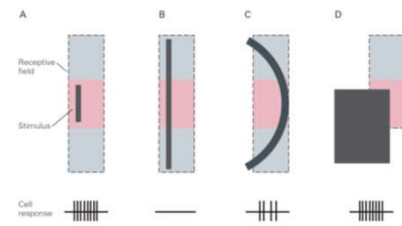
抽象化信息提取

Complex Cells: V1 layers 2, 3 and 5.

- 1: No clear excitatory and inhibitory regions;
- 2: A bar about one third to one half of the RF evokes maximal response;
- 3: A stimulus covering the entire RF evokes no response.



尚未发现对特定物体有反应的cell Grandmother cell.
End-Inhibited Receptive Fields
 但在有对特定线条敏感。



Escaping Behaviours

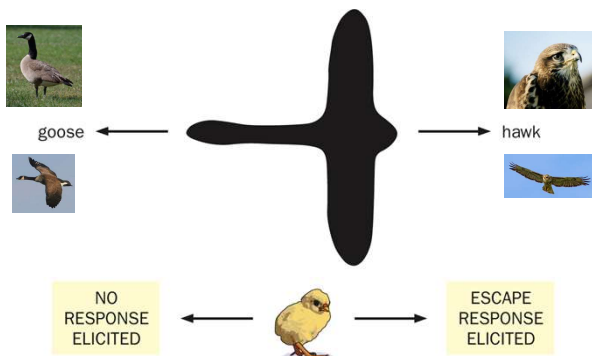


Figure 1-4 Principles of Neurobiology (© Garland Science 2016)

Outline of the Lecture

1. Organization of the retina;
2. Photoreceptors and phototransduction;
3. Signal transformation in the retina;
4. Visual pathways;
5. Signal processing in visual cortex.