# An Introduction to Neuroscience

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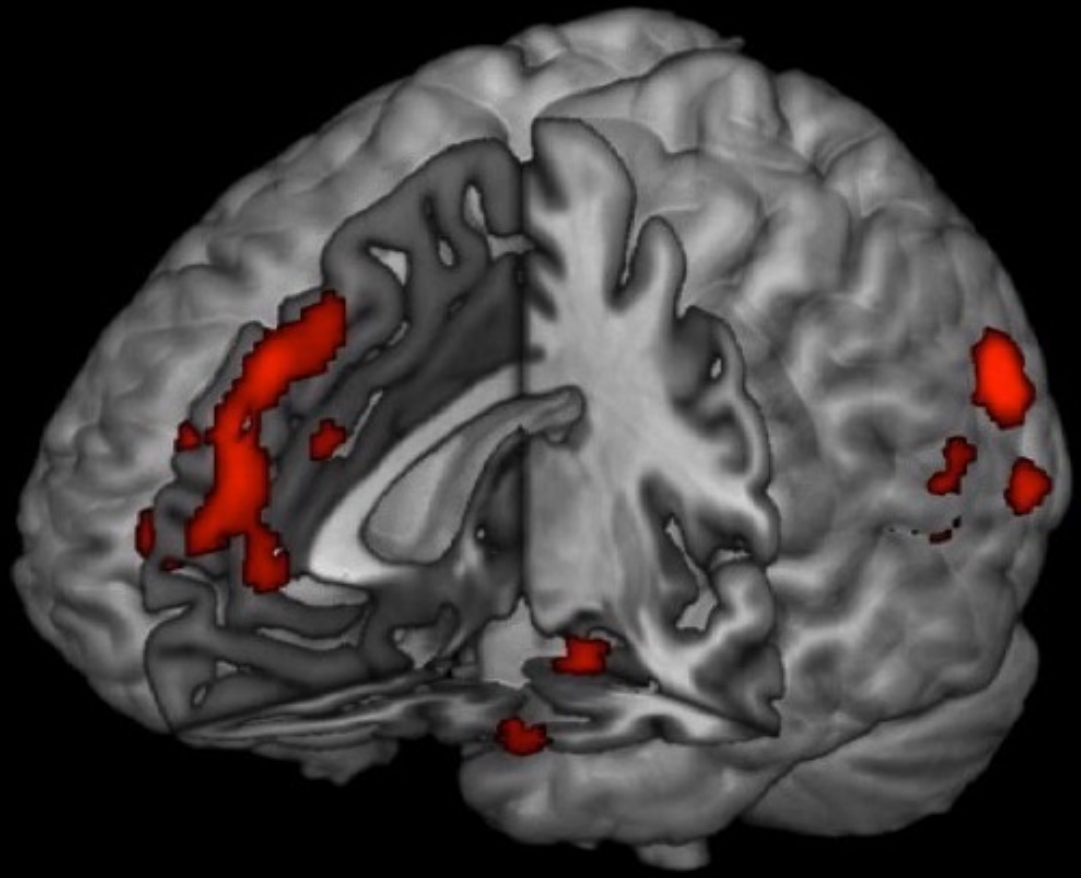


Administrative Stuff
Attendance
Exams
Expectations
Course Outline

**Week I: Neurons** **October 4th, 2023**

Condition: Amyotrophic Lateral Sclerosis (ALS)

Topic: Neurons

Technique: Single Unit Recordings

**Week II: Sensory Perception** **October 11th, 2023**

Condition: Phantom Limbs

Topic: Proprioception and Audition

Technique: Functional Imaging

**Week III: Vision** **October 18th, 2023**

Condition: Aging

Topic: Vision

Technique: Electroencephalography

**Week IV: Motor Control** **October 25th, 2023**

Condition: Parkinson's Disease

Topic: Movement Planning and Control

Technique: Transcranial Magnetic Stimulation

**Week V: Attention** **November 1st, 2023**

Condition: Neglect

Topic: Attention

Technique: Patient Studies

**Week VI: Memory** **November 8th, 2023**

Condition: Alzheimer's Disease

Topic: Memory

Technique: Optical Imaging

# www.krigolsonteaching.com

Me

Formal Training

Expertise

Style

Disclaimers

Knowing Everything

Scope of Course

BS in the Media

Dr. Phil

Pace of Research

# Lecture Format

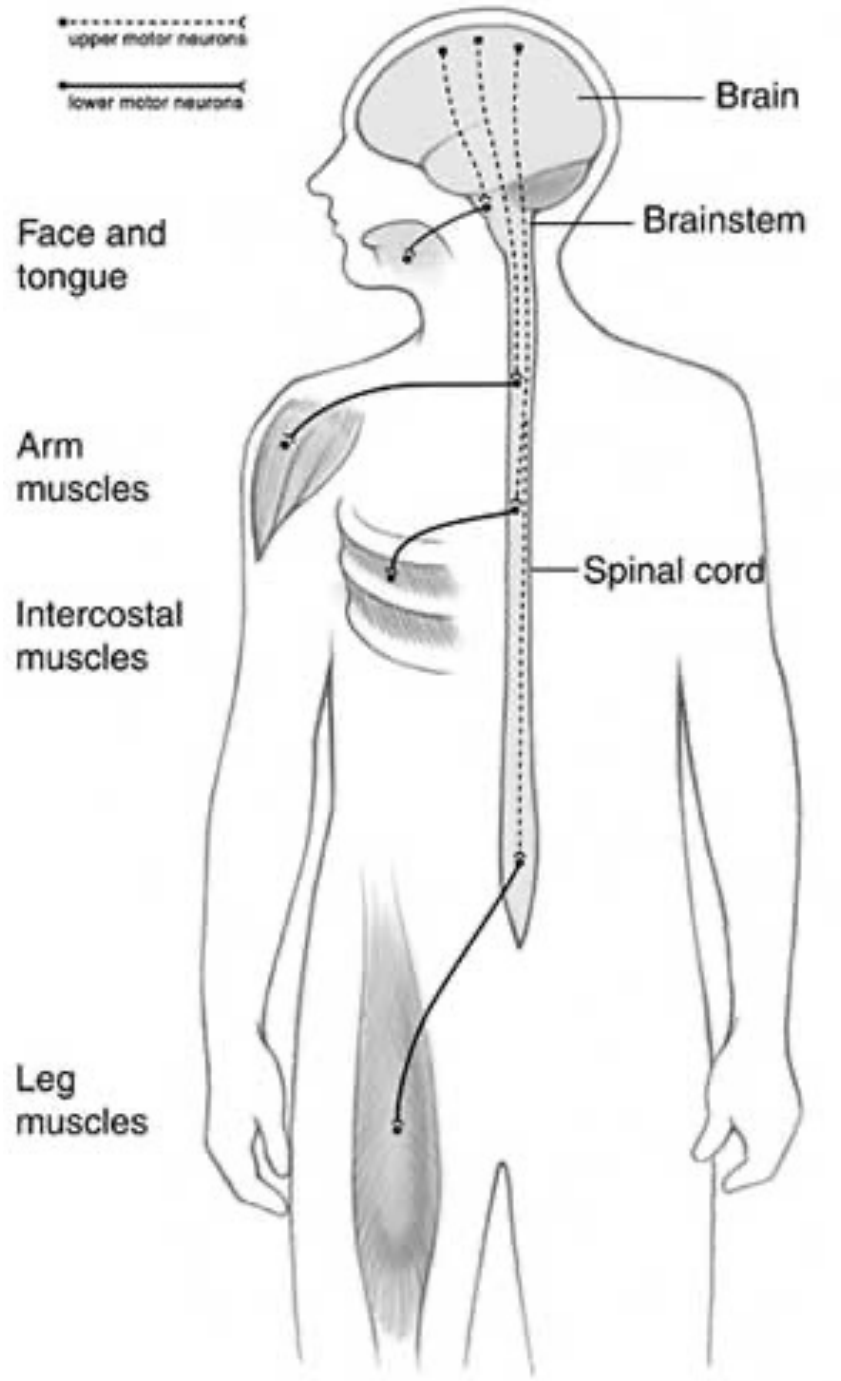
1. Clinical Issue (relevant to topic)
2. Topic
3. Technique

# Topic One: Neurons

# Lecture 1A:
# Amyotrophic Lateral Sclerosis

# What is amyotrophic lateral sclerosis?

It is a progressive neurological disease that affects the control of muscle movement due to its damaging affects on motor neurons in the spinal cord and the brain



# Significance of the Name of this Disease

- A-myo-trophic  comes from Greek
- “A” = no/negative
- “myo” = muscle
- “trophic” = nourishment
- “No Muscle Nourishment”

- Lateral = defines location of the nerve cells that signal and control the muscles

- Sclerosis = scarring and hardening in the degenerating region

# Other common names for this disease:

- Motor neuron disease
- Charcot’s disease
- Lou Gehrig’s disease

# Nature and Characteristics of ALS

- Forms:
  - Two types of ALS:
    - Sporadic – no family history
    - Familial – family history/background
  - 90% of the known cases are sporadic

# Who Gets ALS?

- According to the ALS CARE Database, 60% of the people with ALS in the database are men and 93% of patients in the database are caucasian

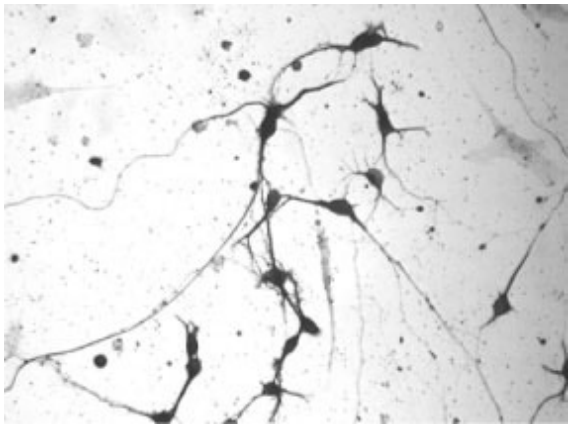
- Normally occurs in people between 40 to 70 years of age
  - Also can occur in people in their 20's and 30's

# Mechanism of ALS

- starting point is a mutation of Chromosome 21 (also suspect in many other conditions, probably the most common being Down's)
- Most Common: the mutation changes the SOD1 gene/protein (currently over 21 "types of ALS" though)
- SOD1 change results in superoxide radicals not being neutralized
- The radicals "attack" the motor neurons and degrade them (many effects here – inflammation? over-excitation?)
- Muscles are not able to be stimulated

# Symptoms of ALS

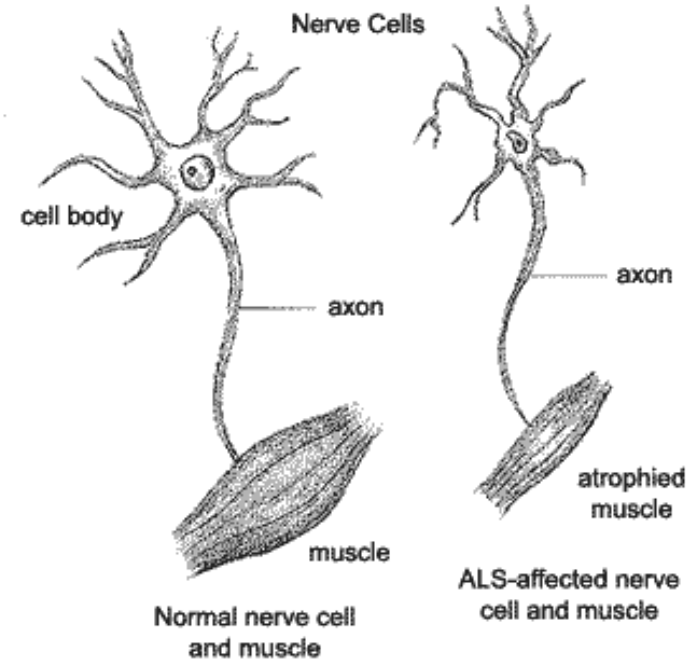
- First signs and symptoms (frequently overlooked)
  - Twitching and cramping of muscles (especially in hands and feet)
  - Stiffness
  - Weakness (especially in hands, arms and legs)
  - Slurred speech



Picture taken from the National Institute of Aging

# Symptoms continued . . .

- Later signs and symptoms:
  - Difficulty chewing and swallowing
  - Shortness of breath
  - Muscle weakness due to wasting away of muscles
    - Causes muscles to become smaller
  - Respiratory failure
  - Paralysis




Picture from the ALS Association

This picture from the Neuromuscular website shows the wasting away of a person's hands and arms

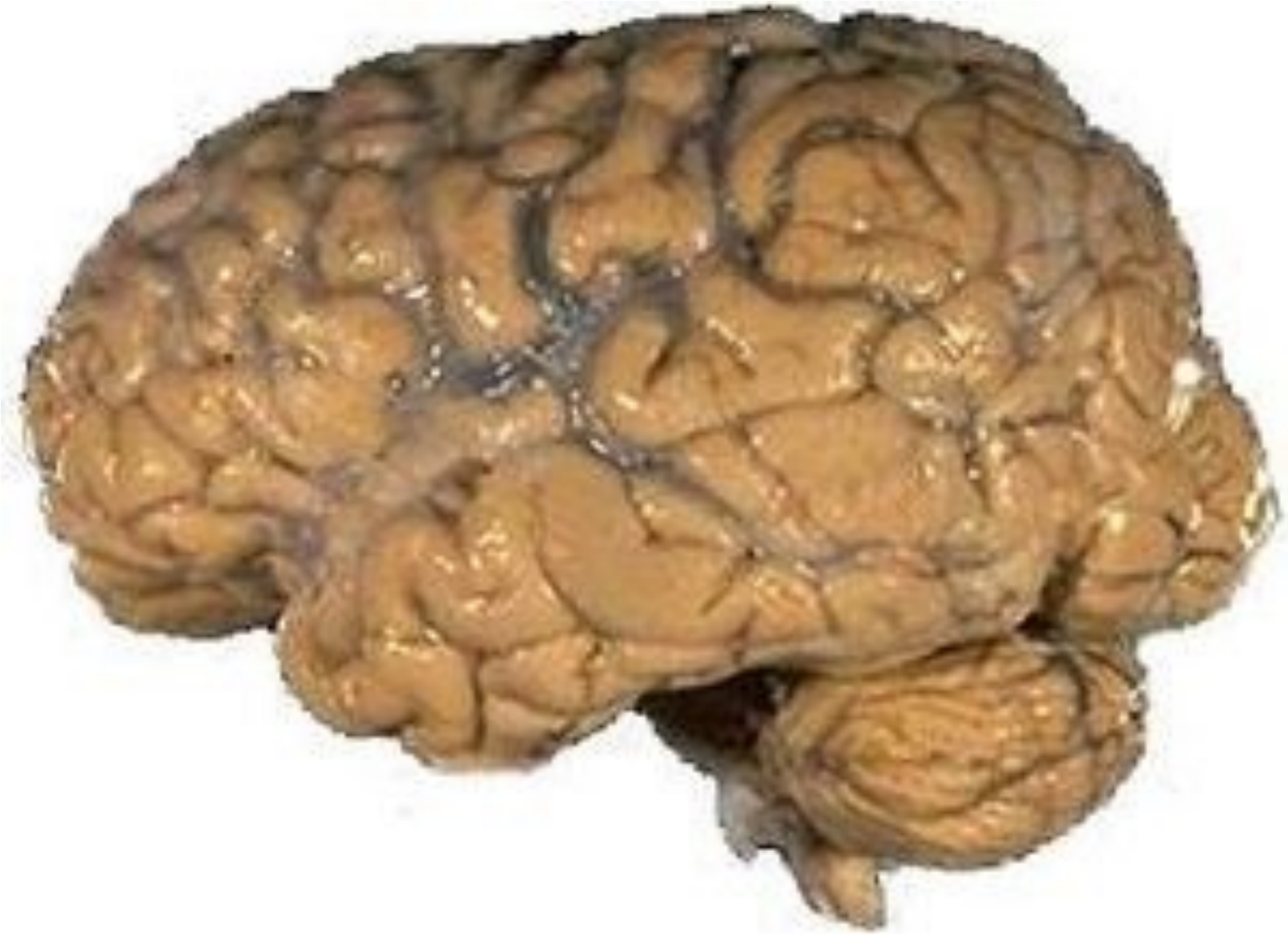
- Symptoms, or patterns of symptoms, are not the same for each ALS individual
- However, progressive muscle weakness and paralysis are universally experienced
- Since ALS attacks only motor neurons, the sense of sight, touch, hearing, taste, and smell are not affected
- Patients usually only live 3 to 5 years after they are diagnosed
- There are some cases; however, where individuals have lived 10 or more years

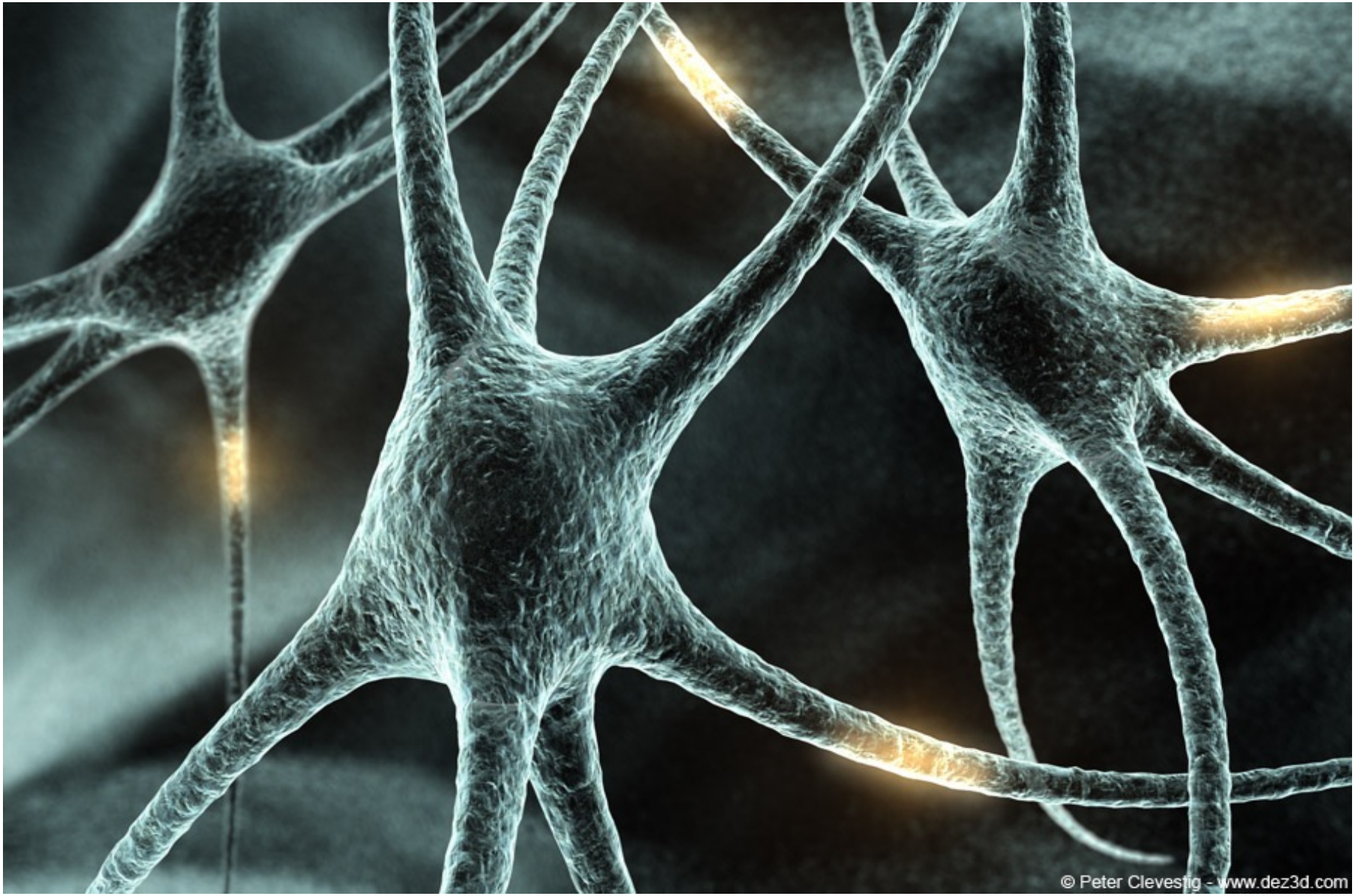
# Diagnosing ALS

- 5,600 people in the US are diagnosed with ALS each year (about 700 in Canada)

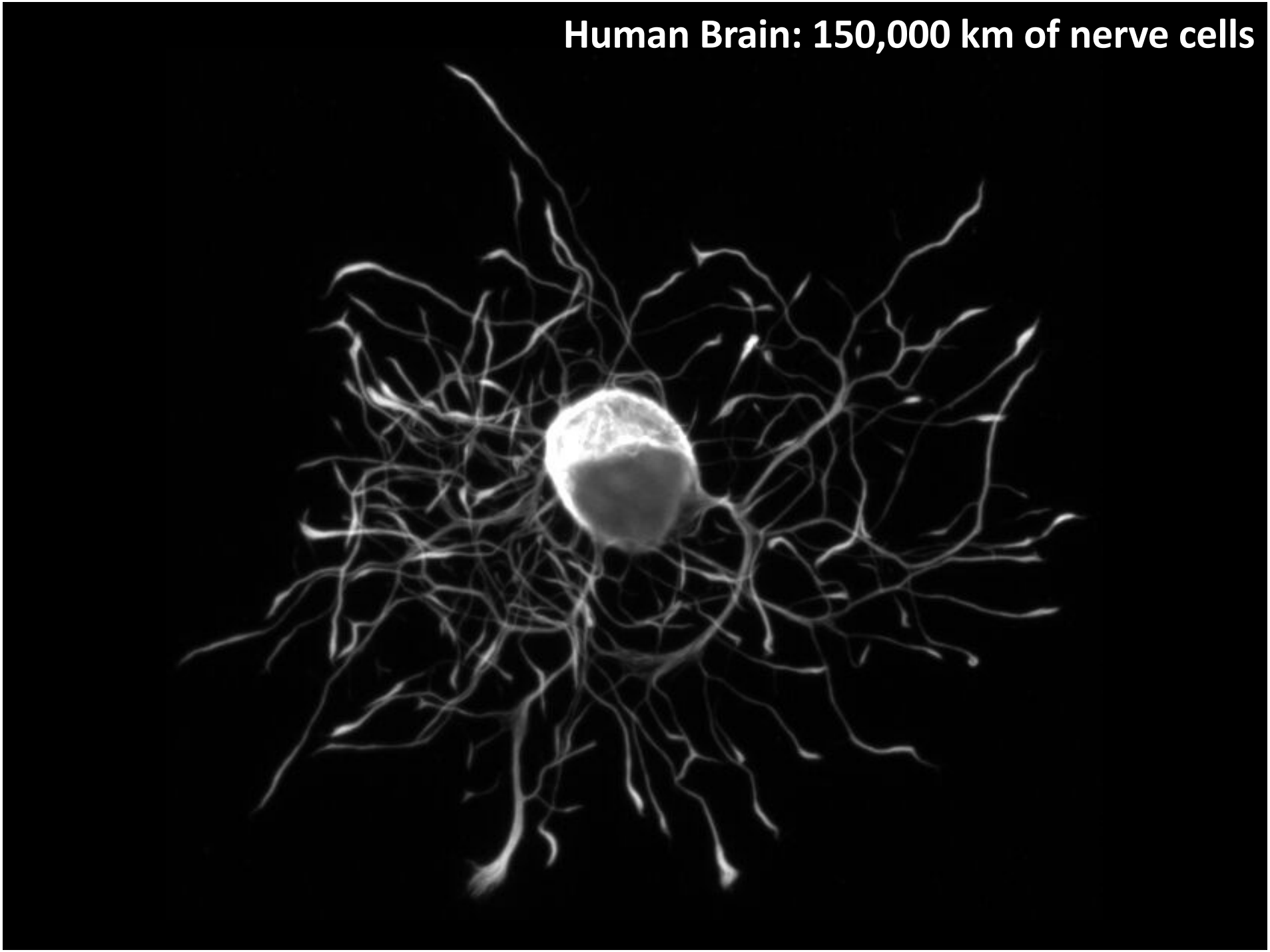
- ALS is a very difficult disease to diagnose

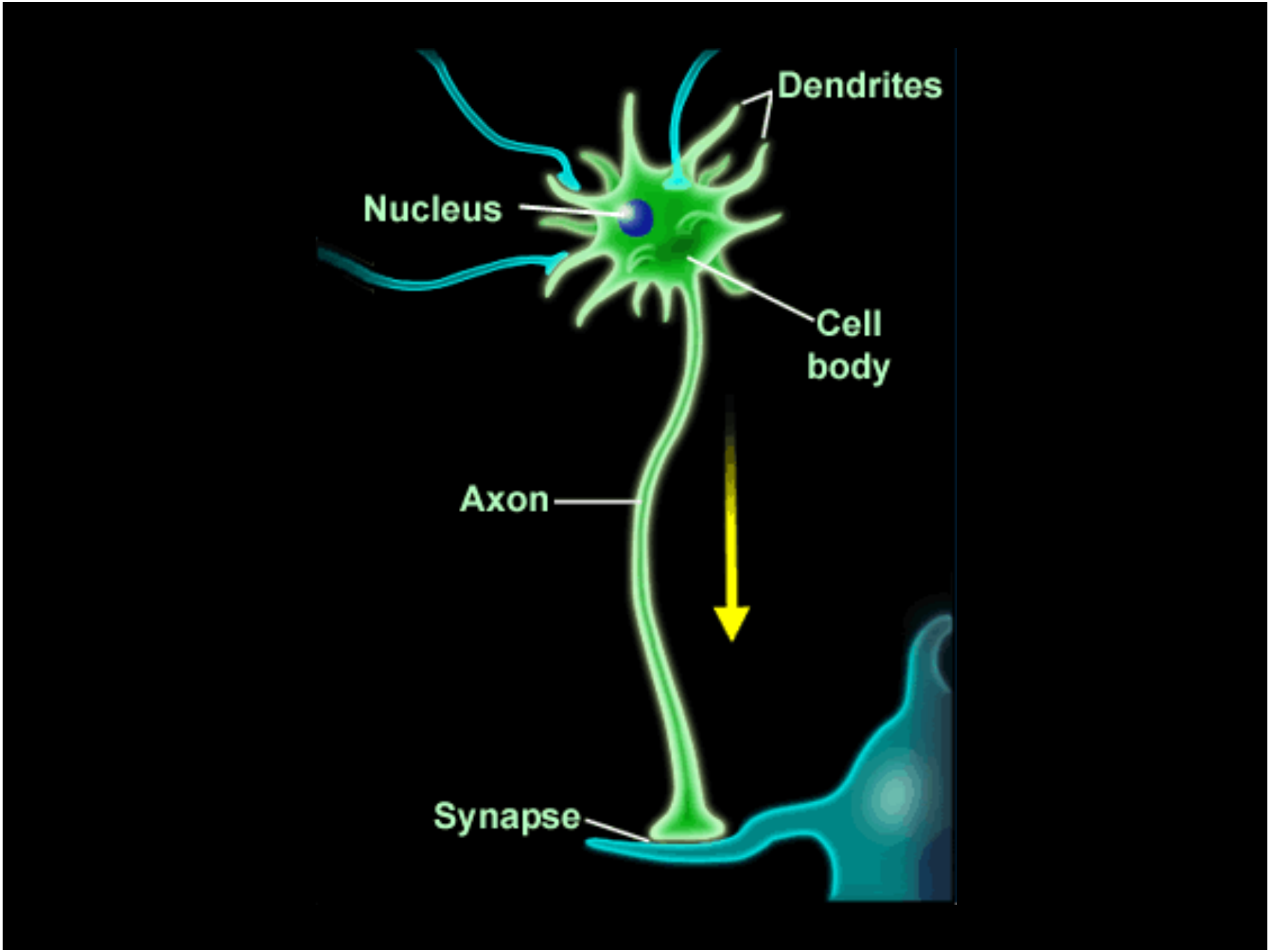
# Lecture 1B:
# Neurons

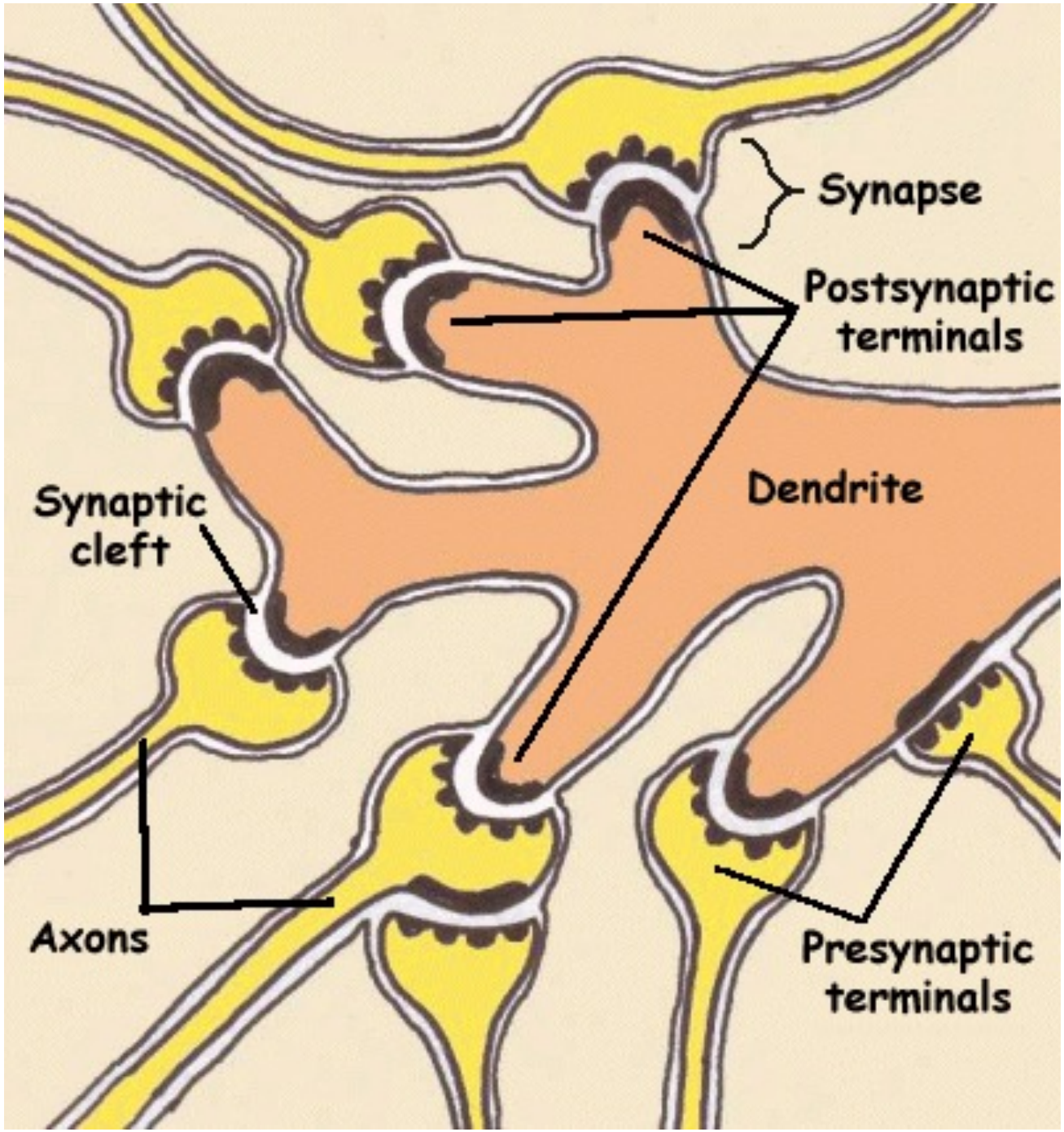


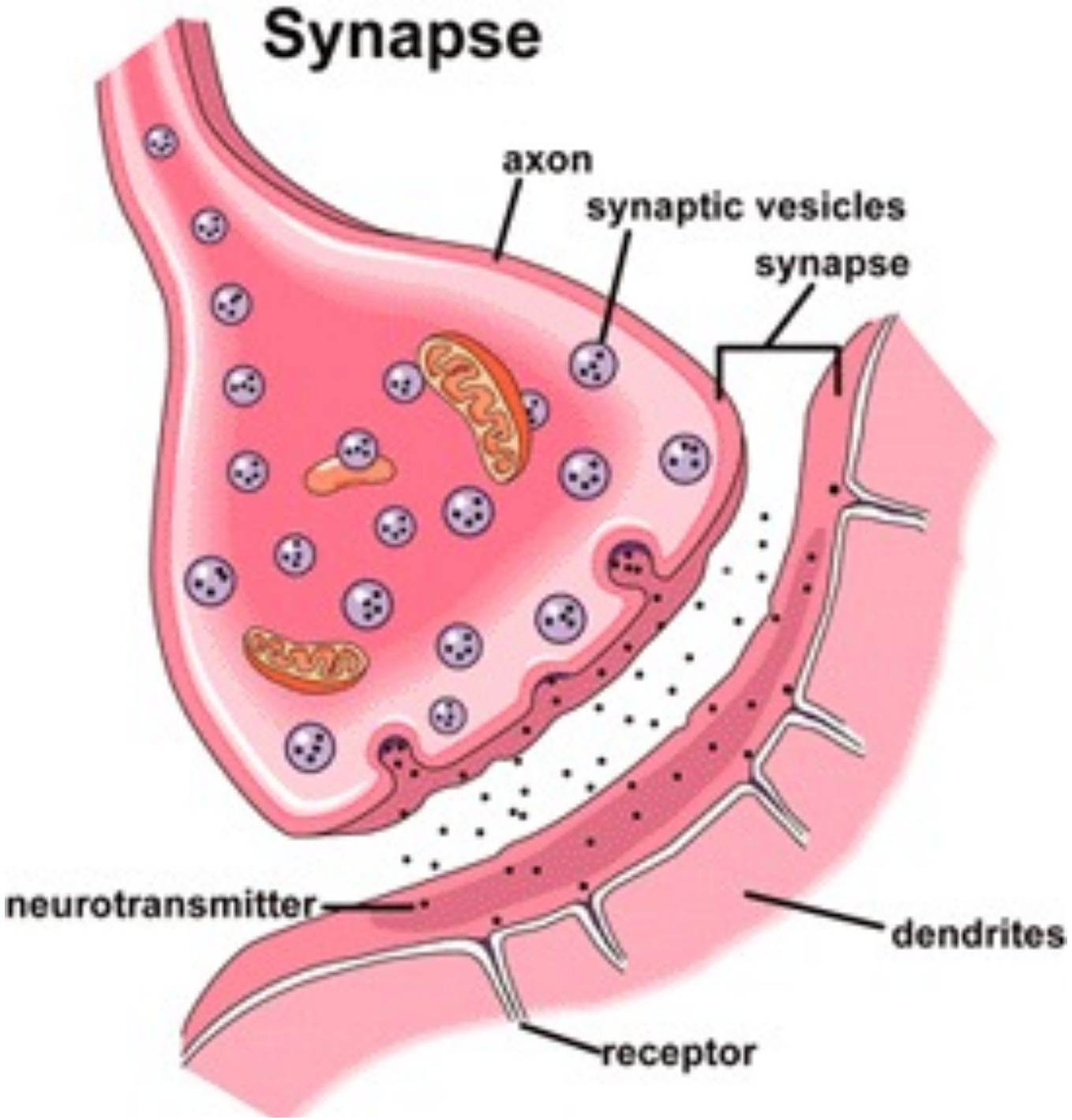


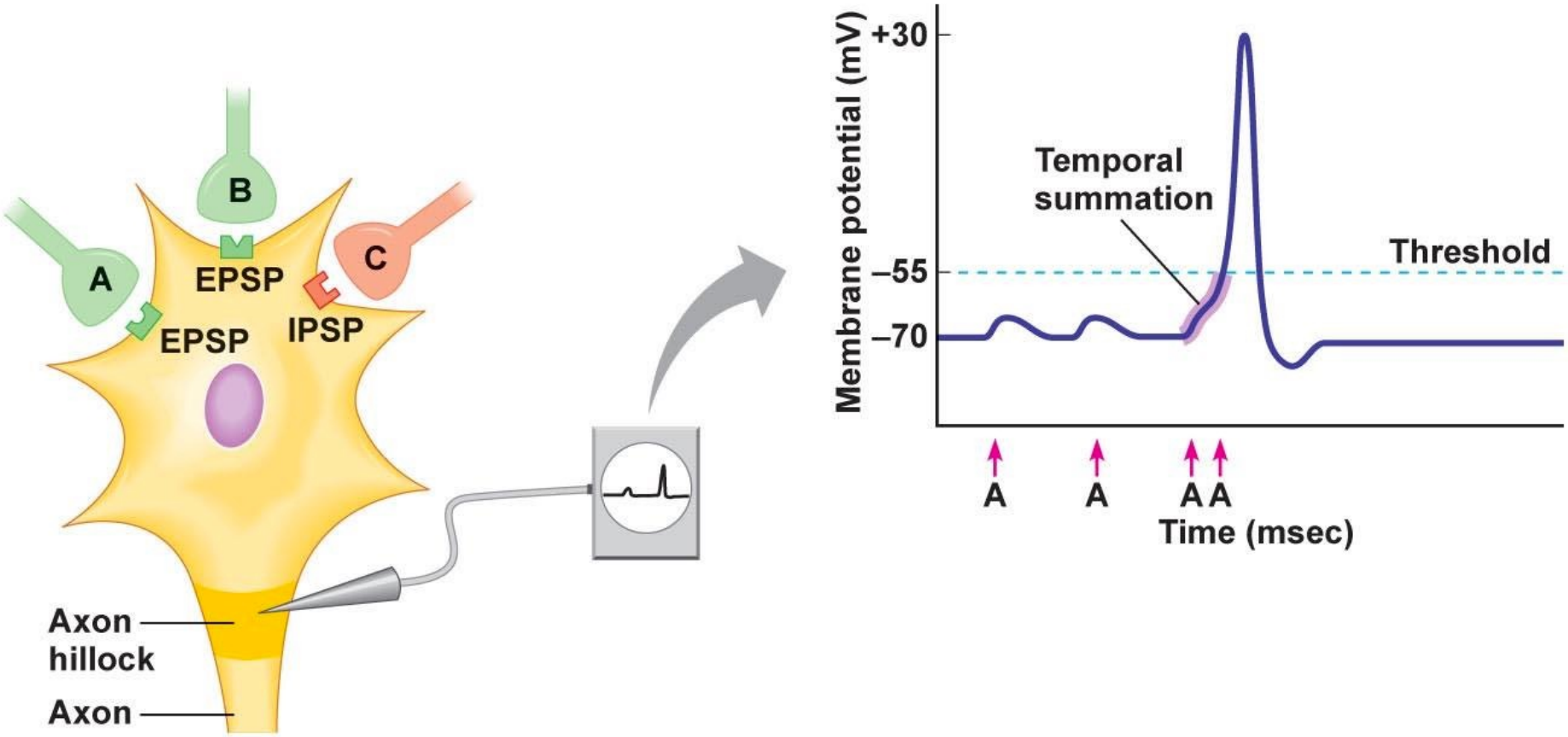

**Human Brain:** **86 billion neurons**
**0.15 quadrillion nerve synapses (million x billion)**

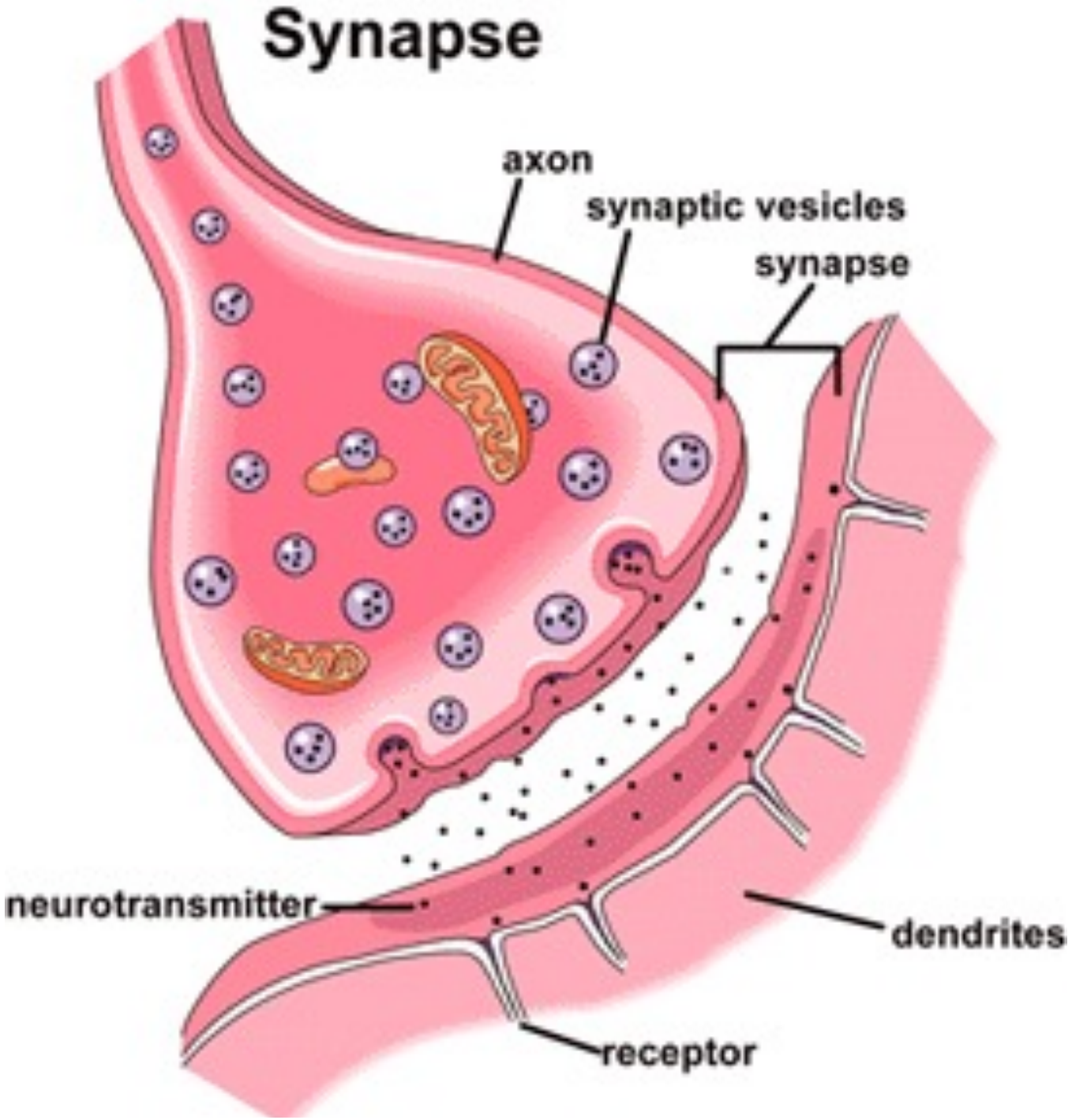

Human Brain: 150,000 km of nerve cells


Dendrites
Nucleus
Cell body
Axon
Synapse


Synapse
Postsynaptic terminals
Dendrite
Synaptic cleft
Axons
Presynaptic terminals

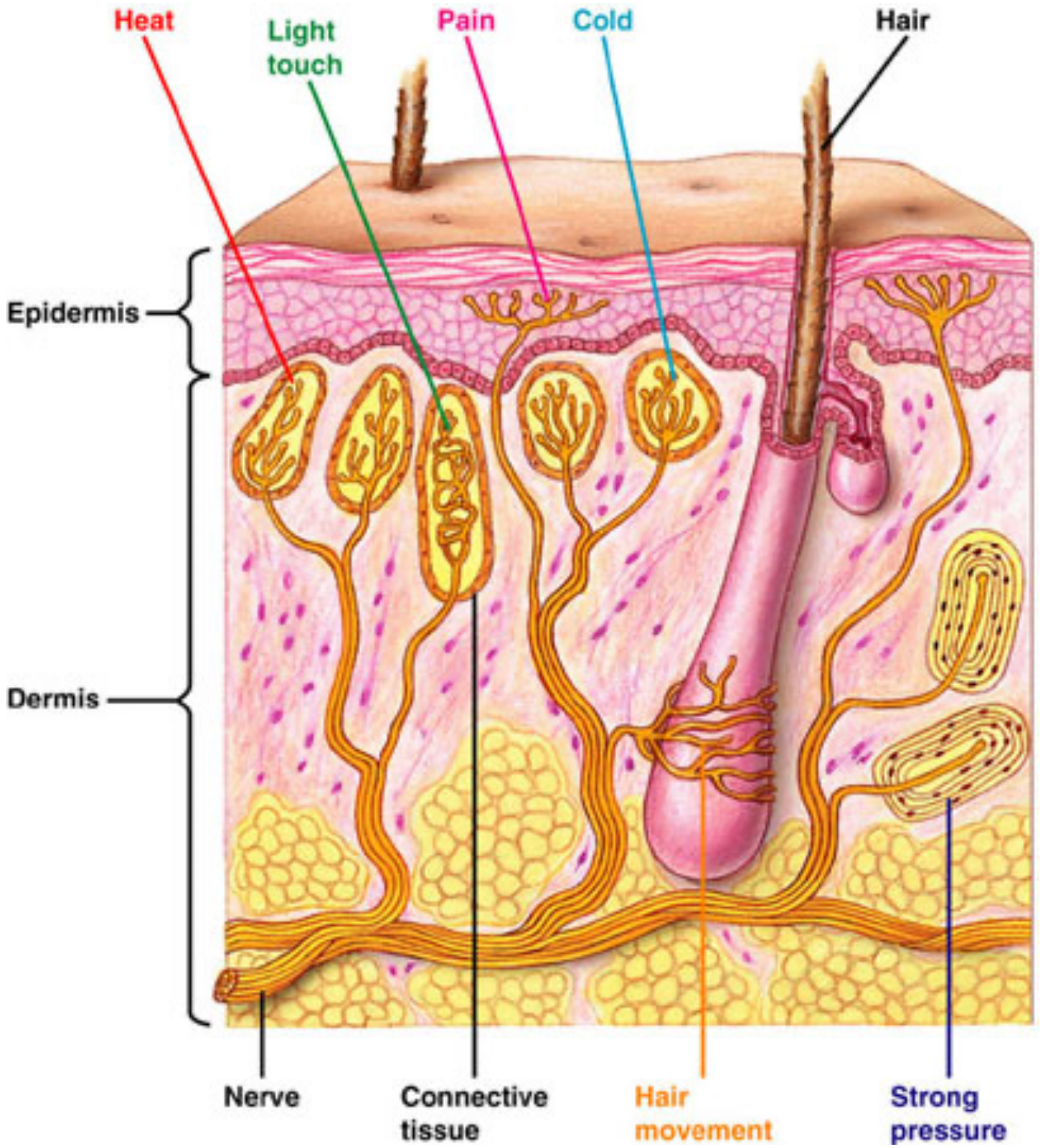

Synapse
axon
synaptic vesicles
synapse
neurotransmitter
dendrites
receptor

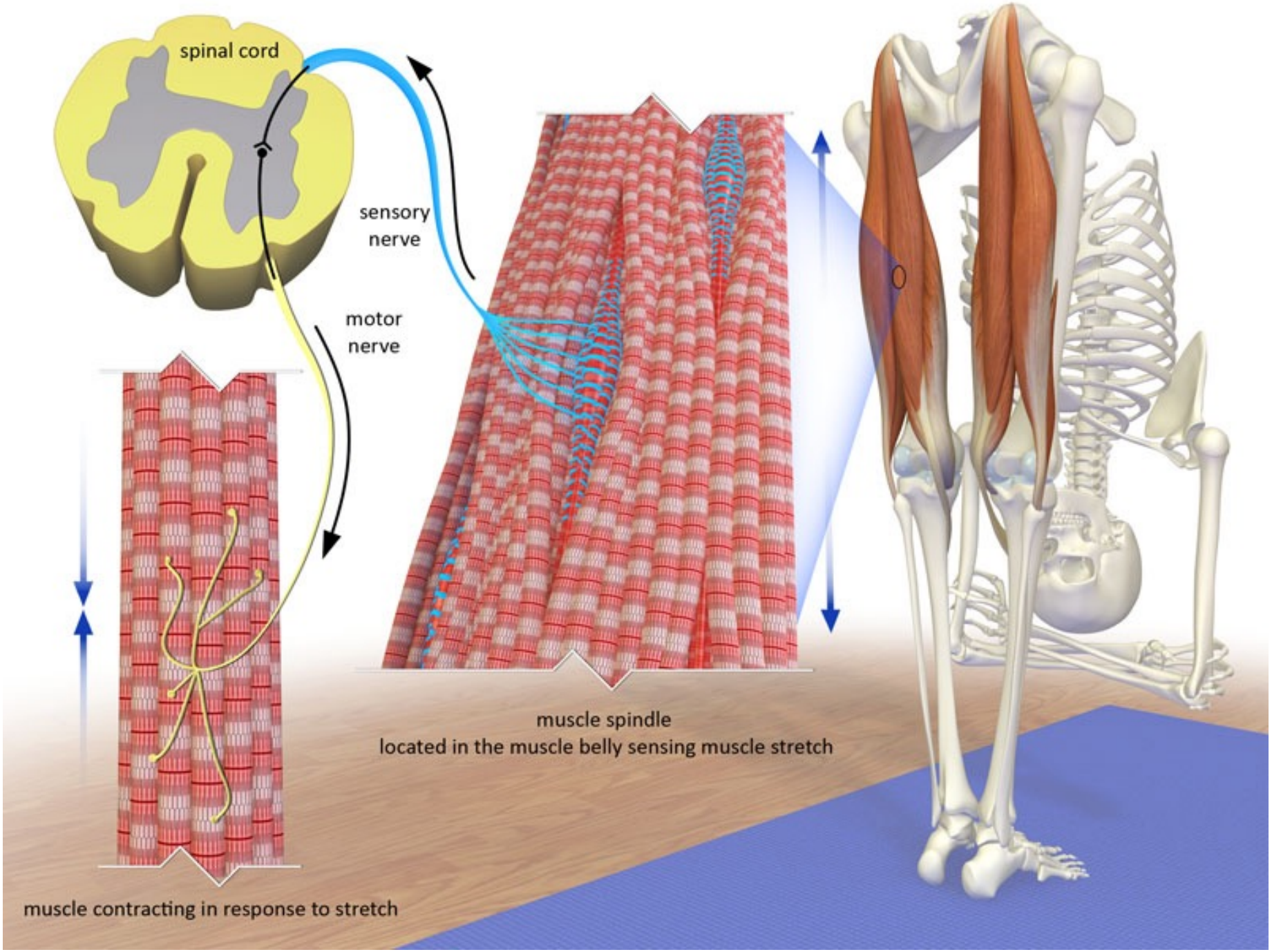


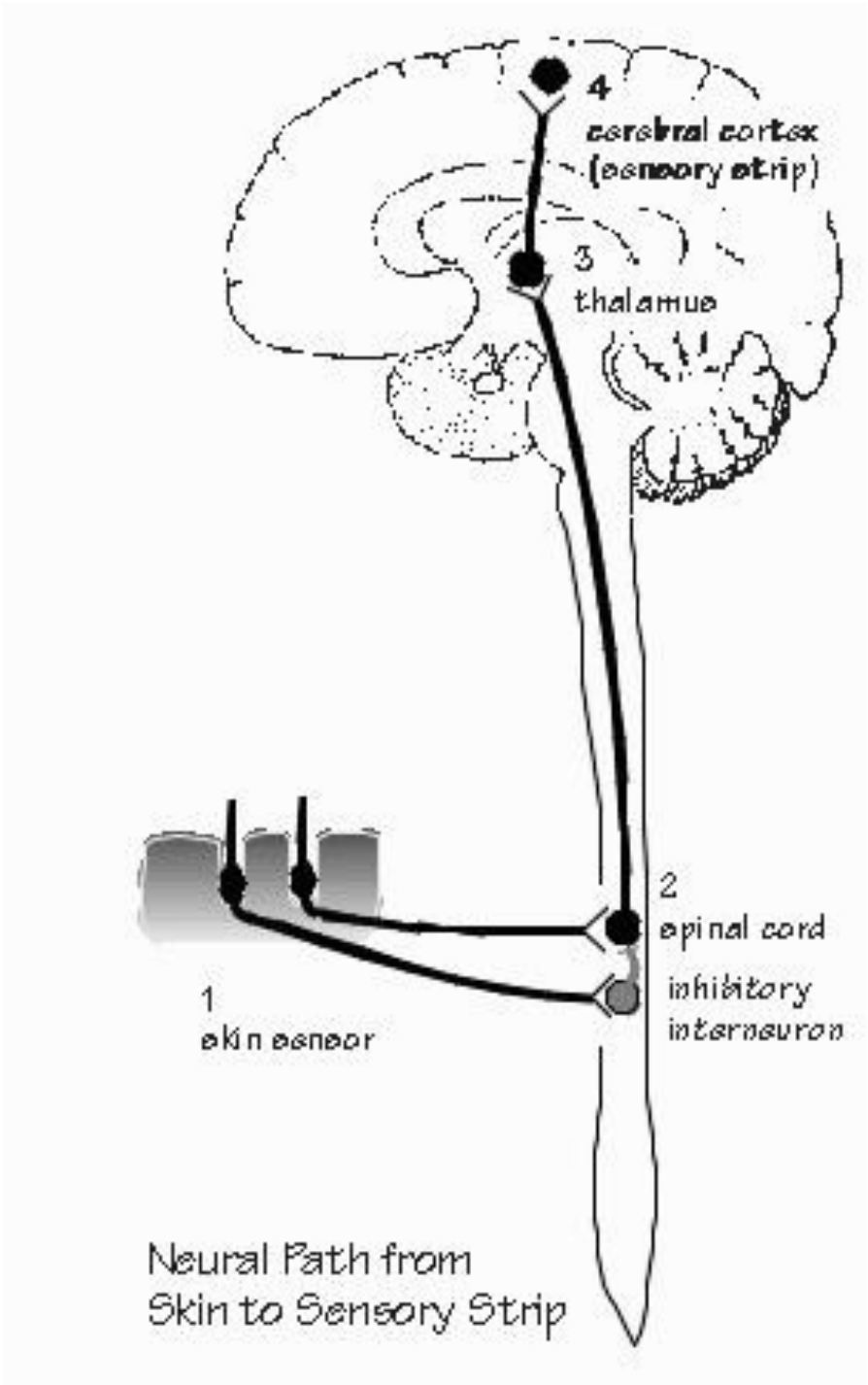

Synapse
axon
synaptic vesicles
synapse
neurotransmitter
dendrites
receptor

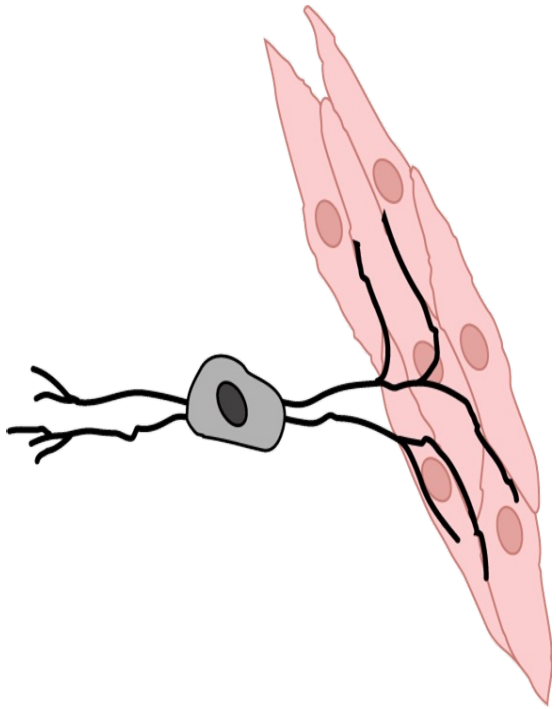
0 or 1

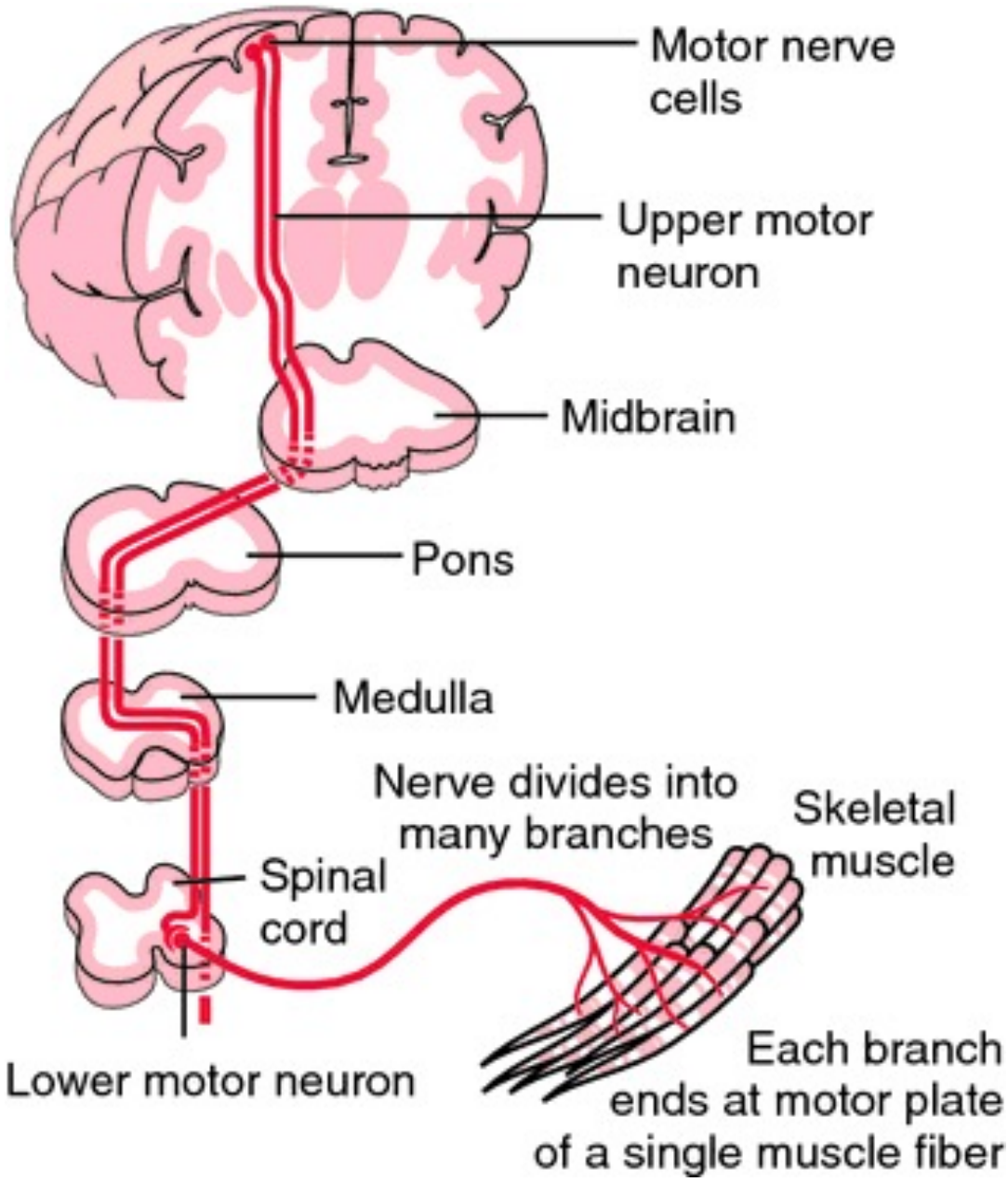
# The Neuron as a Detector


Heat
Light touch
Pain
Cold
Hair
Epidermis
Dermis
Nerve
Connective tissue
Hair movement
Strong pressure

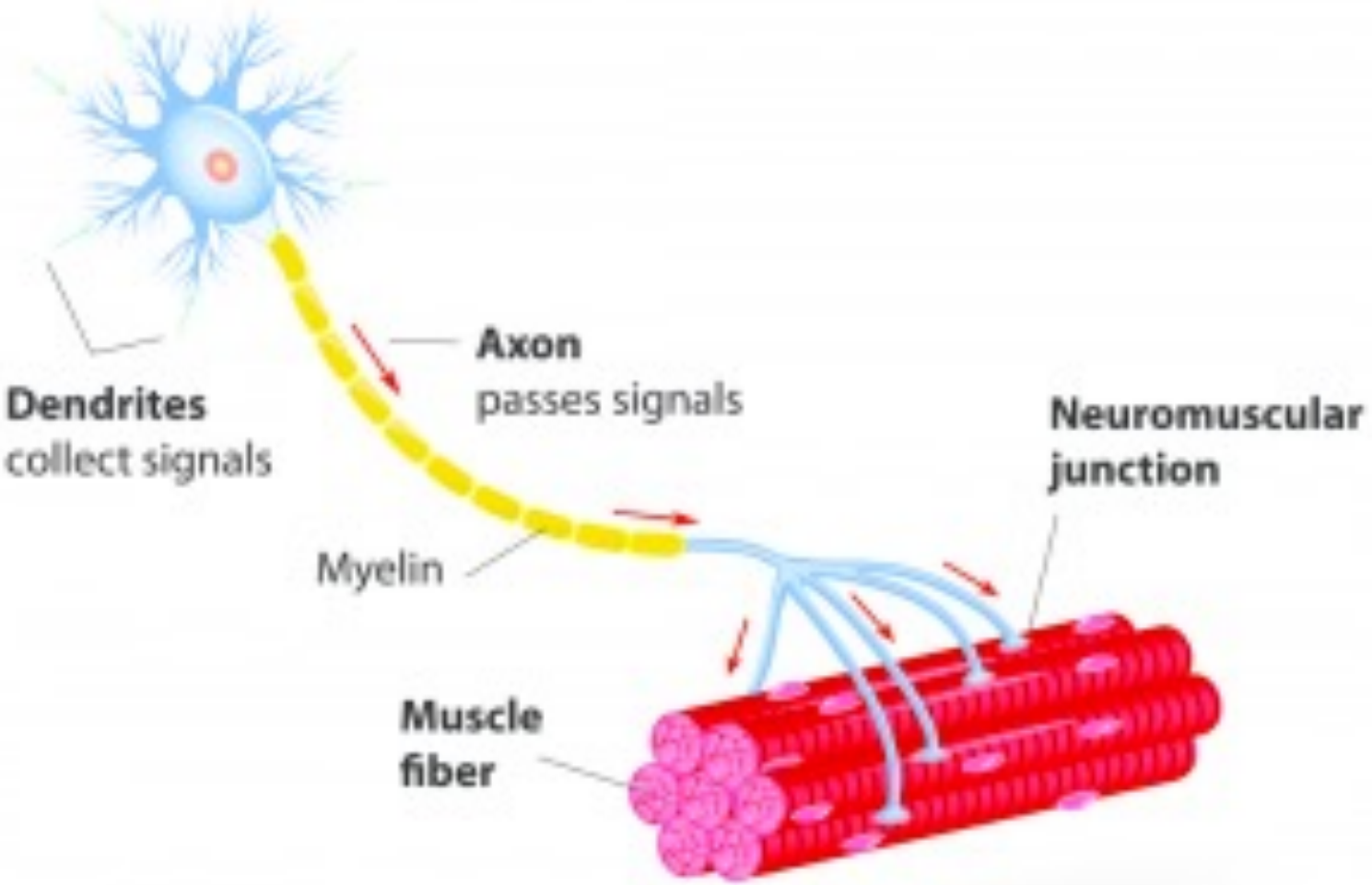

spinal cord
sensory nerve
motor nerve
muscle spindle
located in the muscle belly sensing muscle stretch
muscle contracting in response to stretch

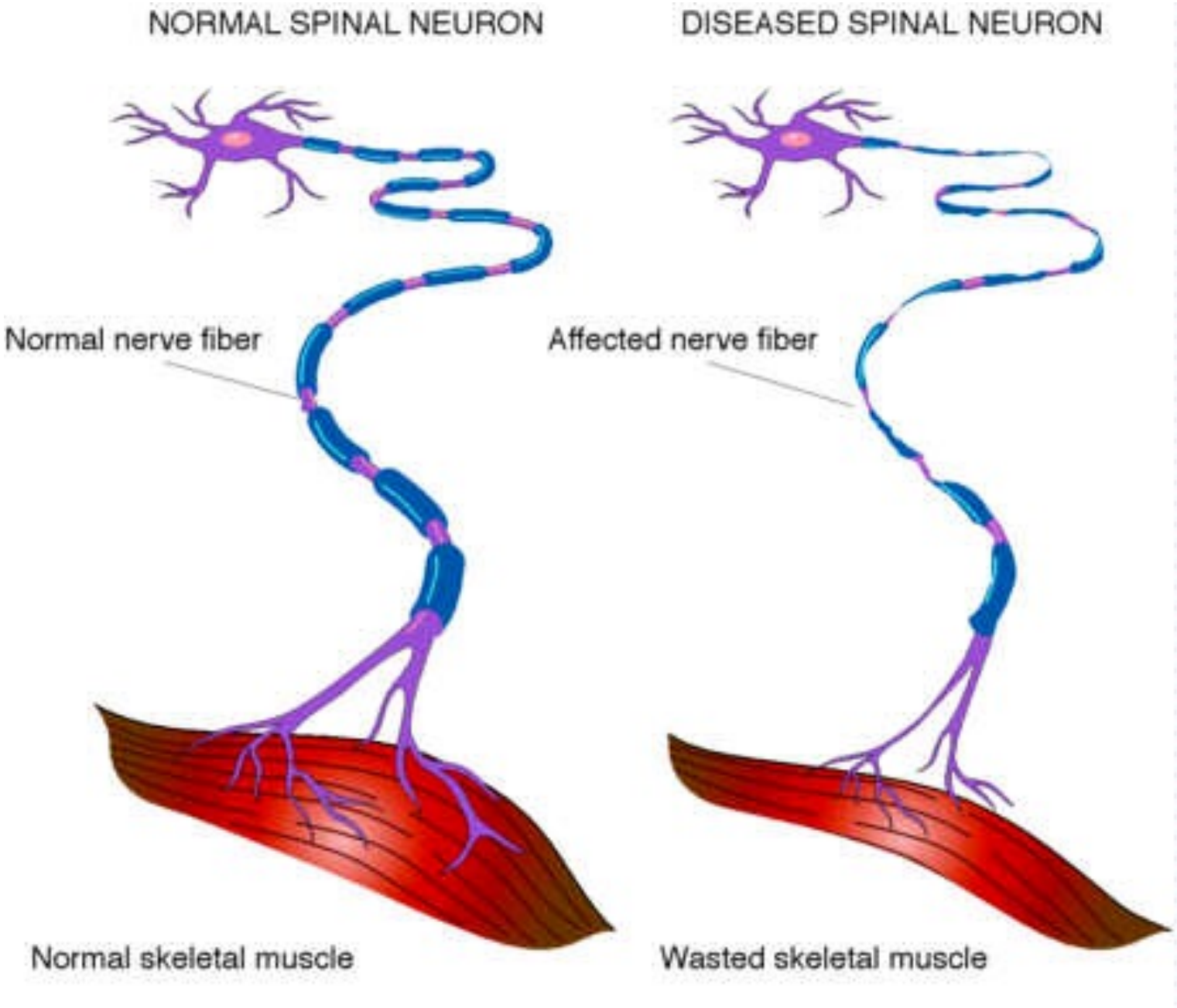

4
cerebral cortex
(sensory strip)
3
thalamus
2
spinal cord
inhibitory
interneuron
1
skin sensor
Neural Path from
Skin to Sensory Strip



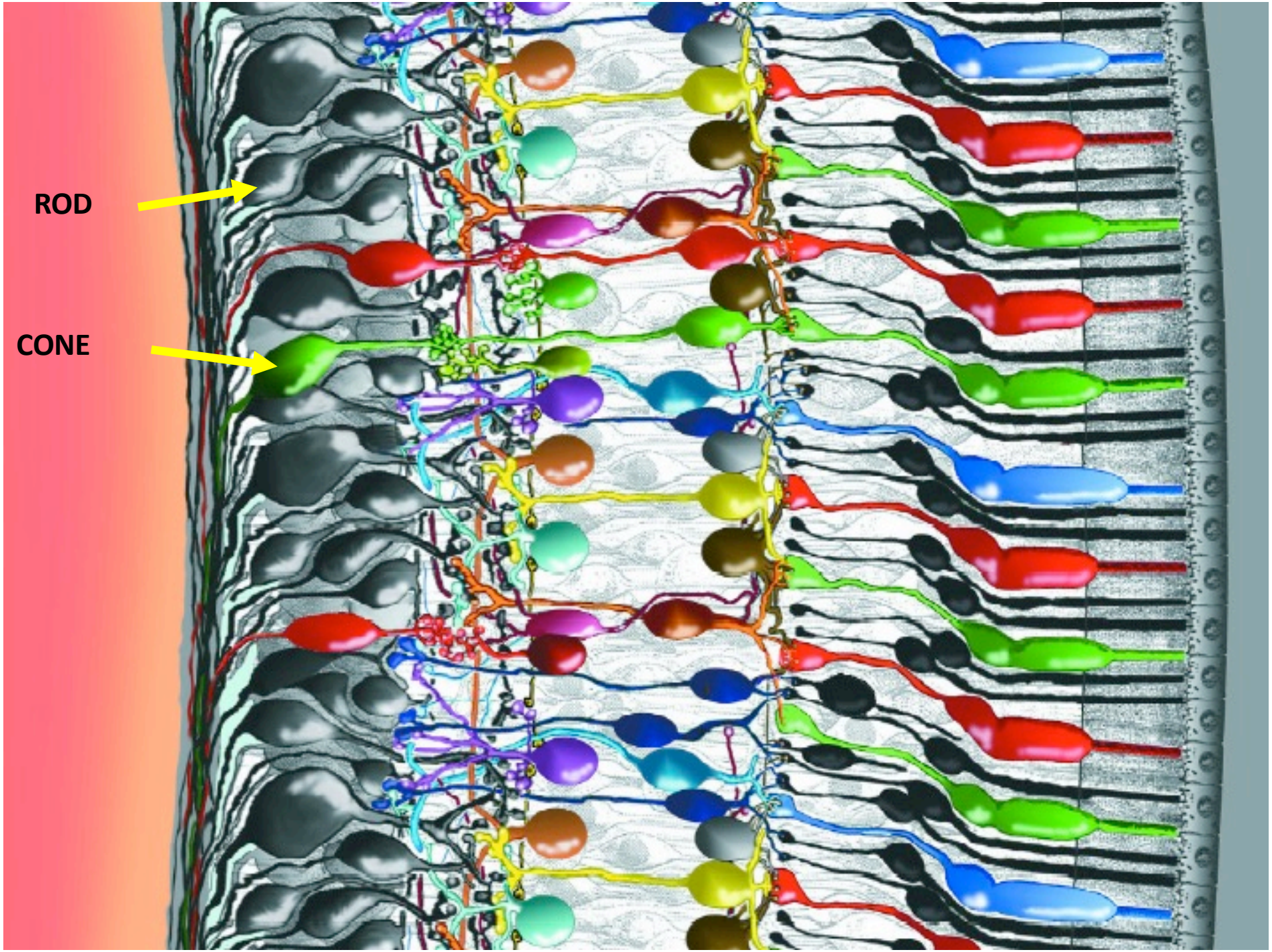

Motor nerve cells
Upper motor neuron
Midbrain
Pons
Medulla
Nerve divides into many branches
Skeletal muscle
Spinal cord
Lower motor neuron
Each branch ends at motor plate of a single muscle fiber

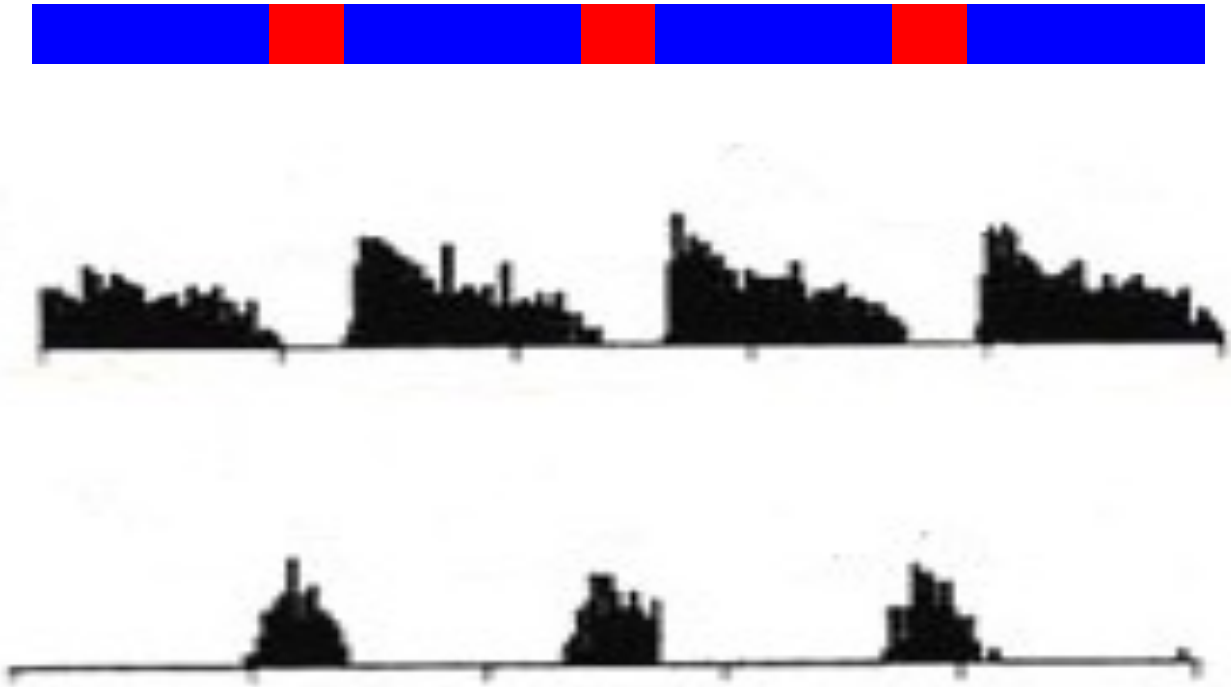
# MOTOR NEURON

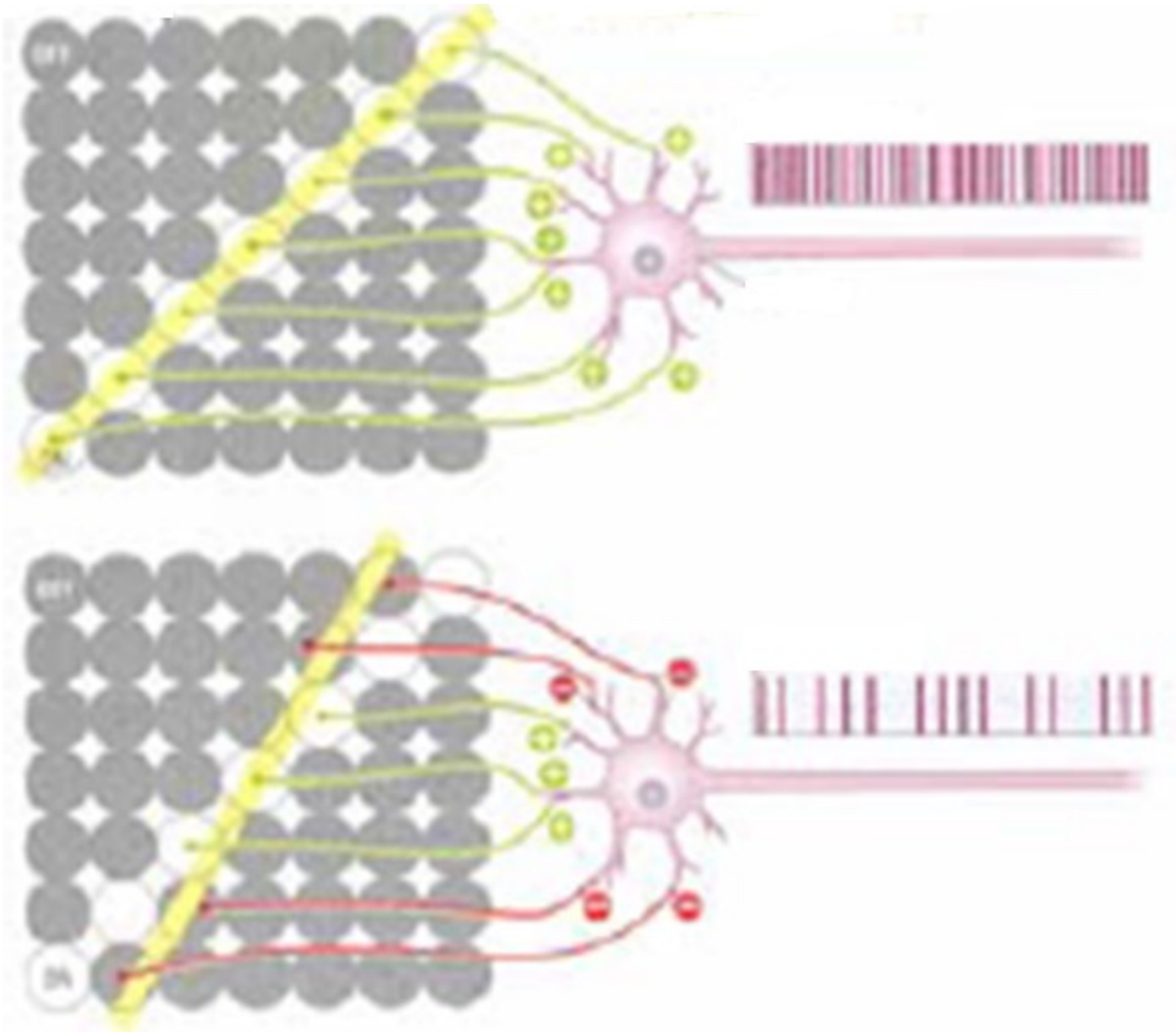



NORMAL SPINAL NEURON
DISEASED SPINAL NEURON
Normal nerve fiber
Affected nerve fiber
Normal skeletal muscle
Wasted skeletal muscle

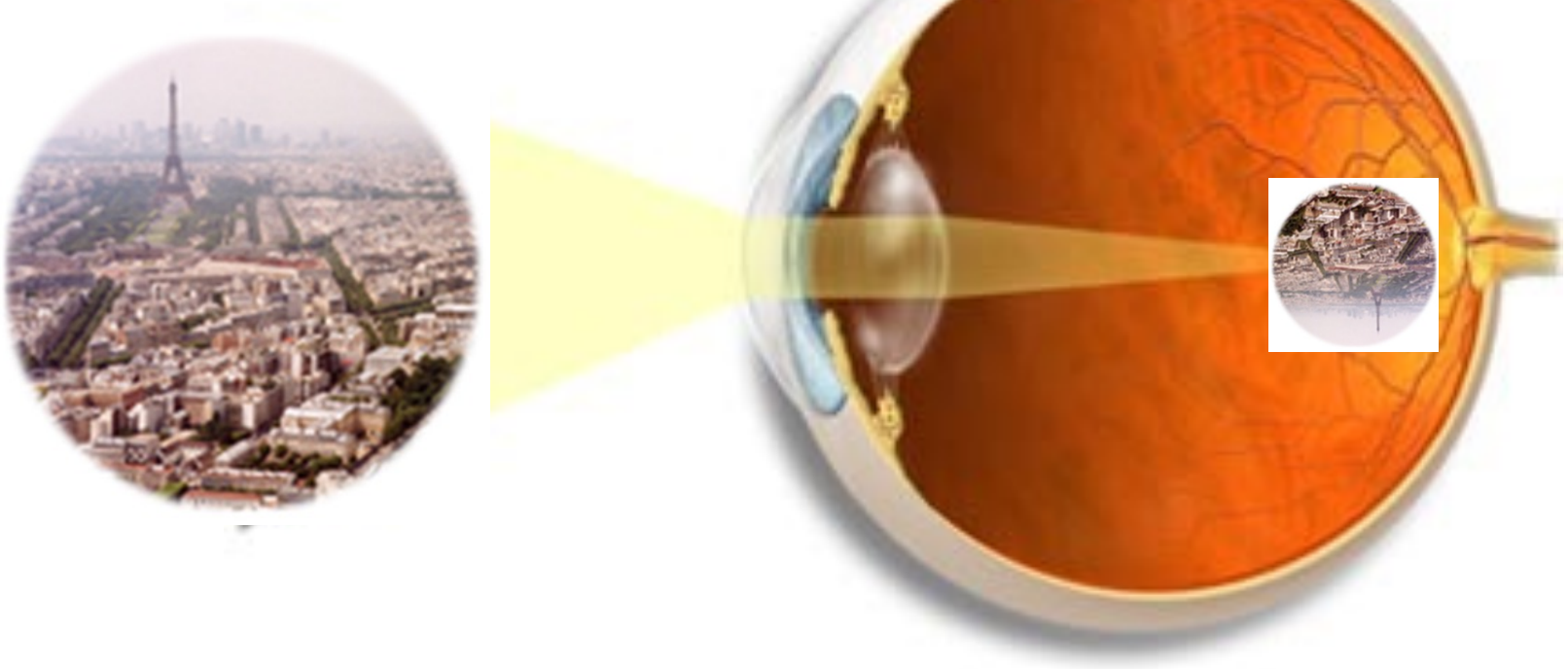
# Other Types of Neurons

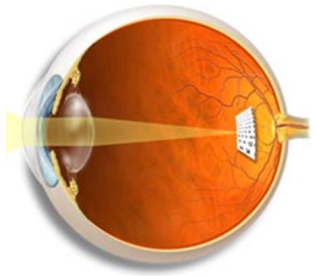

ROD
CONE

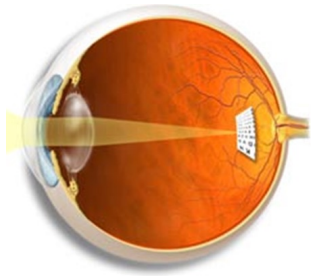


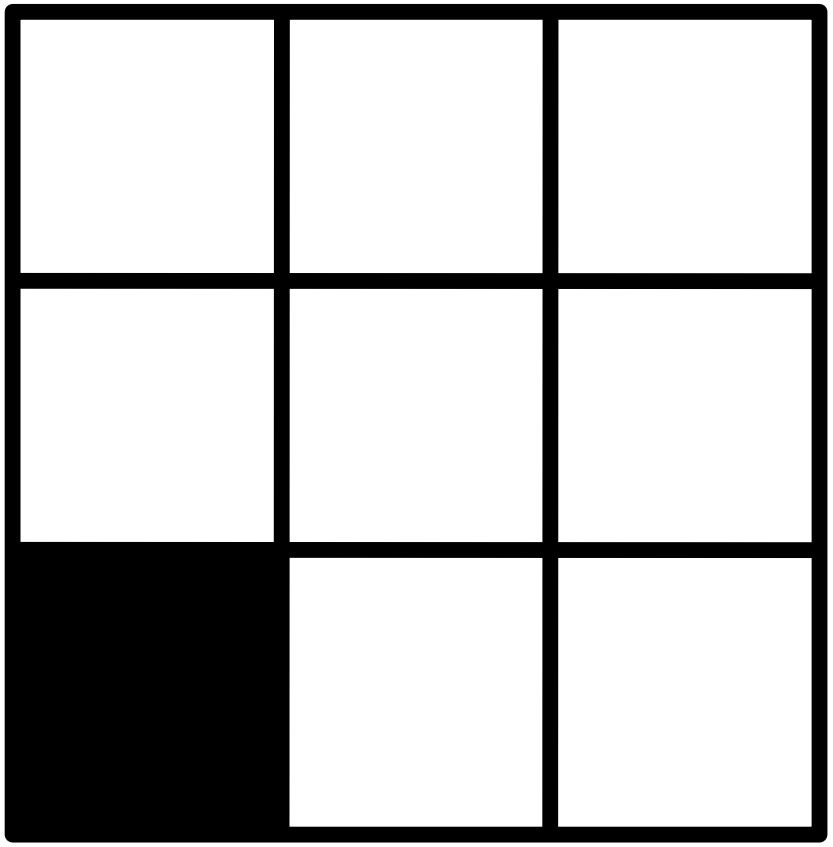


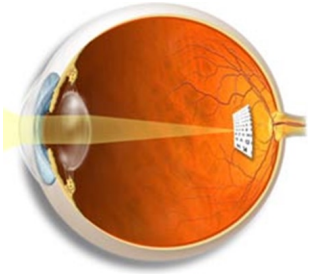
# Layers of Detectors

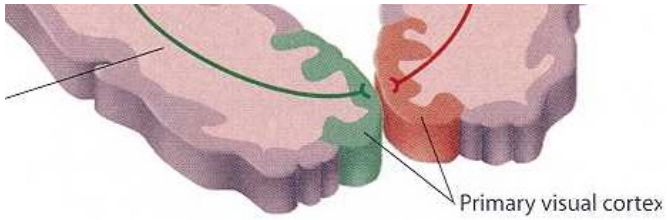


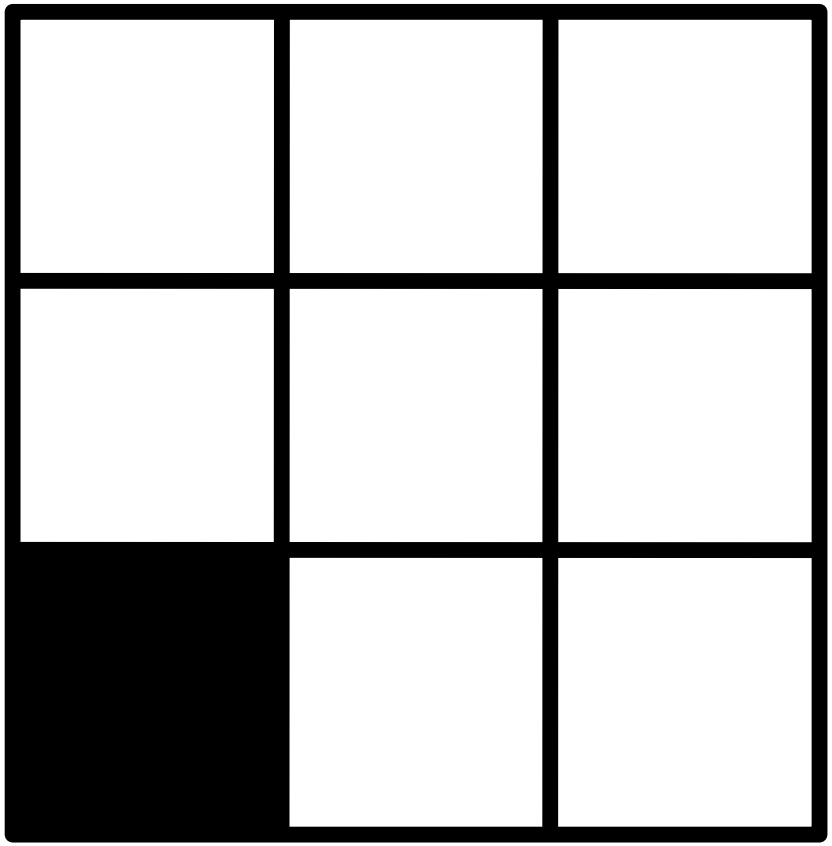


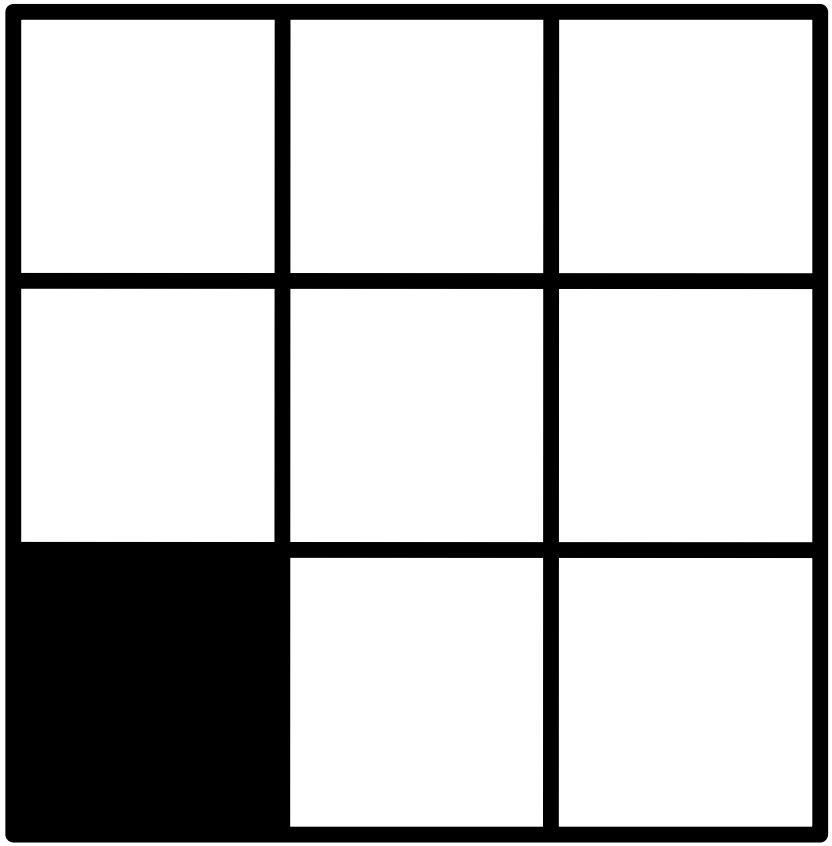


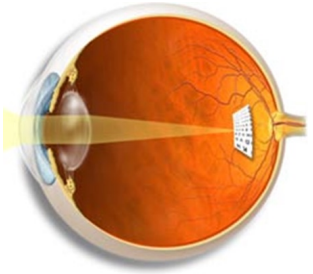


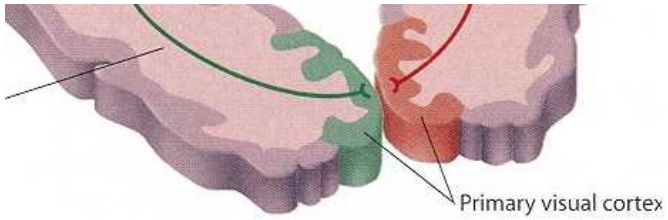


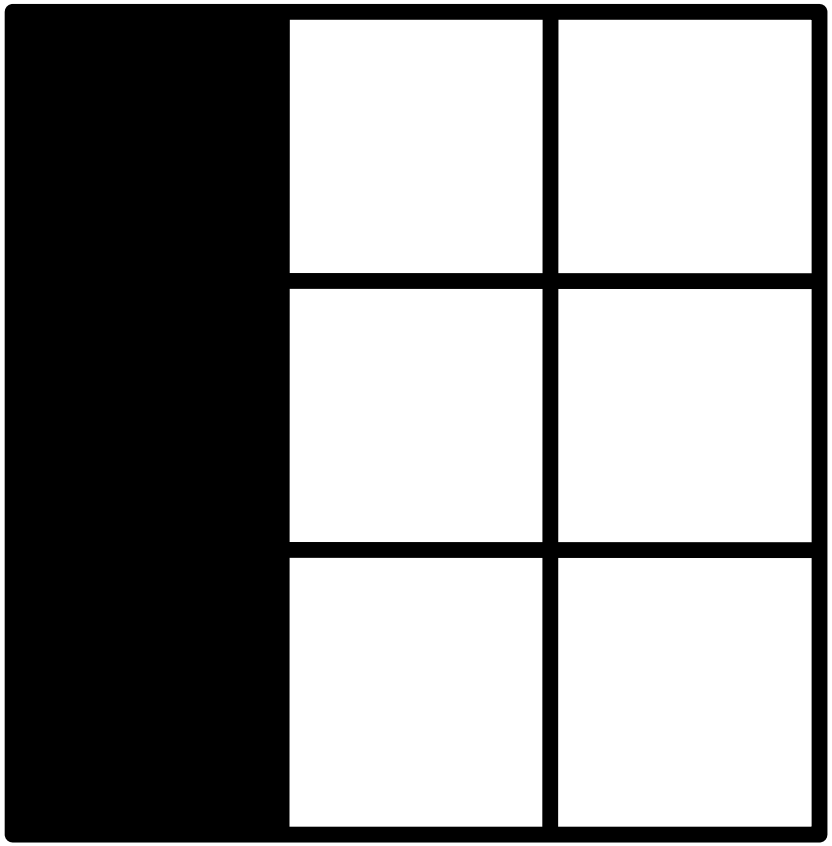

Primary visual cortex

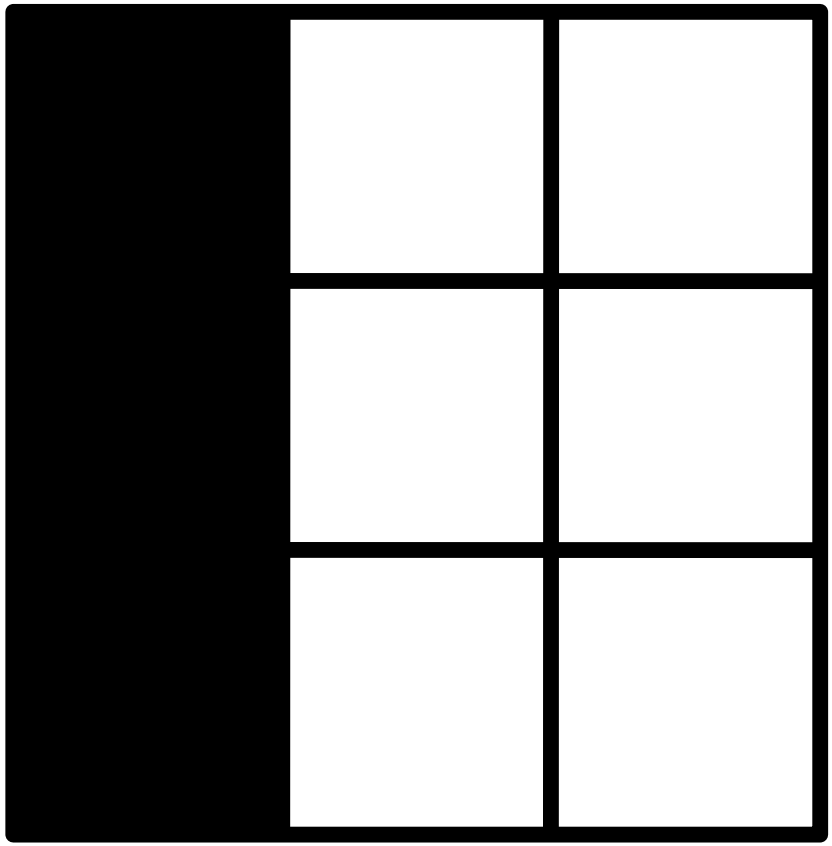


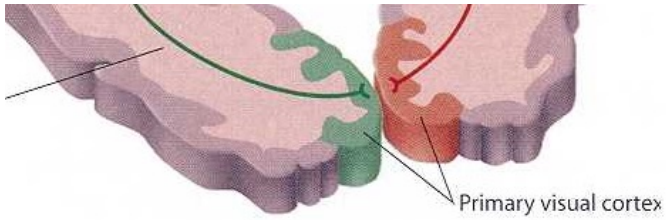


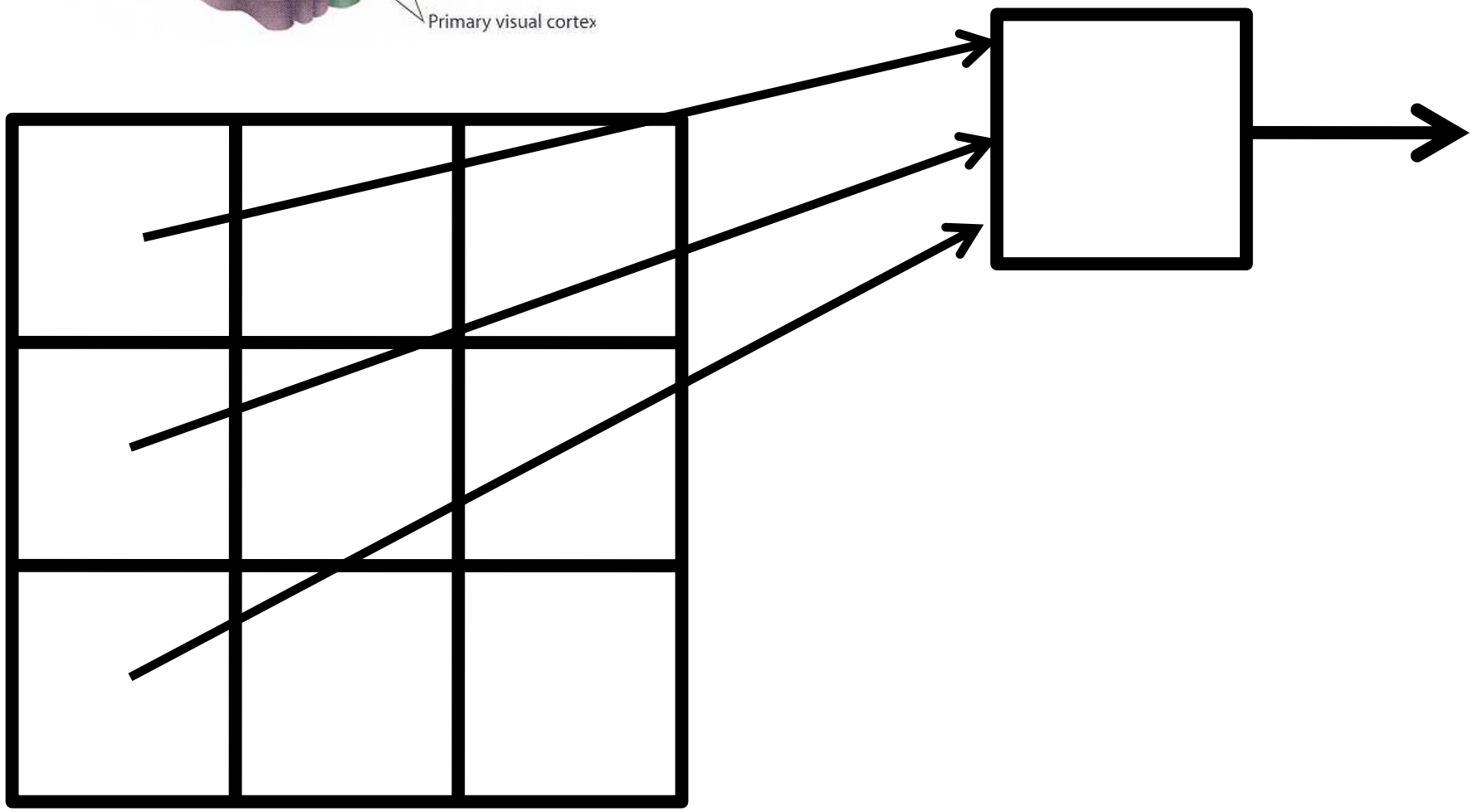


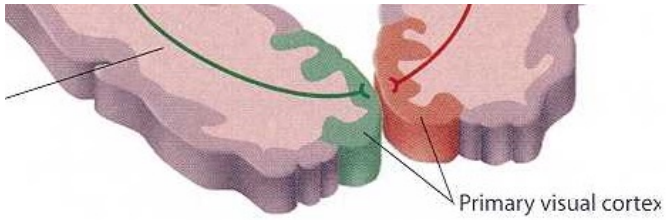

Primary visual cortex

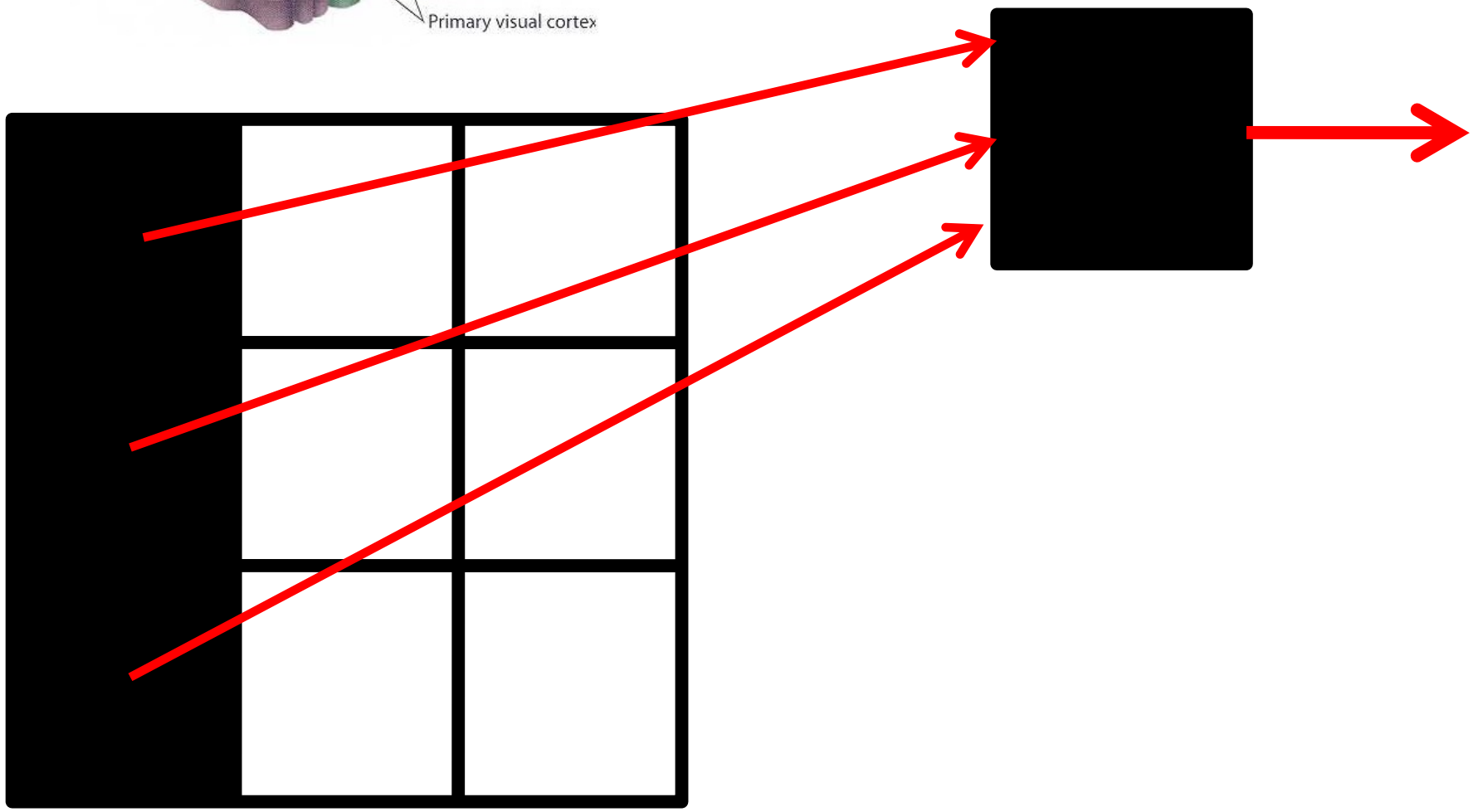


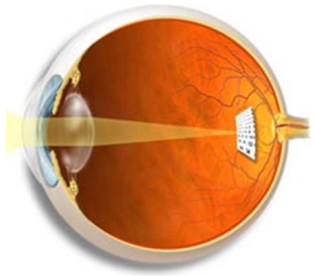


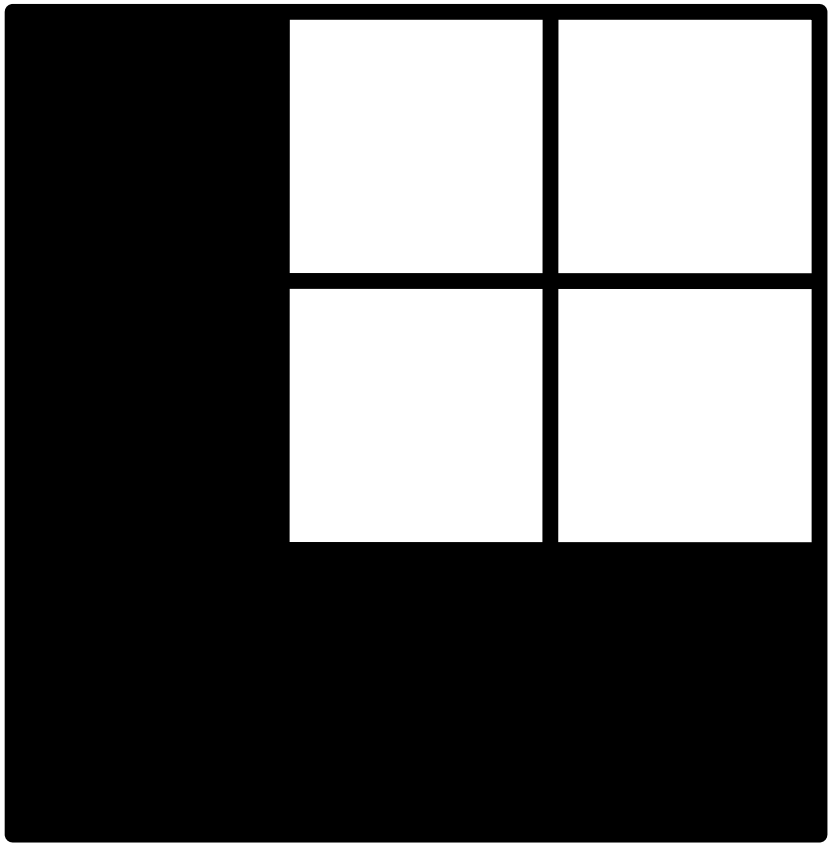

Primary visual cortex

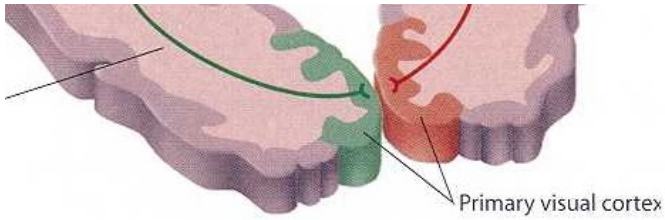


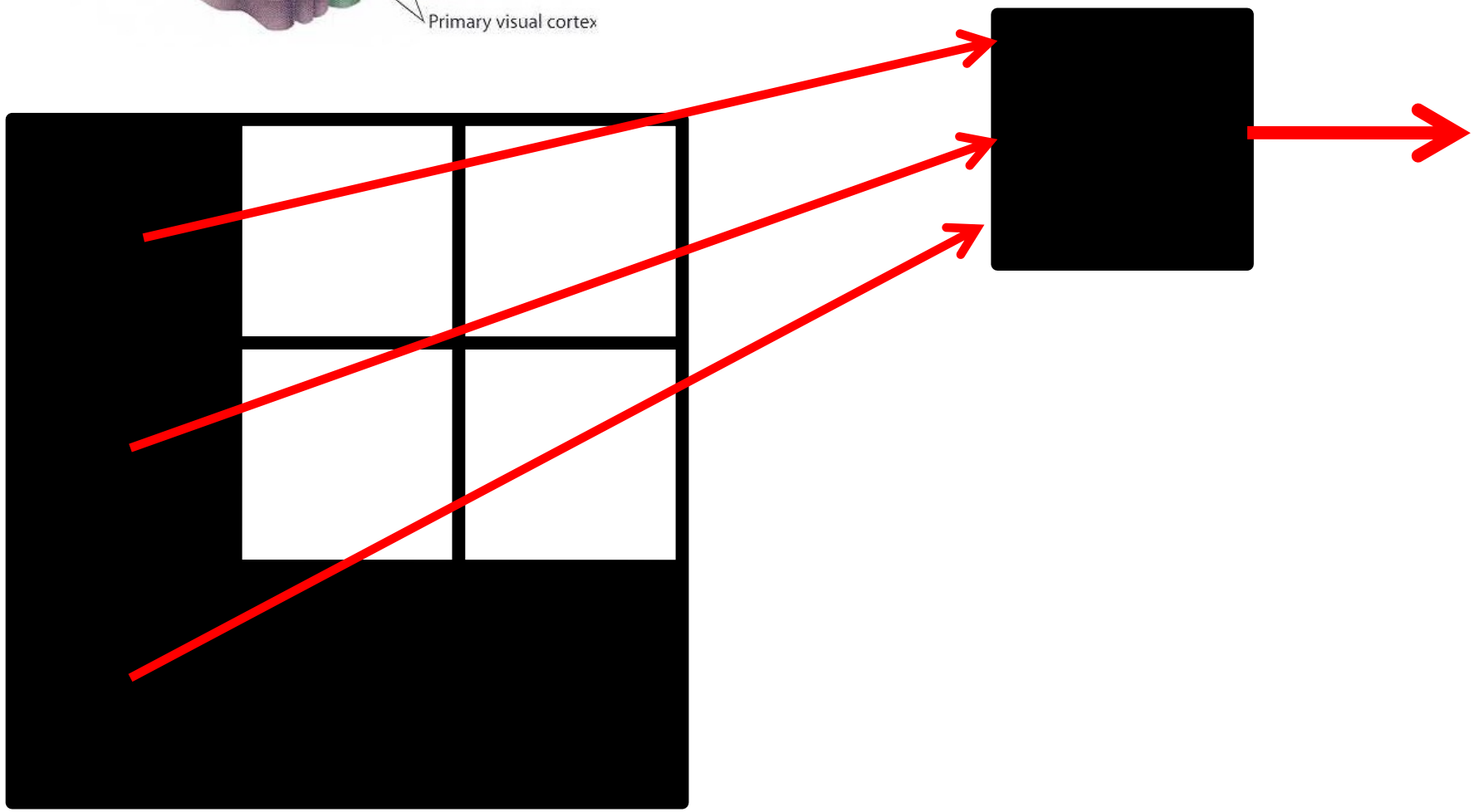

Primary visual cortex

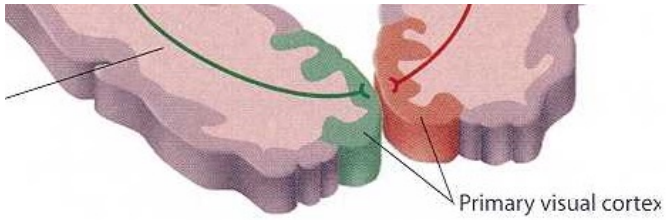







Primary visual cortex

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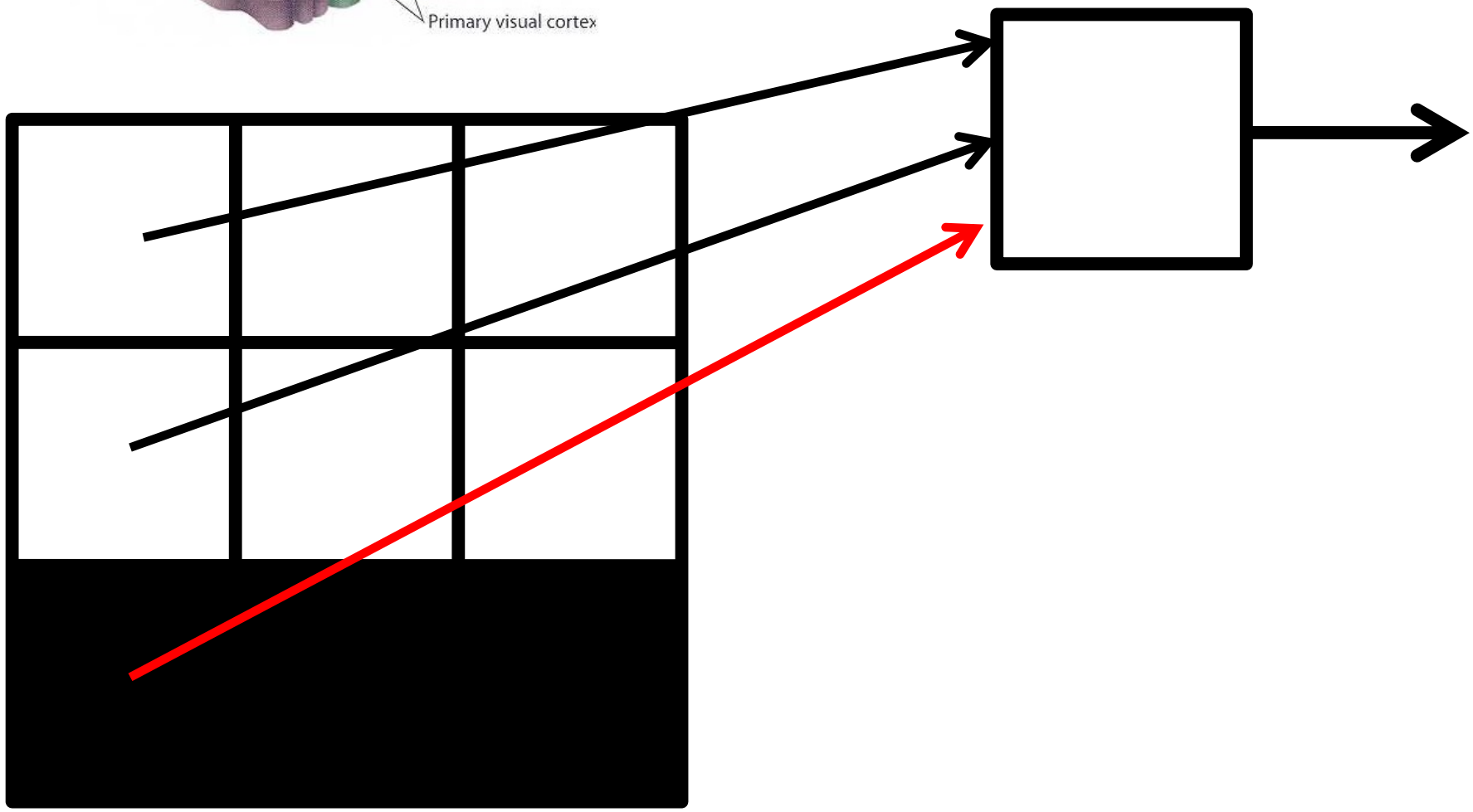

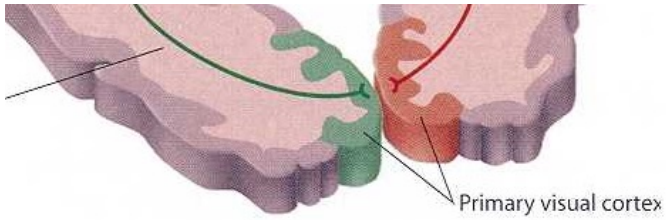
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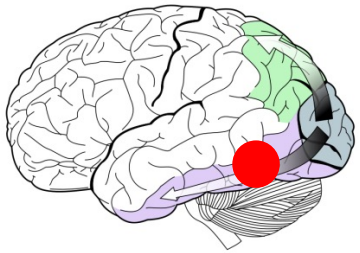
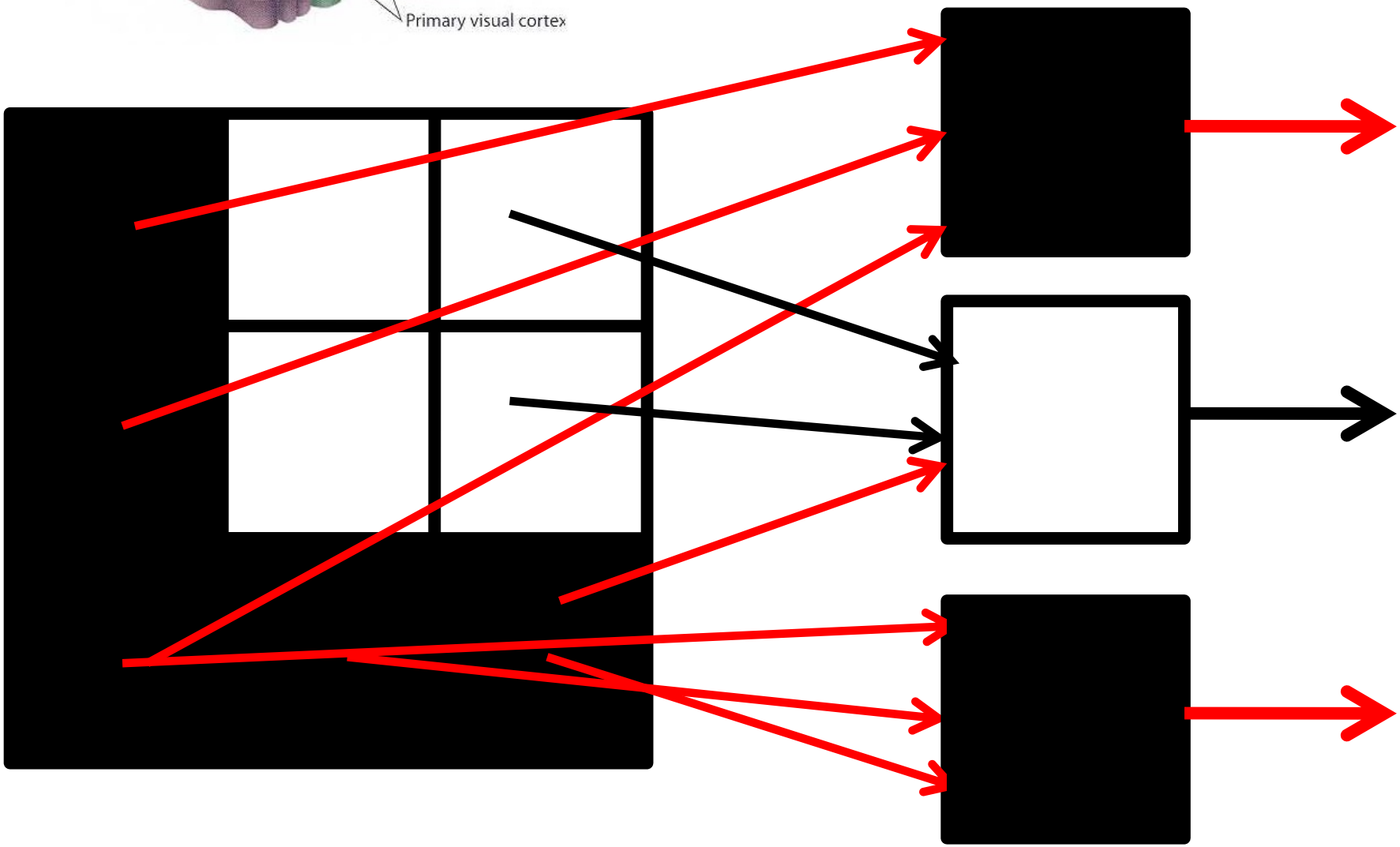
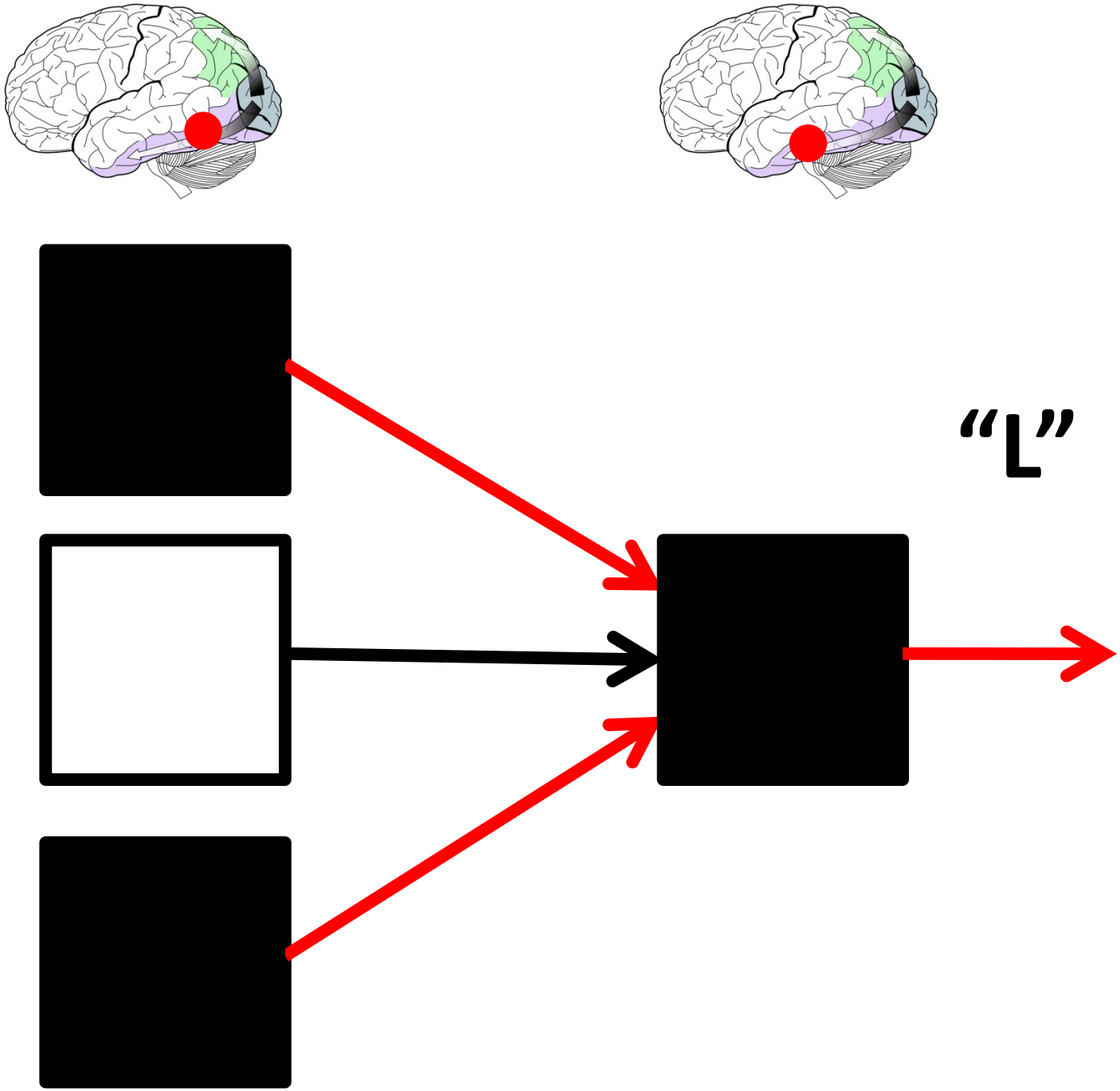
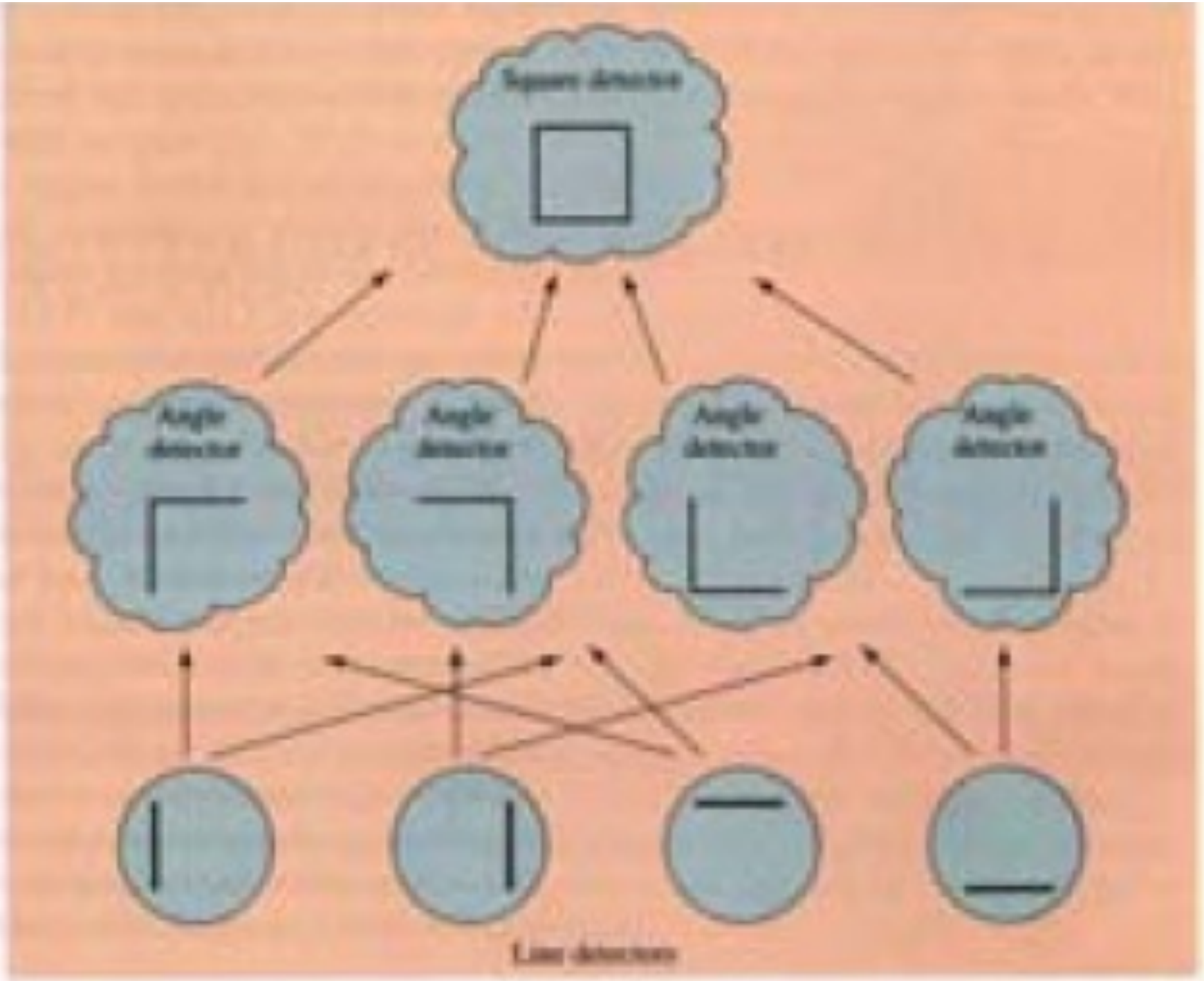
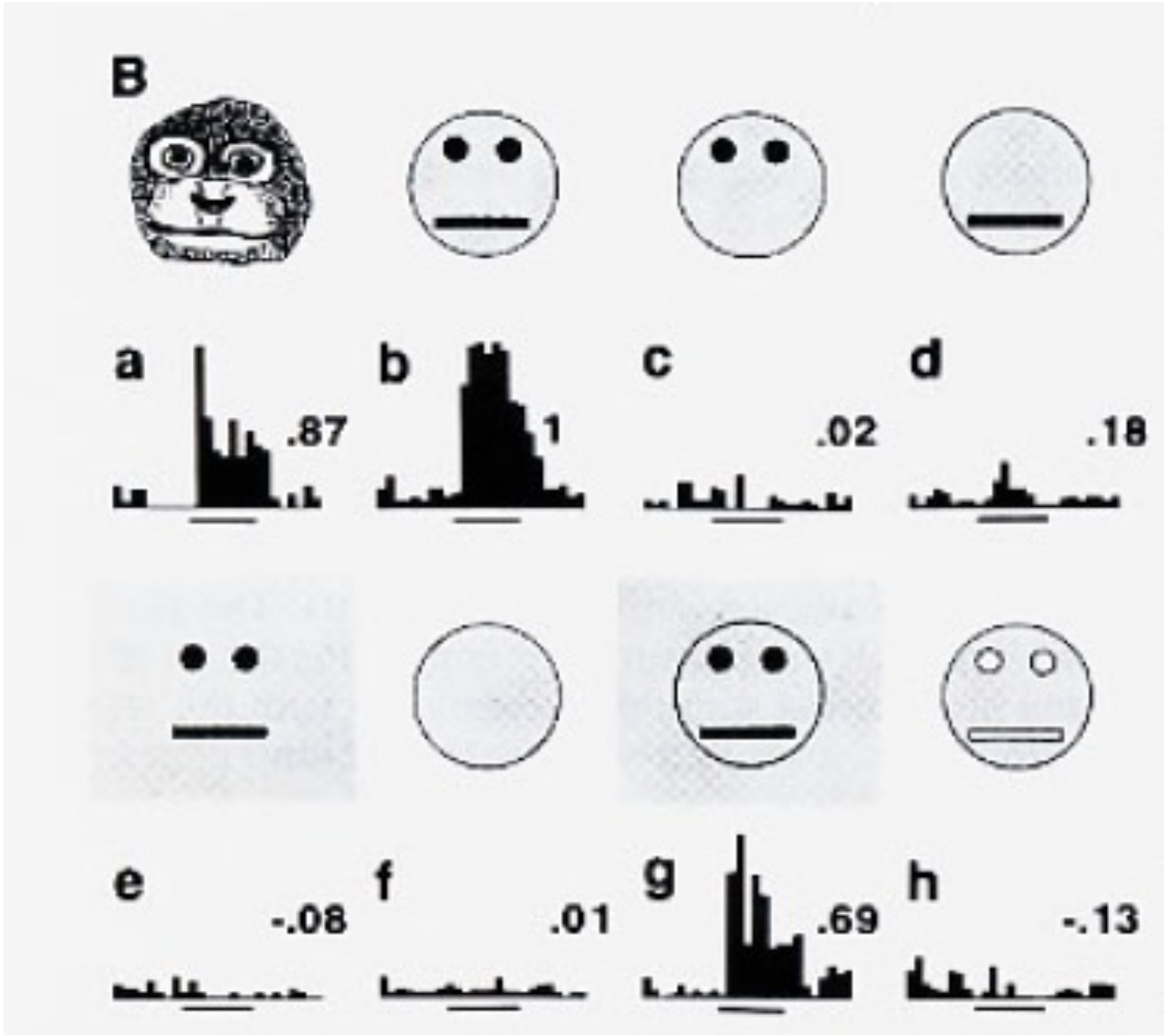


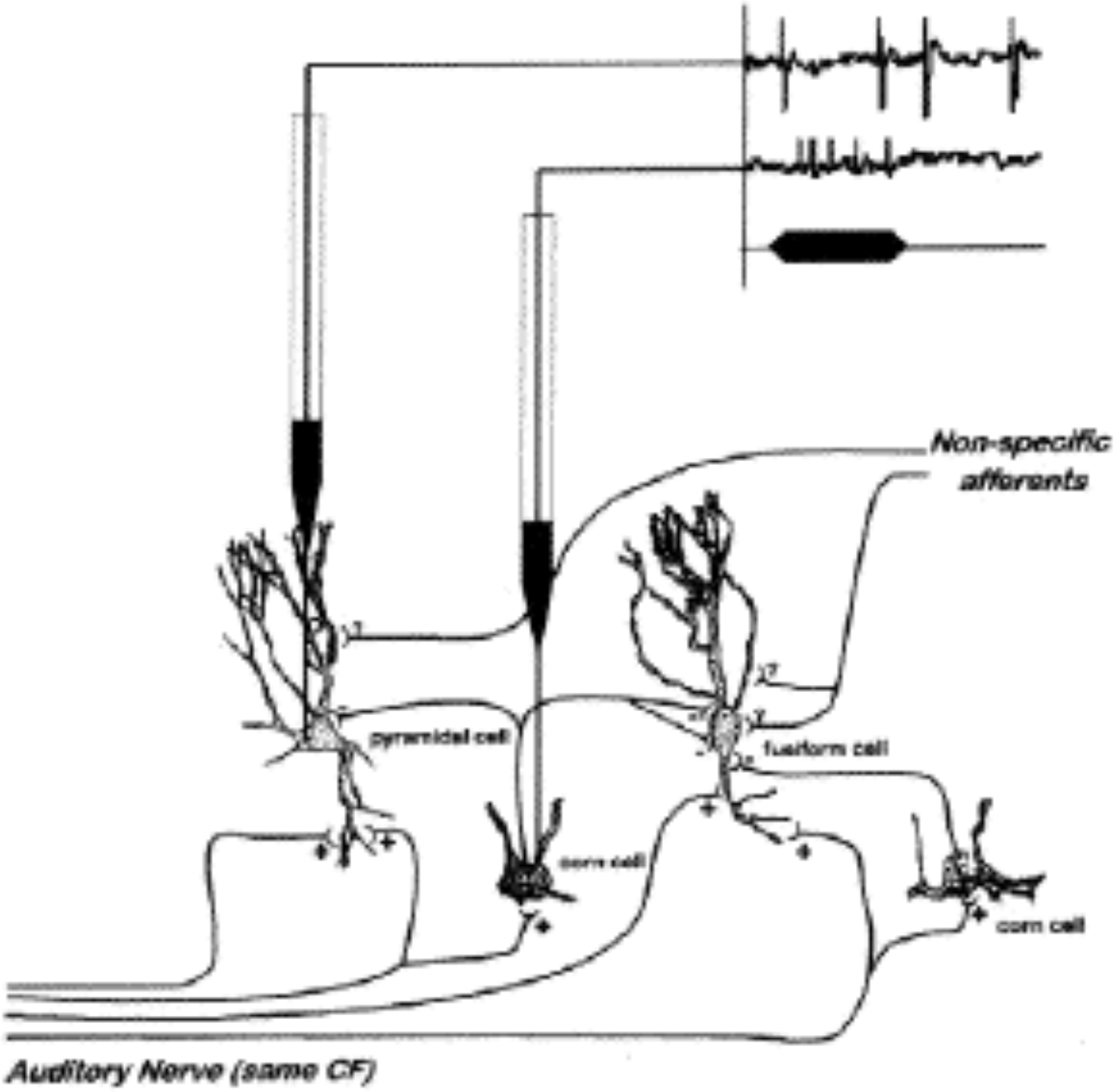


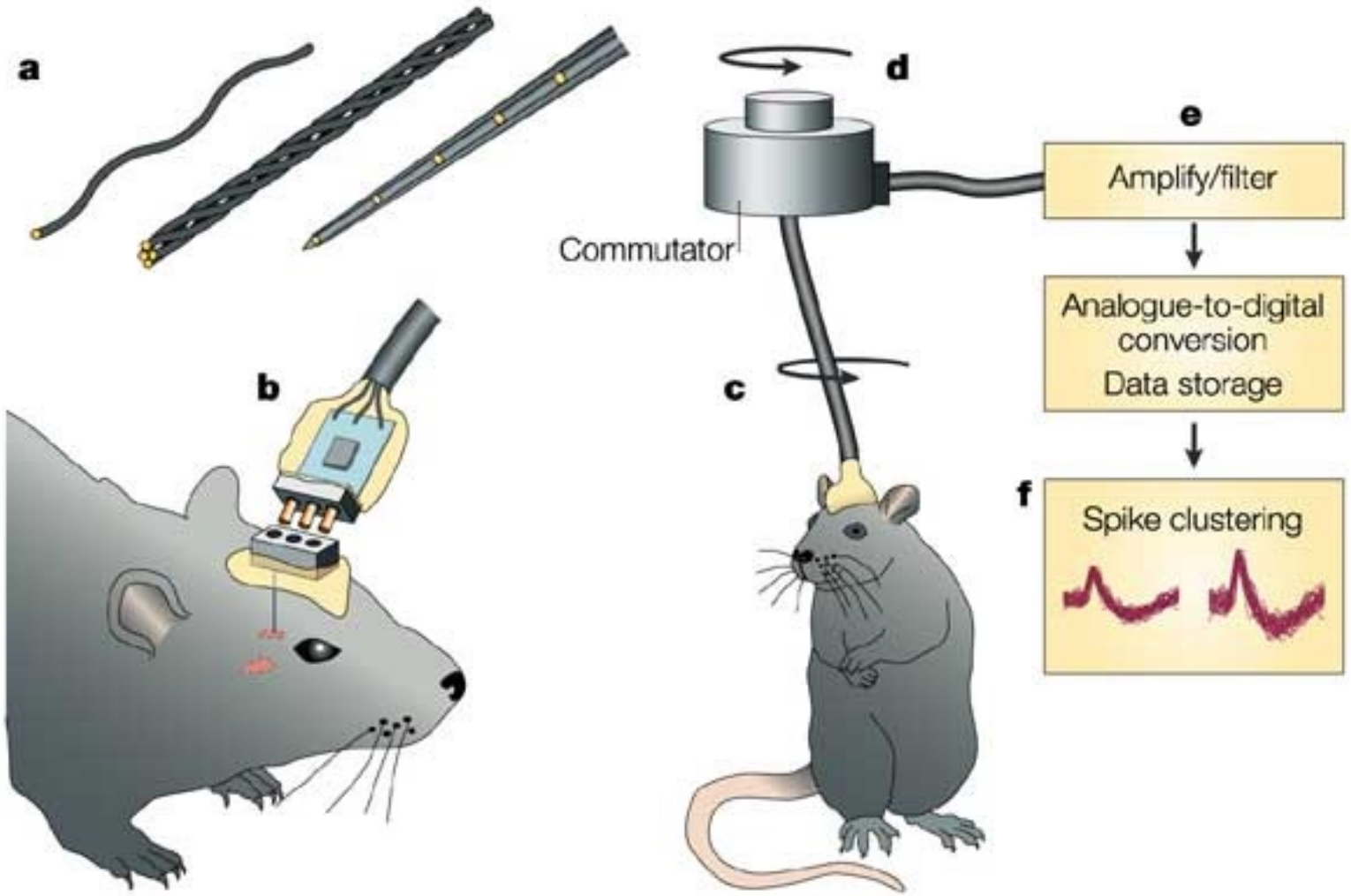

"L"


Square detector
Angle detector
Angle detector
Angle detector
Angle detector
Line detectors


B
a
.87
b
1
c
.02
d
.18
e
-.08
f
.01
g
.69
h
-.13

# Lecture 1C:
# Techniques


Non-specific
afferents
pyramidal cell
fusiform cell
corn cell
corn cell
Auditory Nerve (same CF)

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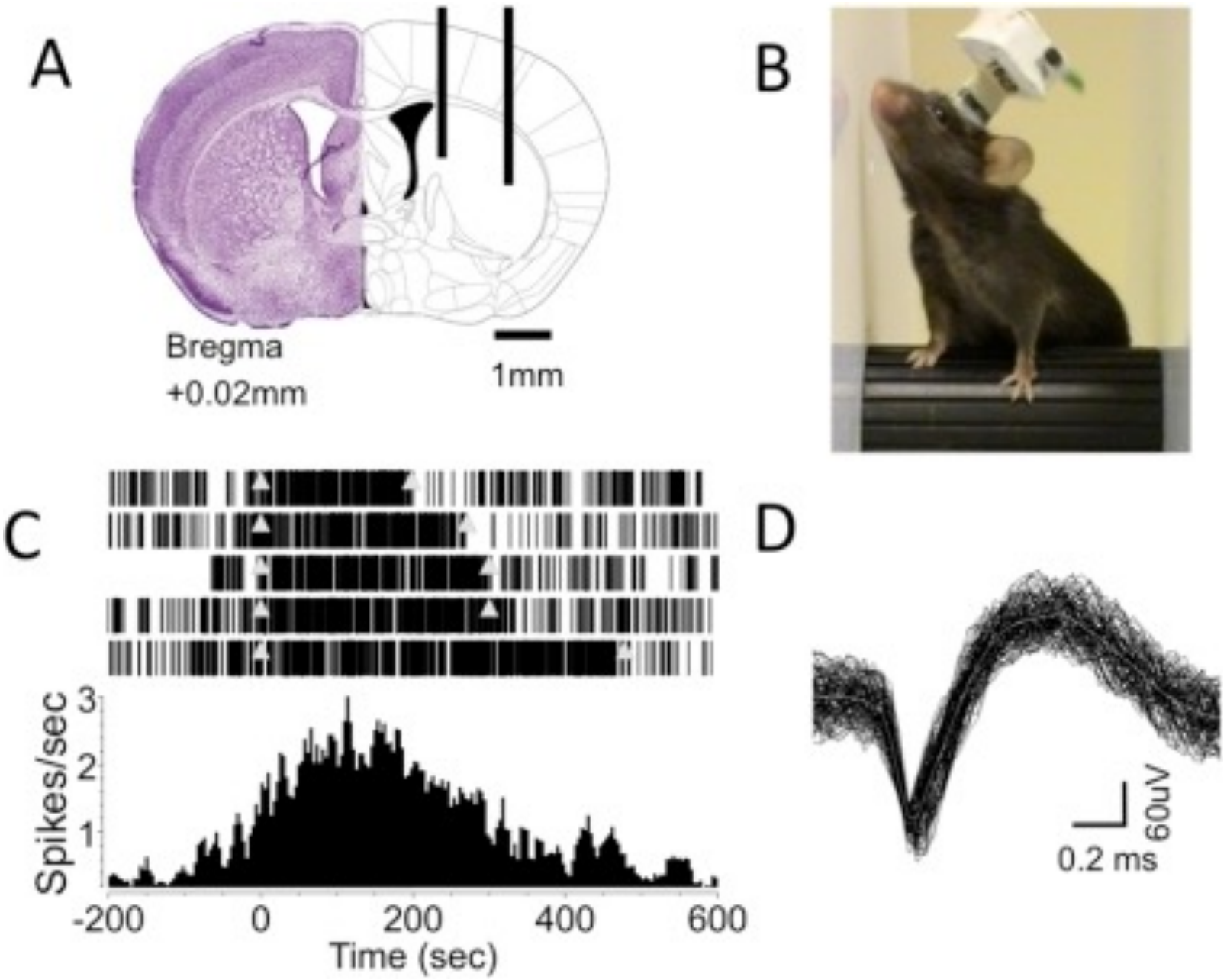
A
Bregma
+0.02mm
1mm
B
C
Spikes/sec
3
2
1
-200
0
200
400
600
Time (sec)
D
60uV
0.2 ms