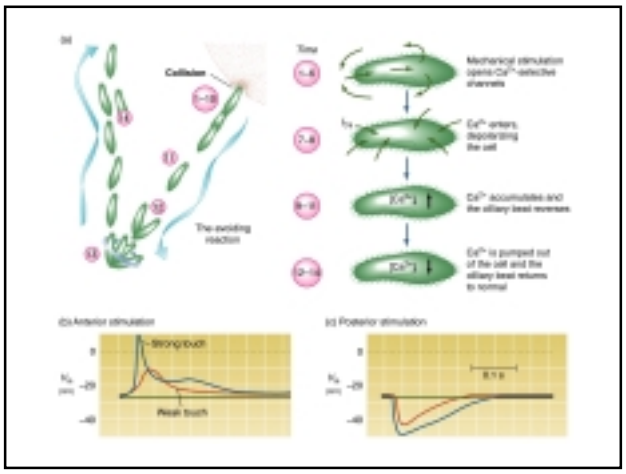
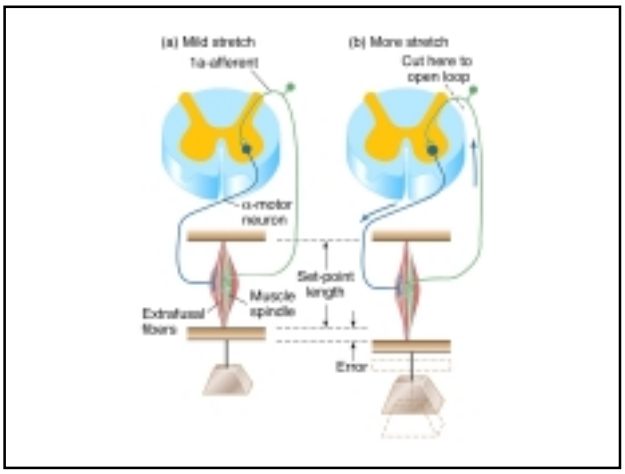
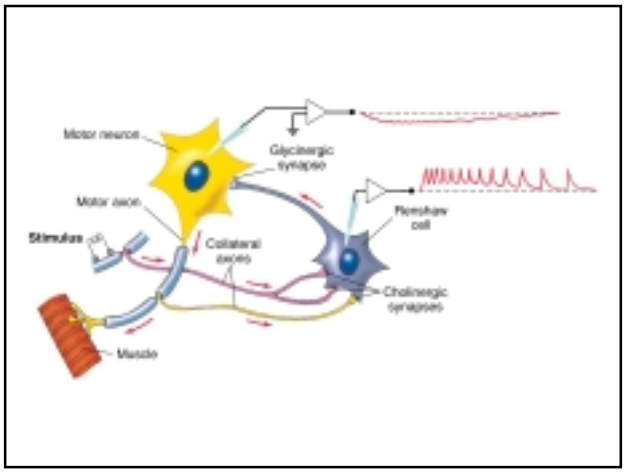
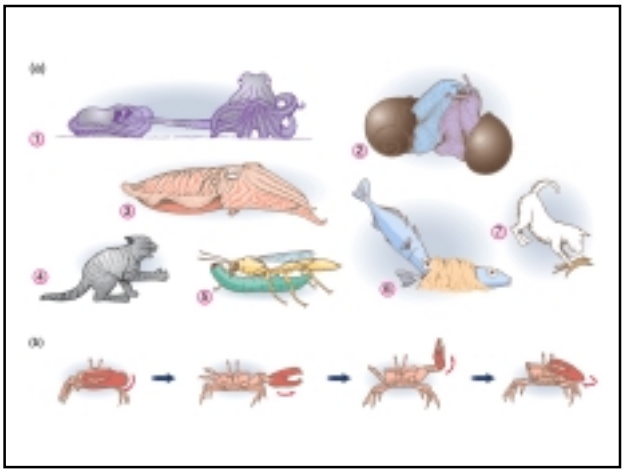
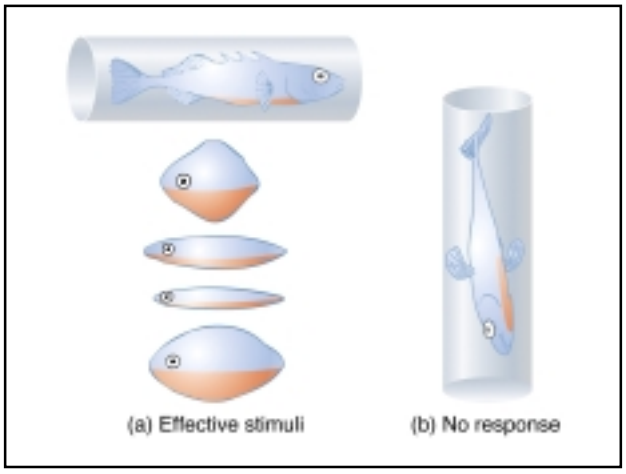
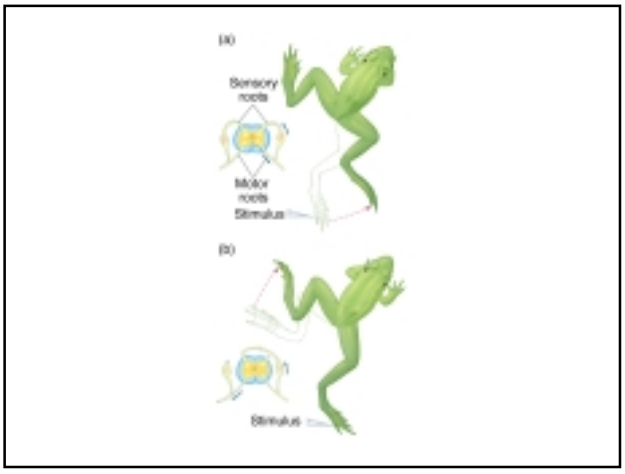

Collision
The avoiding reaction
Time
Mechanical stimulation opens Ca2+-selective channels
Ca2+ enters, depolarizing the cell
Ca2+ accumulates and the ciliary beat reverses
Ca2+ is pumped out of the cell and the ciliary beat returns to normal
(b) Anterior stimulation
Strong touch
Weak touch
(c) Posterior stimulation

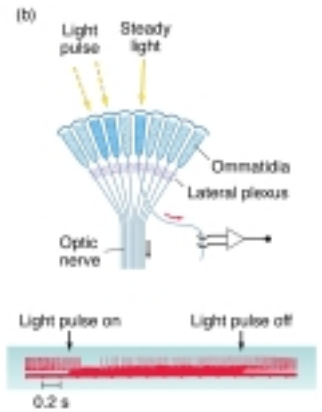

(a) Mild stretch
1a-afferent
(b) More stretch
Cut here to open loop
α-motor neuron
Set-point length
Muscle spindle
Extrafusal fibers
Error

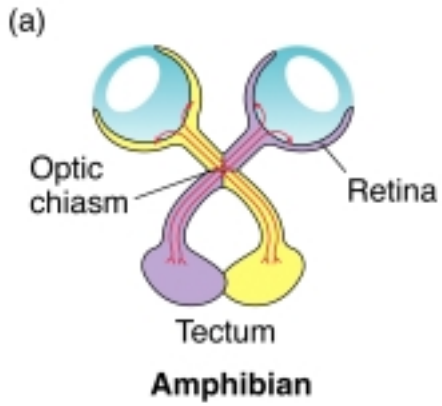

Motor neuron
Glycinergic synapse
Motor axon
Renshaw cell
Stimulus
Collateral axons
Cholinergic synapses
Muscle

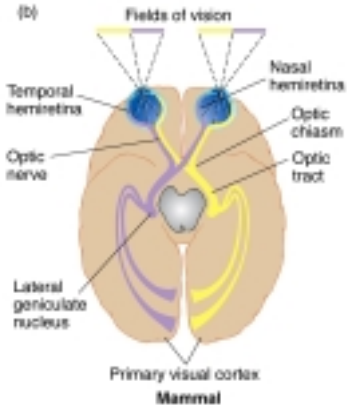


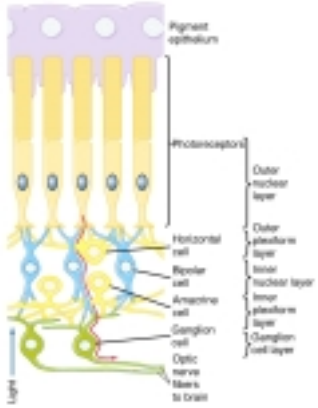

(a) Effective stimuli
(b) No response

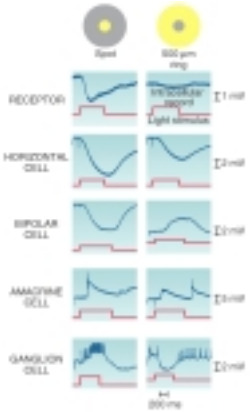

Sensory roots
Motor roots
Stimulus
Stimulus

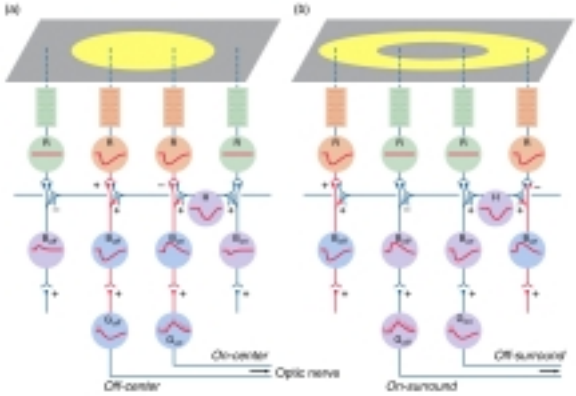

(b)
Light pulse
Steady light
Ommatidia
Lateral plexus
Optic nerve
Light pulse on
Light pulse off
0.2 s

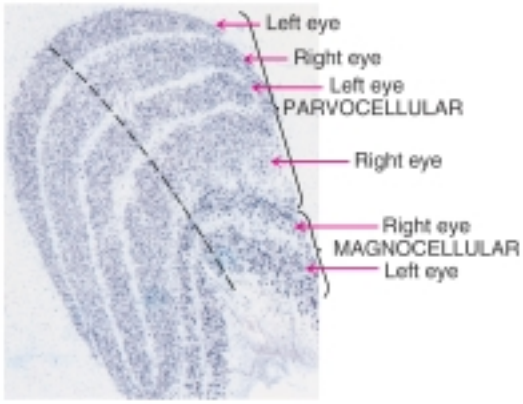

(a)
Optic chiasm
Retina
Tectum
Amphibian

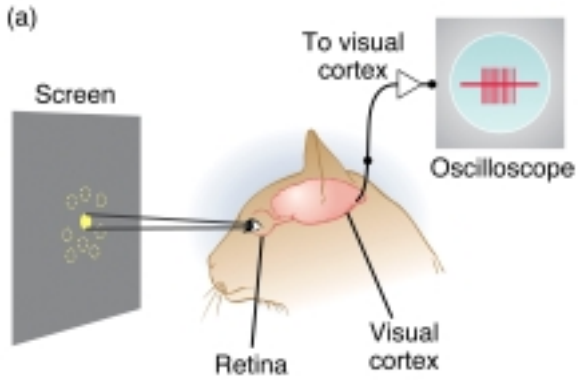

(b)
Fields of vision
Temporal hemiretina
Nasal hemiretina
Optic chiasm
Optic nerve
Optic tract
Lateral geniculate nucleus
Primary visual cortex
Mammal

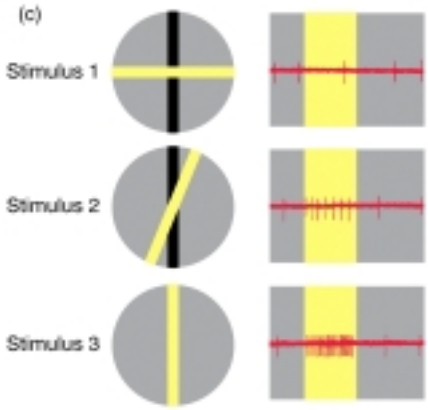

Pigment epithelium
Photoreceptors
Outer nuclear layer
Outer plexiform layer
Horizontal cell
Bipolar cell
Inner nuclear layer
Inner plexiform layer
Amacrine cell
Ganglion cell
Ganglion cell layer
Optic nerve fibers to brain
Light

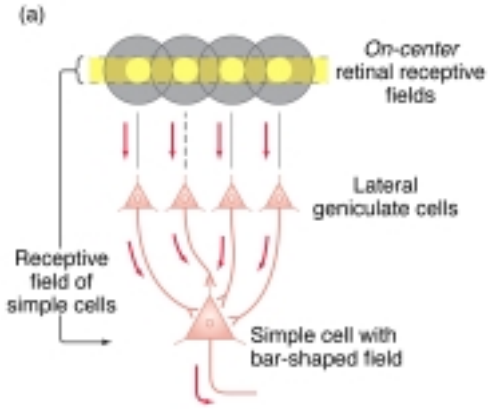

RECEPTOR
HORIZONTAL CELL
BIPOLAR CELL
AMACRINE CELL
GANGLION CELL

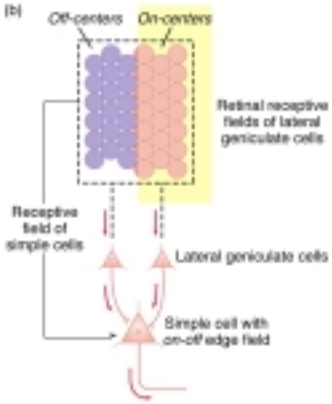

(a)
(b)
On-center
Off-center
Optic nerve
Off-surround
On-surround

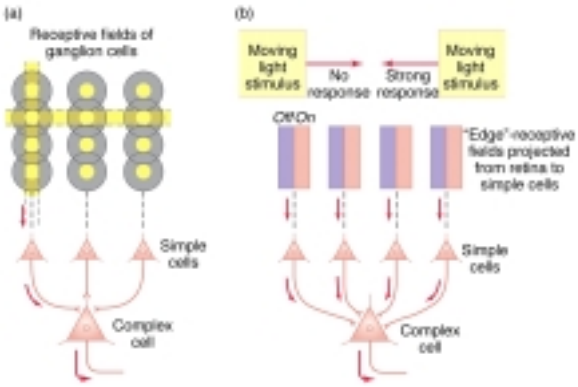

Left eye
Right eye
Left eye
PARVOCELLULAR
Right eye
Right eye
MAGNOCELLULAR
Left eye

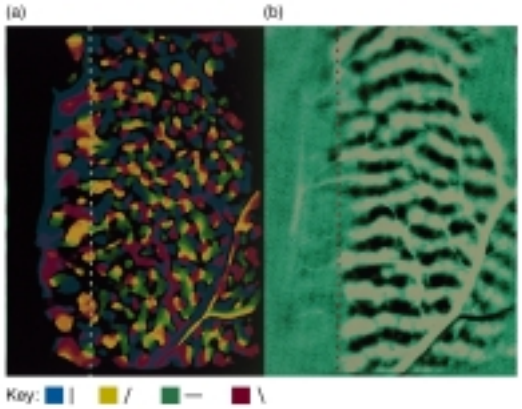

(a)
To visual cortex
Screen
Oscilloscope
Retina
Visual cortex

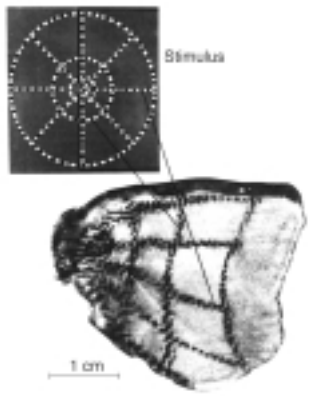

(c)
Stimulus 1
Stimulus 2
Stimulus 3

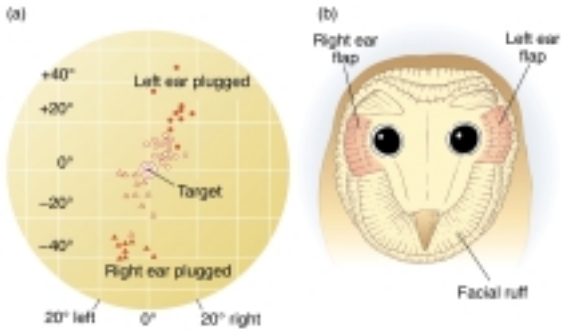

(a)
On-center retinal receptive fields
Lateral geniculate cells
Receptive field of simple cells
Simple cell with bar-shaped field

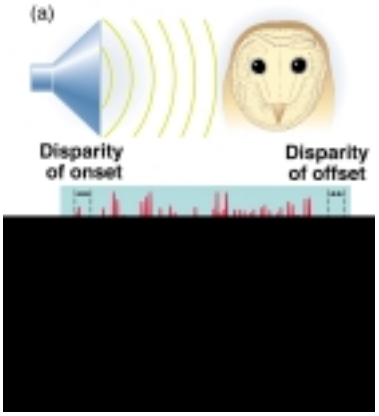

(b)
Off-centers
On-centers
Retinal receptive fields of lateral geniculate cells
Receptive field of simple cells
Lateral geniculate cells
Simple cell with on-off edge field

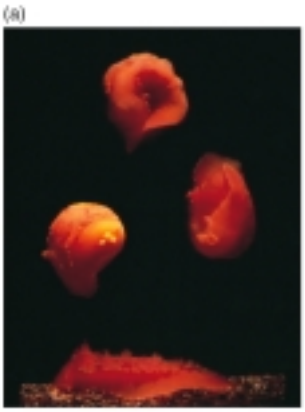

(a)
Receptive fields of ganglion cells
Simple cells
Complex cell
(b)
Moving light stimulus
No response
Strong response
Moving light stimulus
Off On
"Edge" receptive fields projected from retina to simple cells
Simple cells
Complex cell

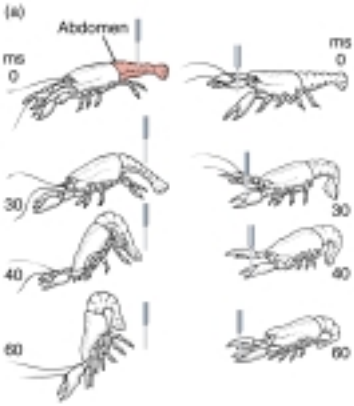

(a)
(b)
Key: | / — \

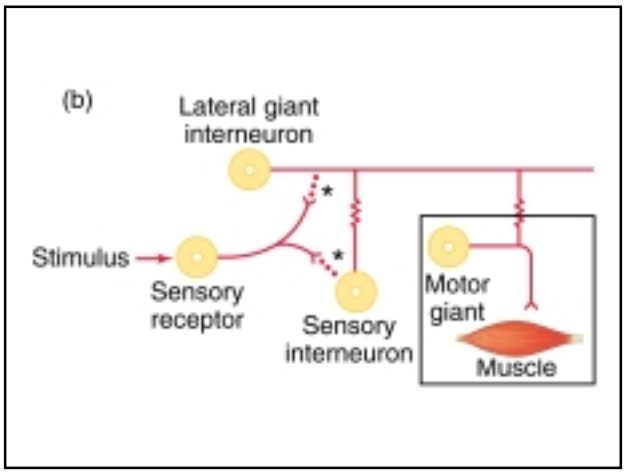

Stimulus
1 cm

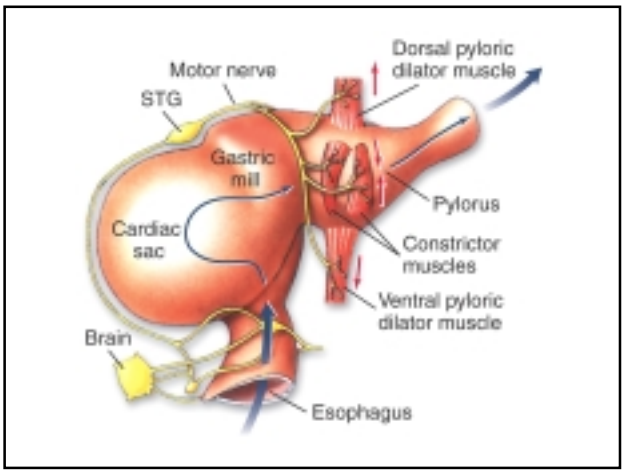

(a)
+40°
+20°
0°
−20°
−40°
Left ear plugged
Target
Right ear plugged
20° left
0°
20° right
(b)
Right ear flap
Left ear flap
Facial ruff

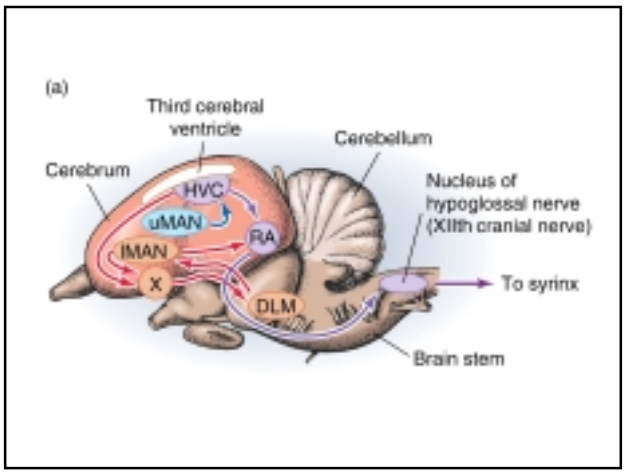

(a)
Disparity of onset
Disparity of offset

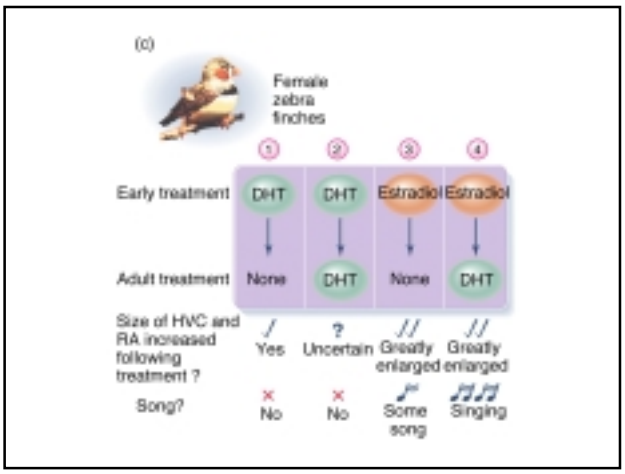

(a)

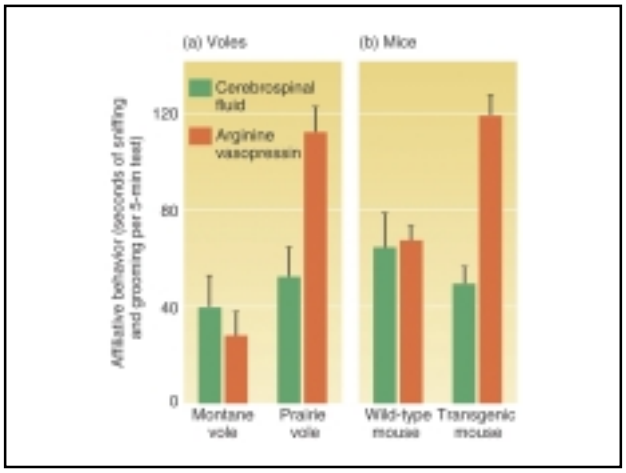

(a)
Abdomen
ms
0
30
40
60
ms
0
30
40
60


(b)
Lateral giant interneuron
Stimulus
Sensory receptor
Sensory interneuron
Motor giant
Muscle


Motor nerve
STG
Dorsal pyloric dilator muscle
Gastric mill
Pylorus
Cardiac sac
Constrictor muscles
Ventral pyloric dilator muscle
Brain
Esophagus


(a)
Third cerebral ventricle
Cerebellum
Cerebrum
HVC
uMAN
RA
lMAN
X
DLM
Nucleus of hypoglossal nerve (XIIth cranial nerve)
To syrinx
Brain stem


(c)
Female zebra finches
1
2
3
4
Early treatment
DHT
DHT
Estradiol
Estradiol
Adult treatment
None
DHT
None
DHT
Size of HVC and RA increased following treatment ?
Yes
Uncertain
Greatly enlarged
Greatly enlarged
Song?
No
No
Some song
Singing


(a) Voles
(b) Mice
Cerebrospinal fluid
Arginine vasopressin
Affiliative behavior (seconds of sniffing and grooming per 5-min test)
120
80
40
0
Montane vole
Prairie vole
Wild-type mouse
Transgenic mouse