

A microscopic image showing a neuron with a central cell body and several branching processes. The neuron is stained in shades of brown and orange. A large, star-shaped astrocyte is visible, with its processes extending towards the neuron. The background is dark, making the stained structures stand out.

Astrocyte – Neuron Cross Talk

Arun Chaudhury

Anatomy, AIIMS

Neuroglia (Kitt)

Camillo Golgi



Rudolf Virchow

Ramon Cajal

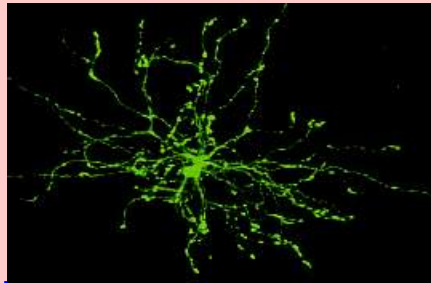


Astrocytes – form & distribution

Fibrous astrocyte

Very long thread like process

GFAP +



Surface of brain , spinal cord, white matter, hippocampus, ant./ dorsal horn of sp. Cord except substantia gelatinosa

Protoplasmic astrocyte

Short sinuous process with cluster of lamellar appendages of grey matter

Astrocytes – form & distribution

Special forms

Radial glia

Bergmann glia

Muller cells (GFAP +
after injury in rats,

+ve in goldfish)

tanycytes

Pituicytes

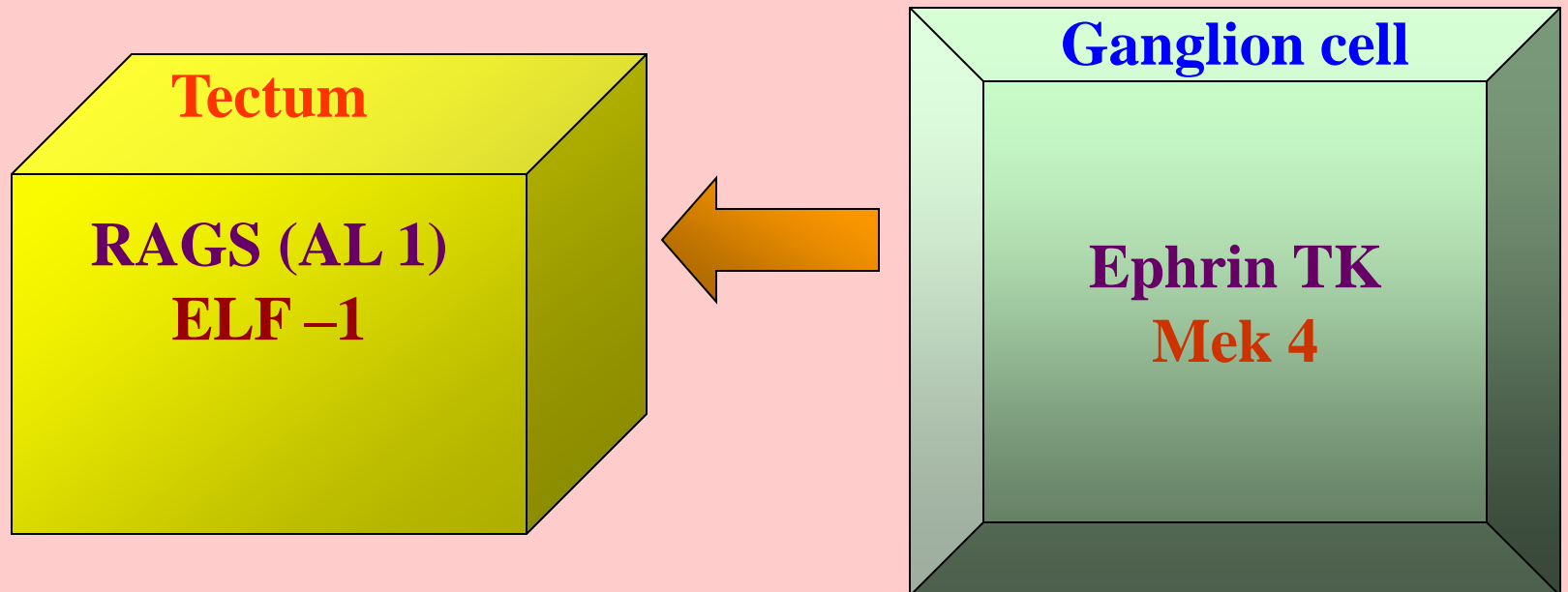
GFAP +

Posterior pituitary

Interstitial cells of
pineal

Specific cues for axonal trajectories provided by glial cells

lessons from retinotectal pathway

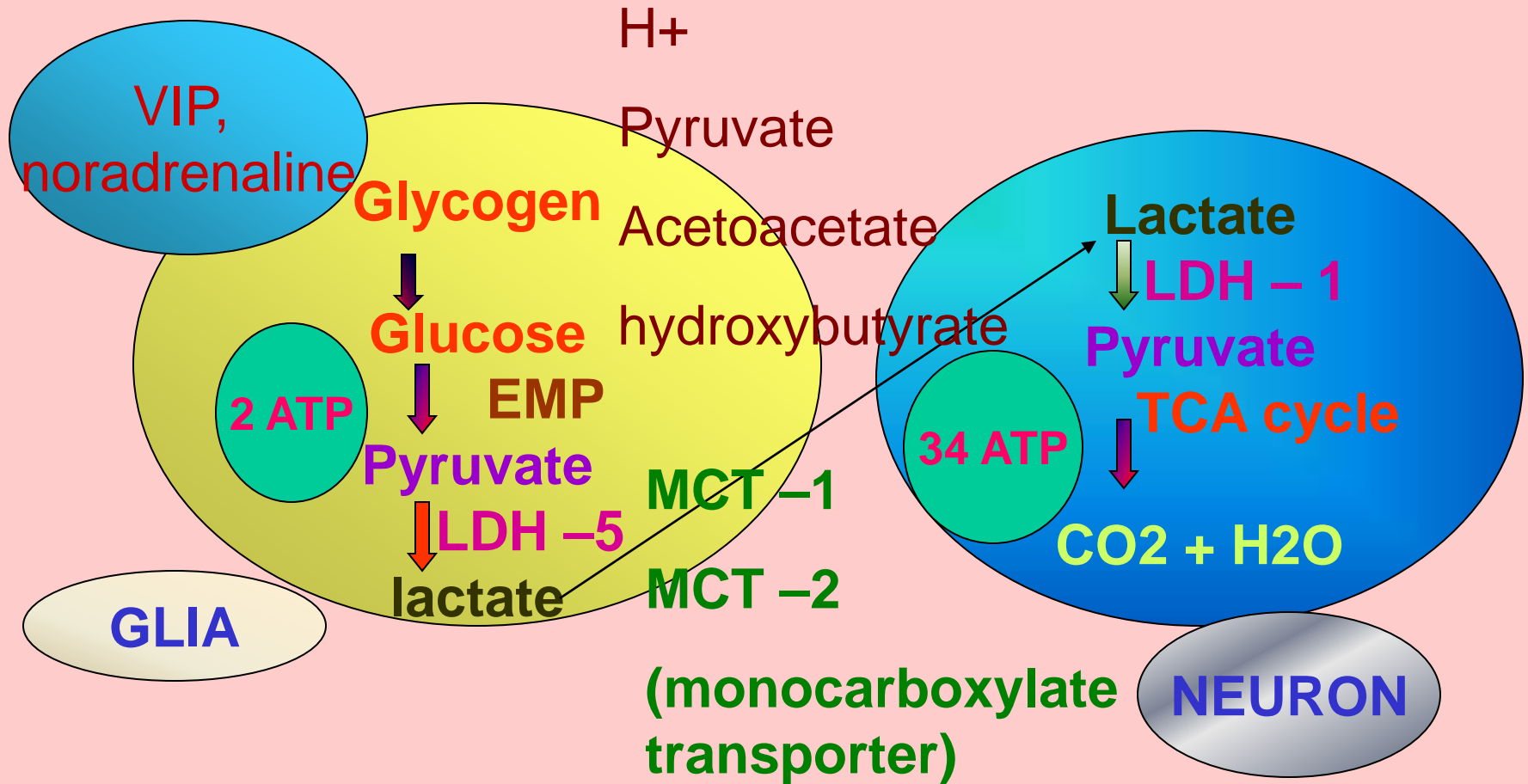


Glucose requirement in brain

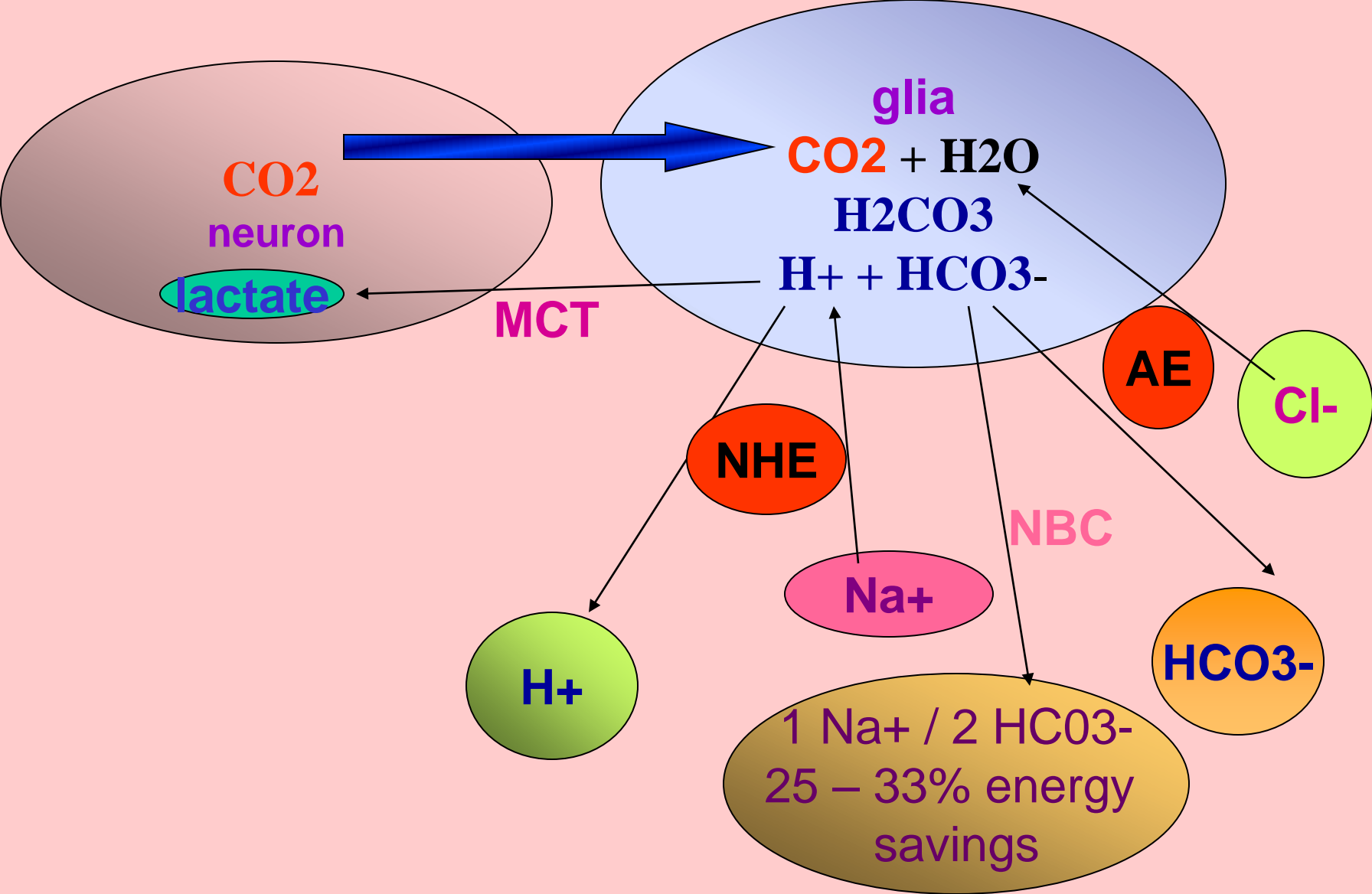
Indispensable

Logistic challenge

Glucose metabolism in neuronal cells & astrocytes



Glia as carbon dioxide sinks



Glutamate receptors

Ionotropic receptors

(ligand gated ion channels)

Alternative splicing

AMPA

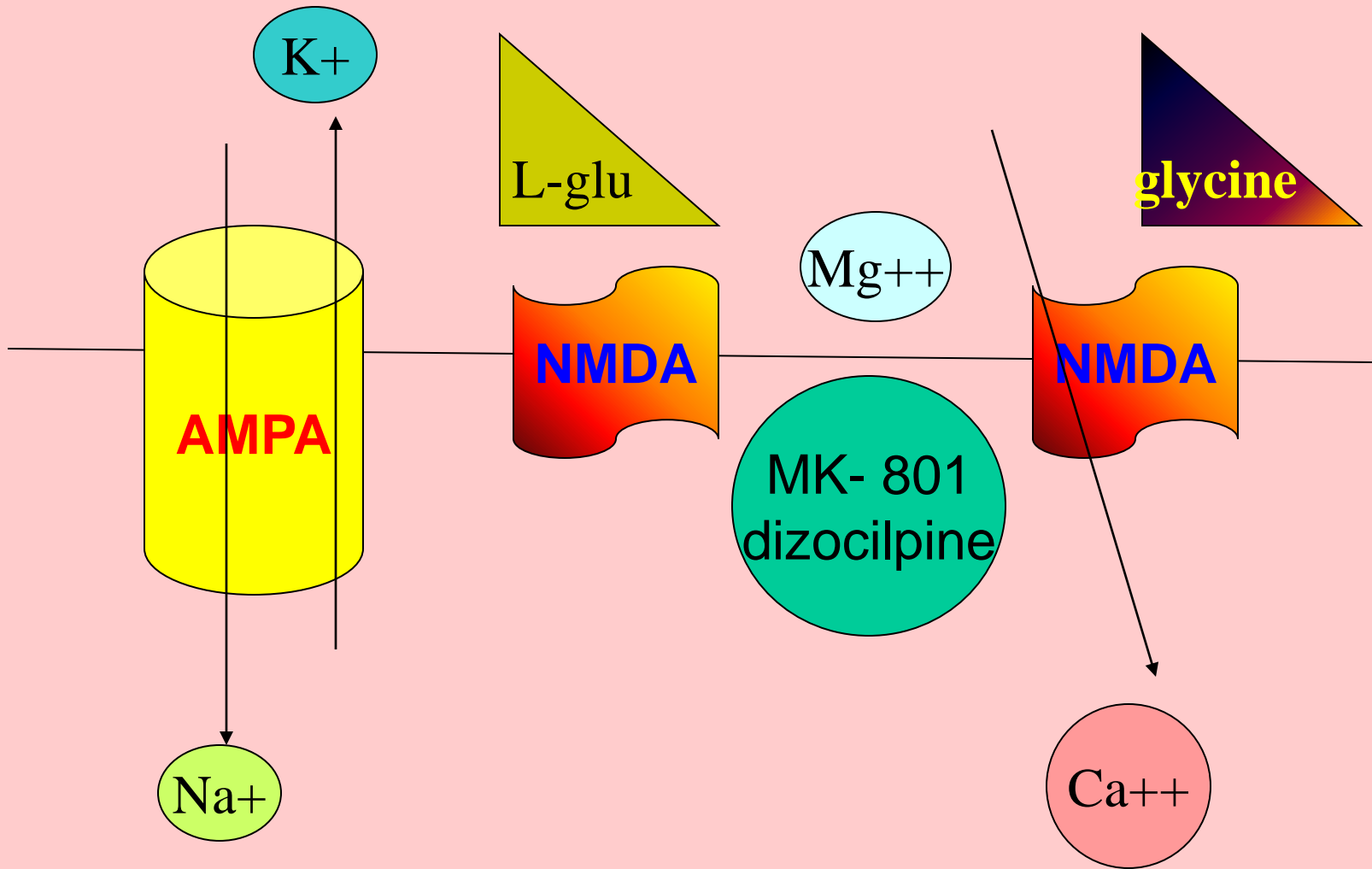
Kainate

(DRG, Hippocampus)

NMDA

(Muller Cells, Visual cortex, Bergmann glia)

Ionotropic receptors



Glutamate receptors

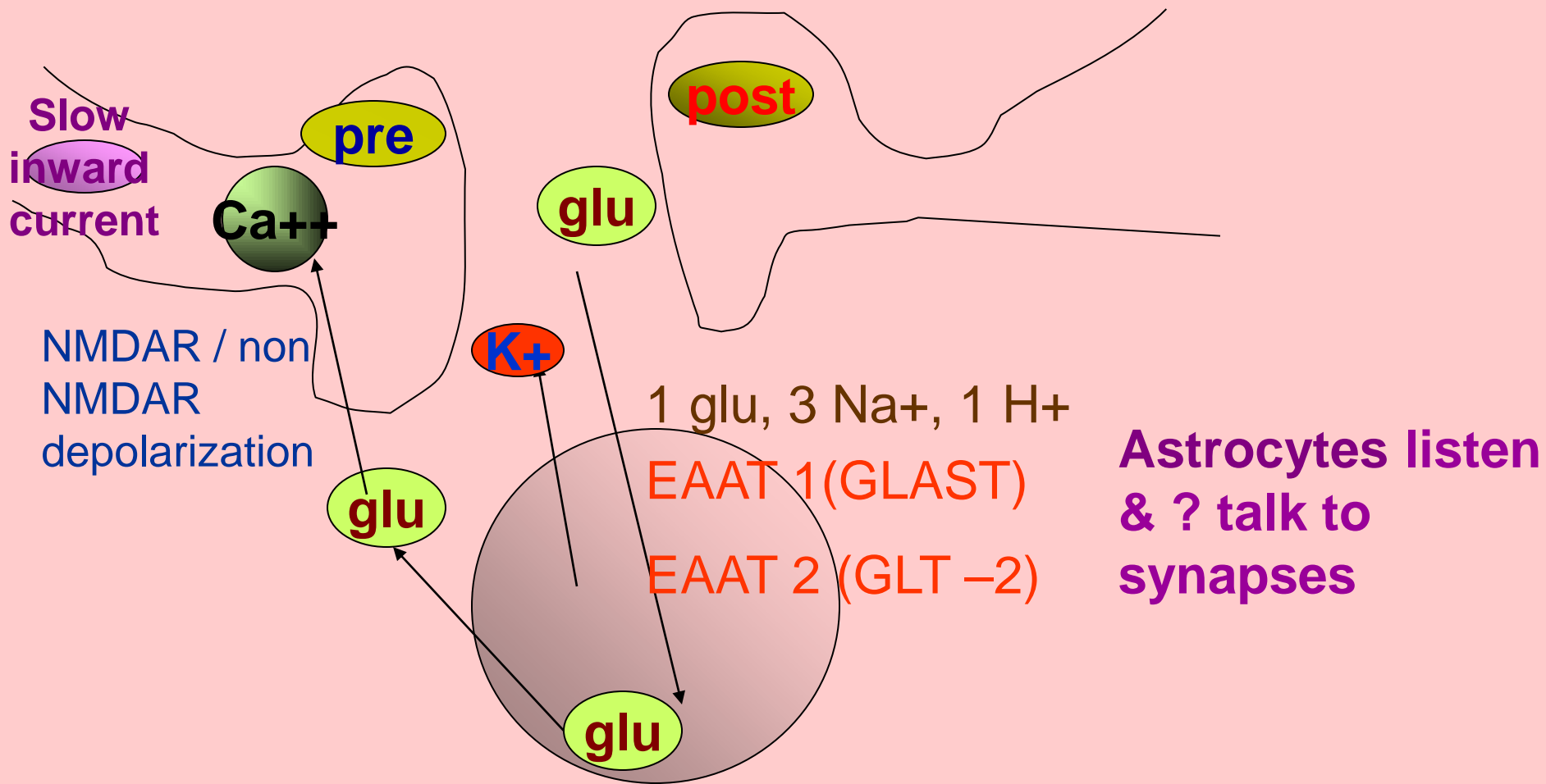
Metabotropic receptors

Gs / Gi

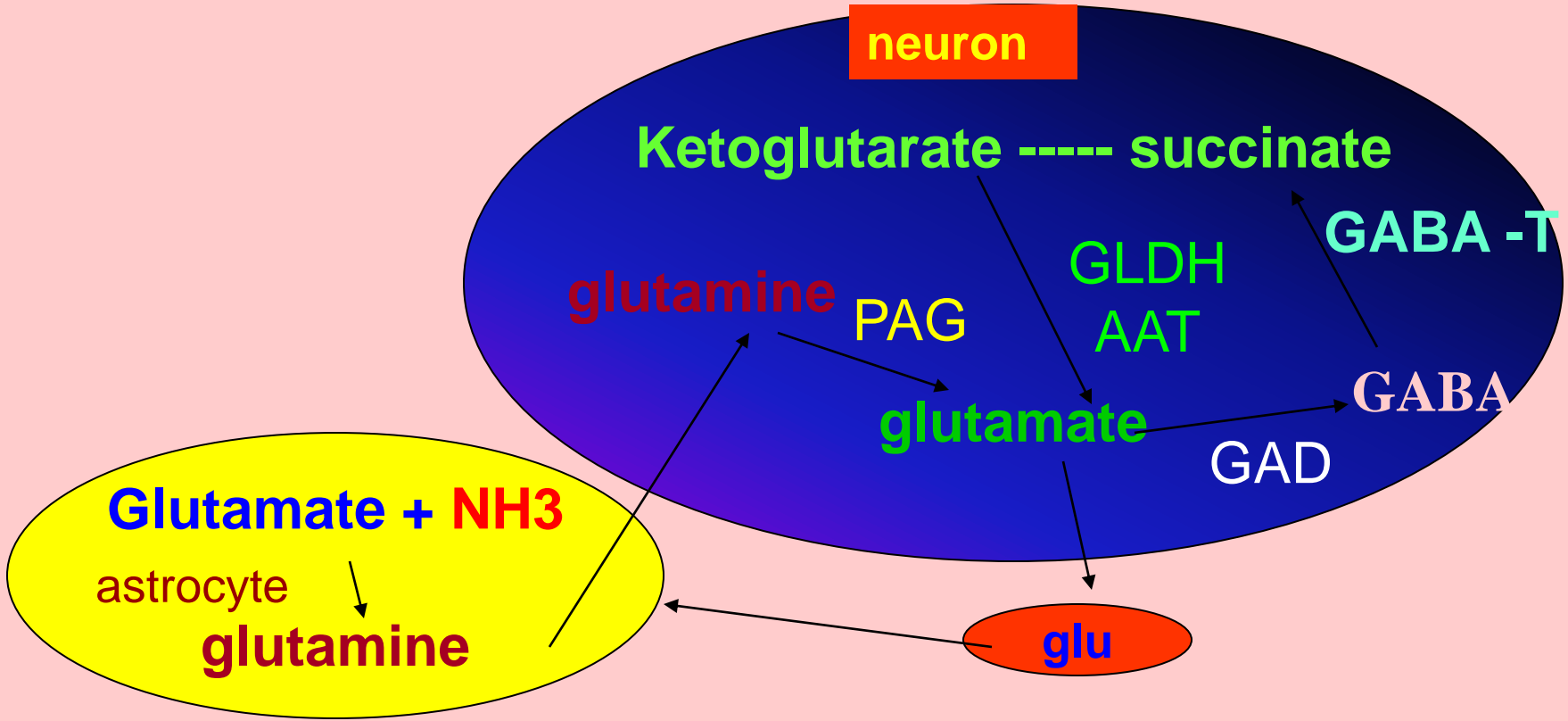
IP3 ----- Ca⁺⁺

Ca fluctuation – role in circadian rhythm

Tripartite synapse – glia, the unclaimed partner



Metabolic trafficking between astrocytes and neurons



Structural neuron – glia plasticity

Parturition

Lactation

Osmotic stimulation

Astrocytic coverage of magnocellular neurons of
SON/ PVN ↓

Pituicyte contraction

Highly sialylated weakly adhesion

isoform of PSA - NCAM

Glutamate receptor mediated signalling to nucleus

Activation of AMPA in Bergmann Glia



Ca⁺⁺

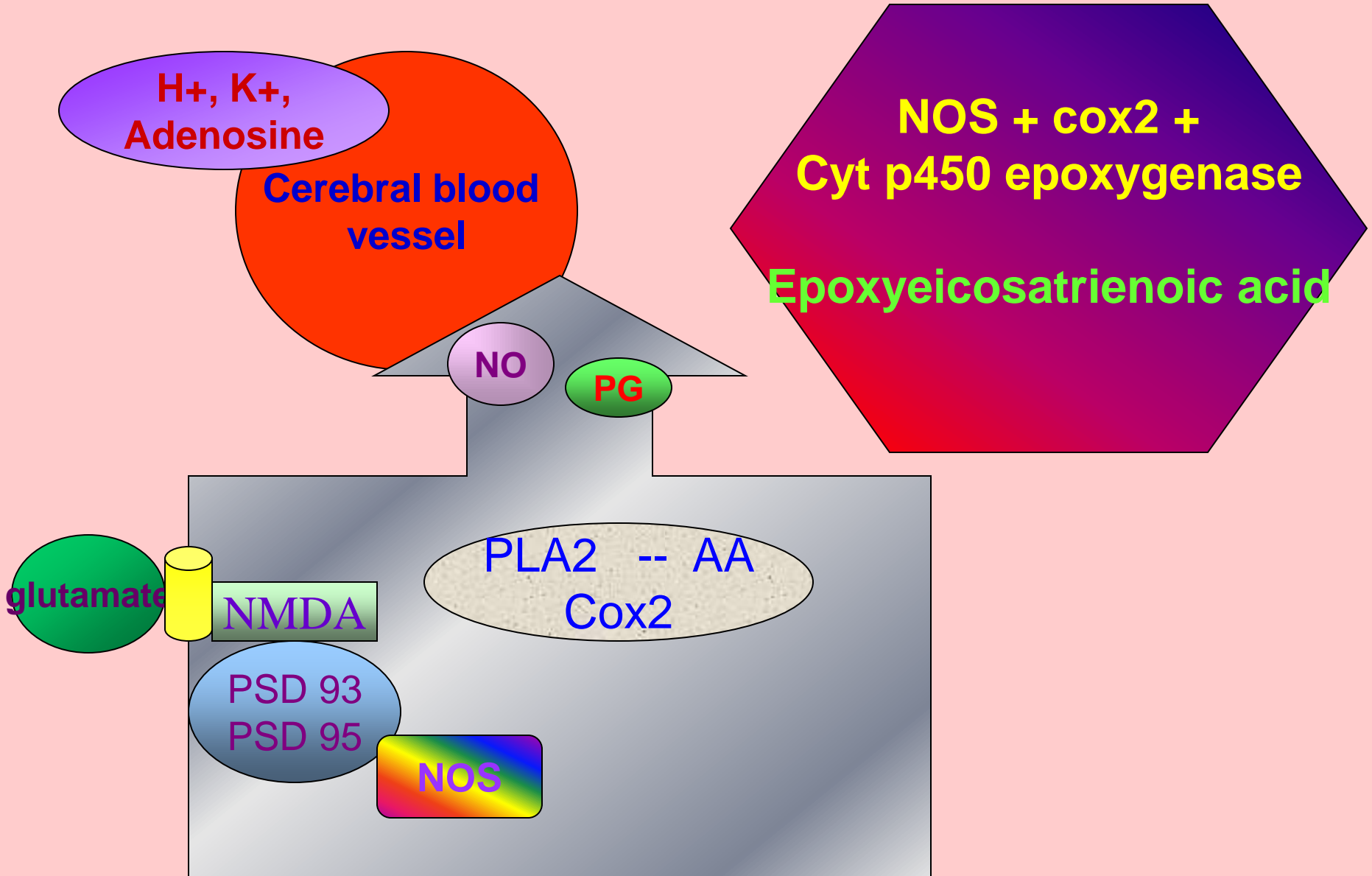


AP –1 (activator protein)

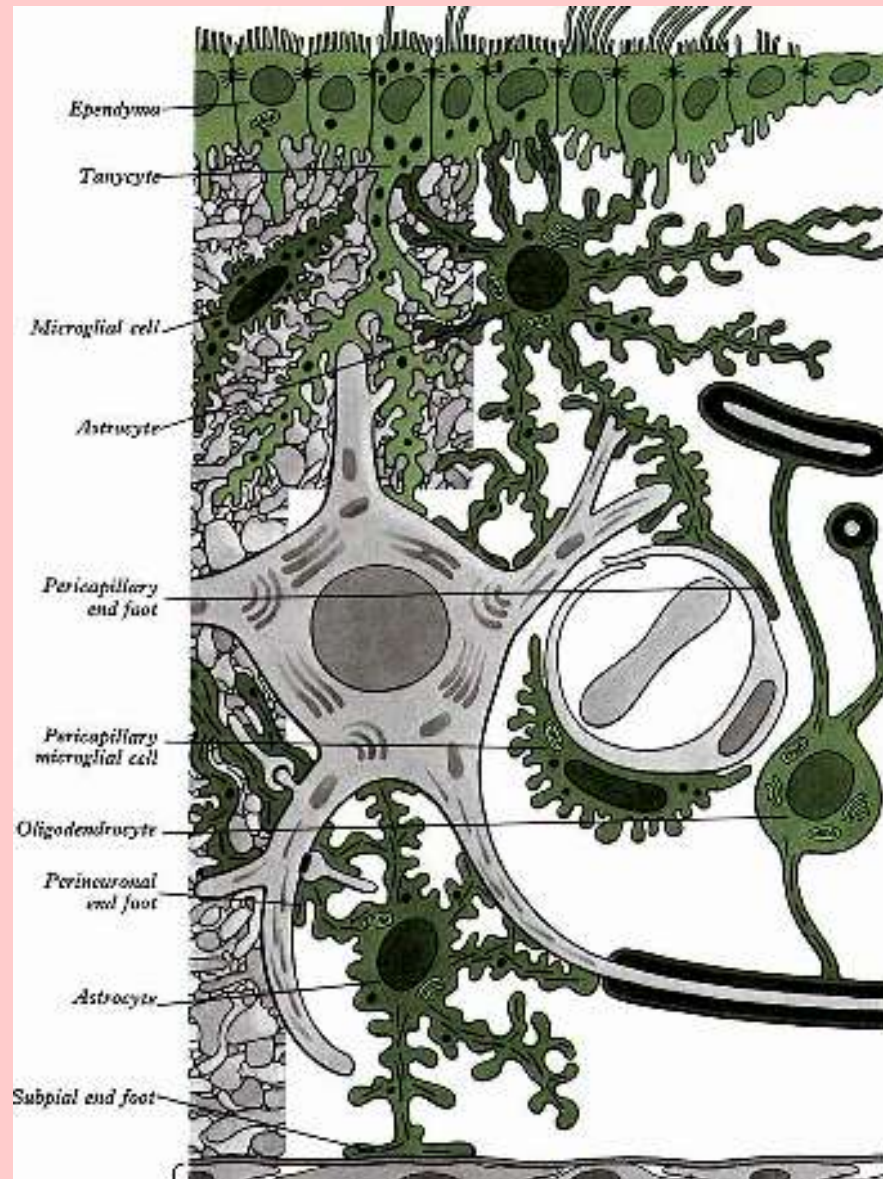


IEG activation (c-fos, c-jun c-myc, NGPI – A)

Neurovascular coupling



Glial Cells



Glial limiting membrane

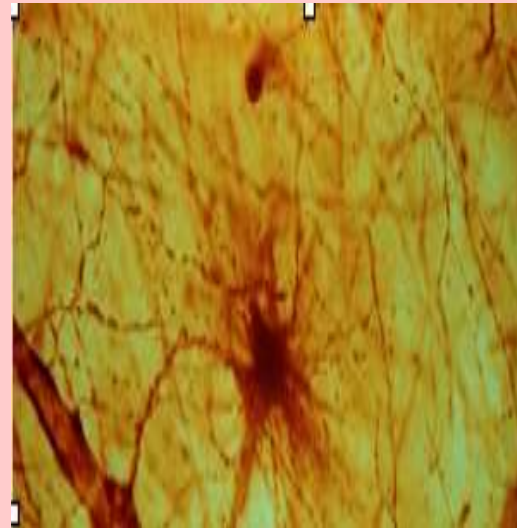
continuous lining separating brain from mesenchymal structures with intervening basal lamina

Blood Brain Barrier

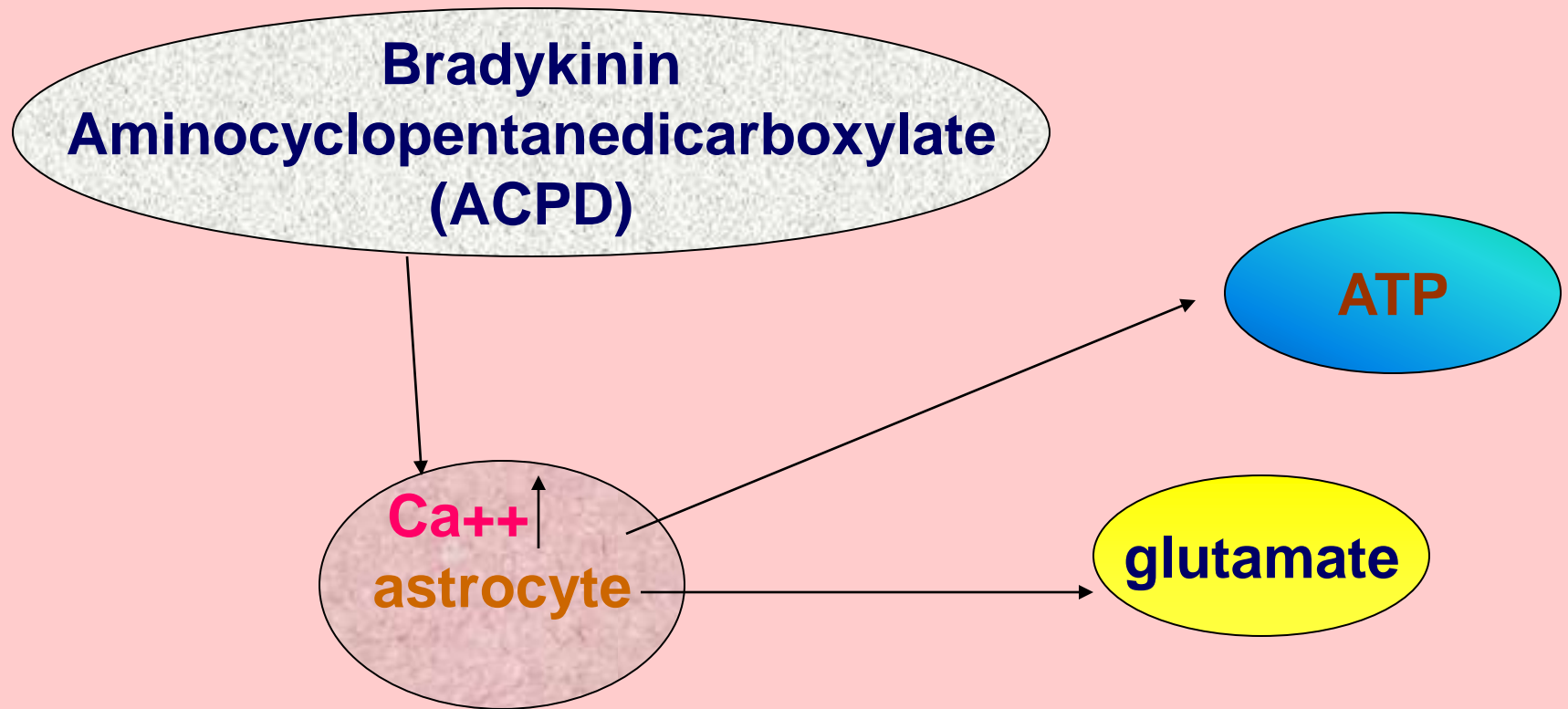
Insects – glial cells

Sharks, skates, rays – open endothelial layer & tight junction between astrocyte end – feet & capillary

Human – tight endothelial junction with surveillance from end–feet of astrocyte

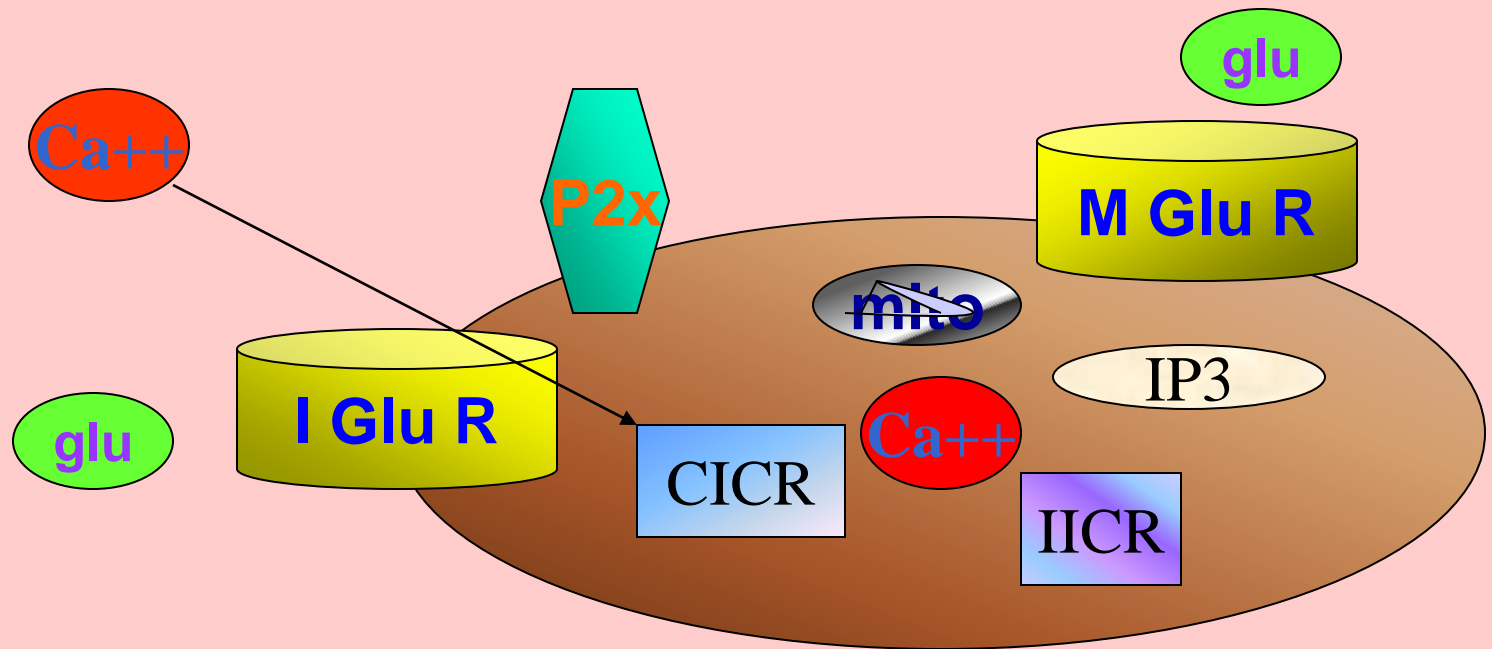


Astrocytes release neurotransmitters



Calcium metabolism in astrocyte

Are glial cells excitable cells?



Effect of intra-astrocytic calcium

Local calcium oscillation

Gap junction (dye coupling, freeze fracture)

(Cx 43, Cx30)

long distance signalling of calcium wave (GJIC)

Low resistance pathways

Increased cytosolic calcium implicated in hypoxia,
hypoglycemia, HIV gp120

Glial membrane potential

High permeability to K^+ ions

20 mV more (-) RMP than neuron

Glial cells hyperpolarise during onset of neuronal activity

? Inadequate number of Na^+ channels

Glia – neuron dialogue in chemosensitive

brain areas \uparrow discharge I n response to \downarrow

pH

Potassium spatial buffering

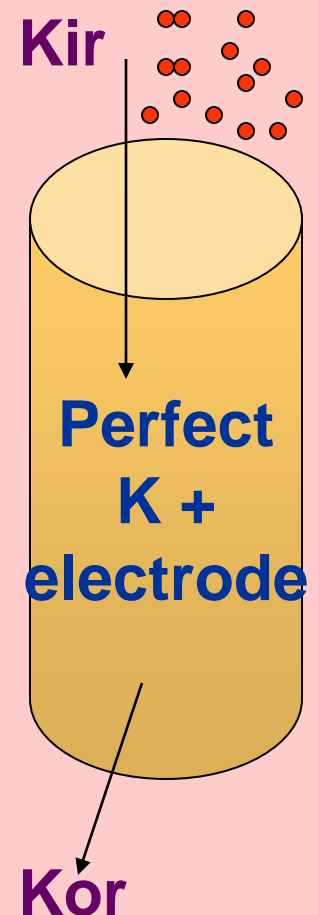
High neuronal activity
(mesencephalic reticular formation)

$[K^+]_e = 3.5 \text{ mV} - 12 \text{ mV}$

Astrocytes help in siphoning K^+
from ECS

No explosive voltage dependent
conductance

Slow potential shifts (SPS)



Is brain insulated from effects of immune system?

Brain grafts

BBB

Absence of lymphatics

TGF β , neuropeptide, ganglioside – immune suppressor

Low expression of MHC

Apoptotic elimination of T cells

Th 1 vs. Th 2 response

Th 1

CD 4+ Th 1

APC

IL-2, γ -IFN,
TNF β

Th 2

IL -4, IL -10, IL-13

Downregulate Th 1
response

Microglia – Tissue guardians of brain

Ontogenically ~ mononuclear phagocyte lineage

? Neuroectodermal origin

- Resting microglia
- Activated microglia

Activated glia

Highly plastic

Stereotypic activation

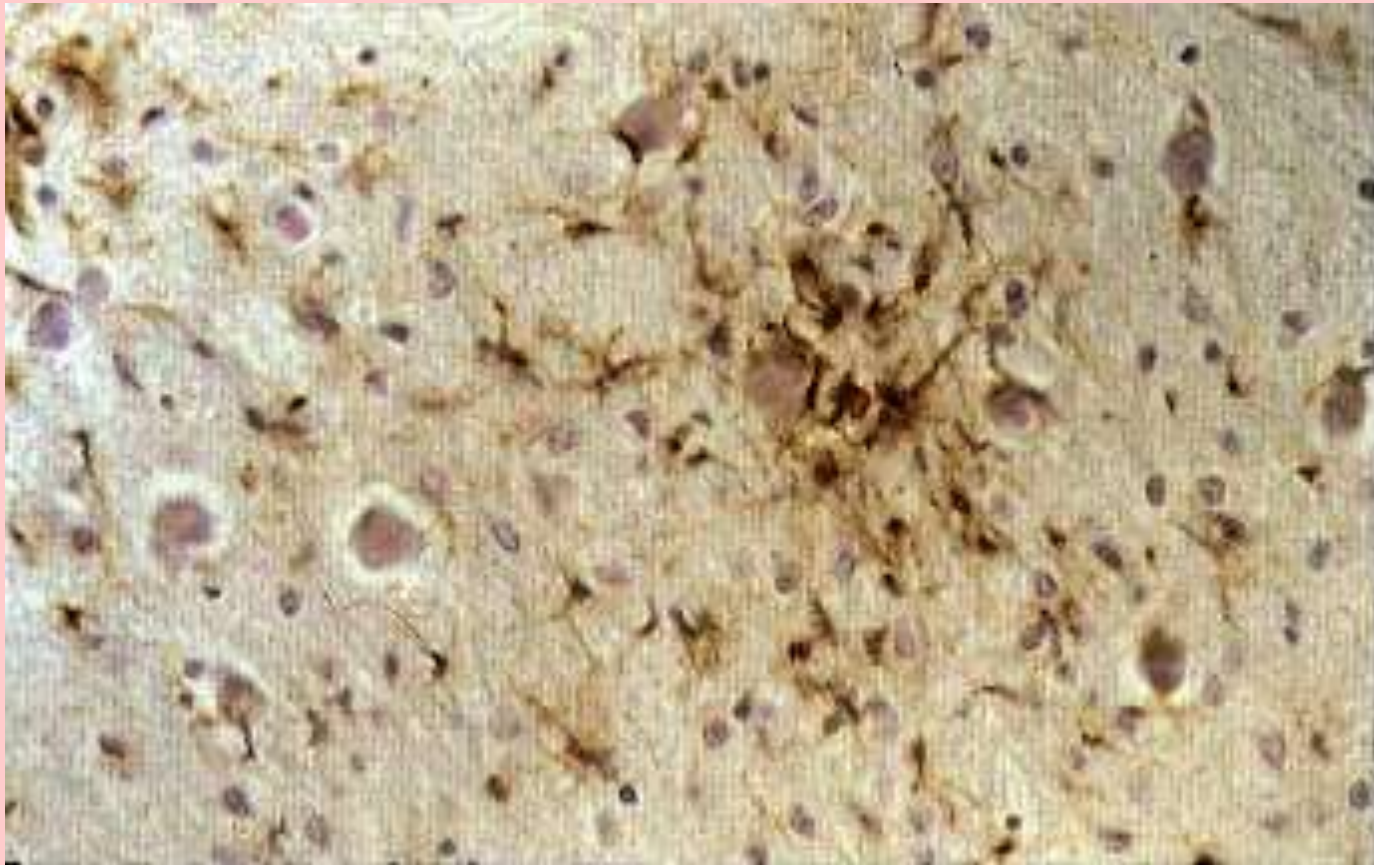
Rod shaped (syphilitic paralysis)

Nodules (spinal neurons of anterior horn in poliomyelitis)

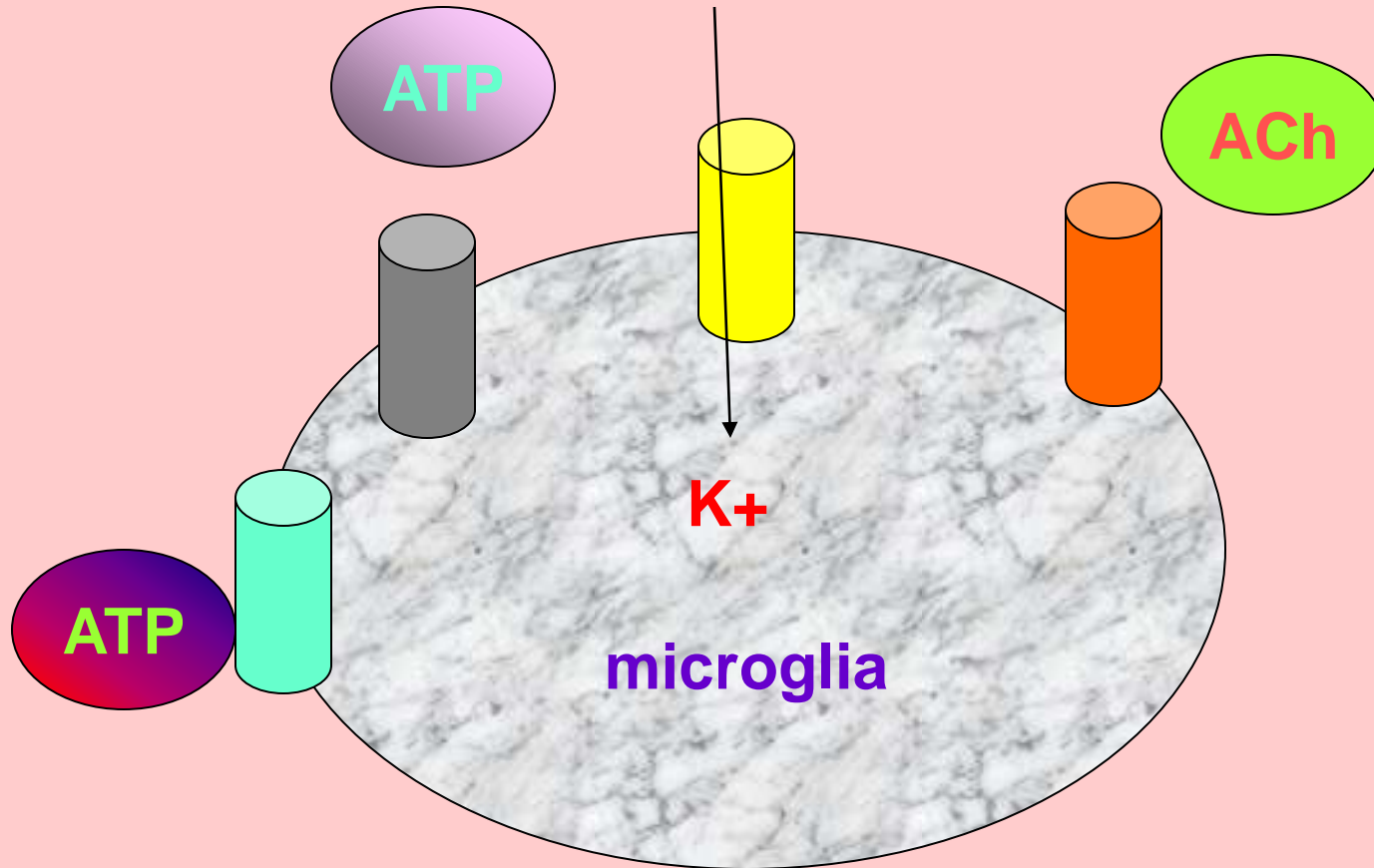
Foam laden macrophages

Gitter cells

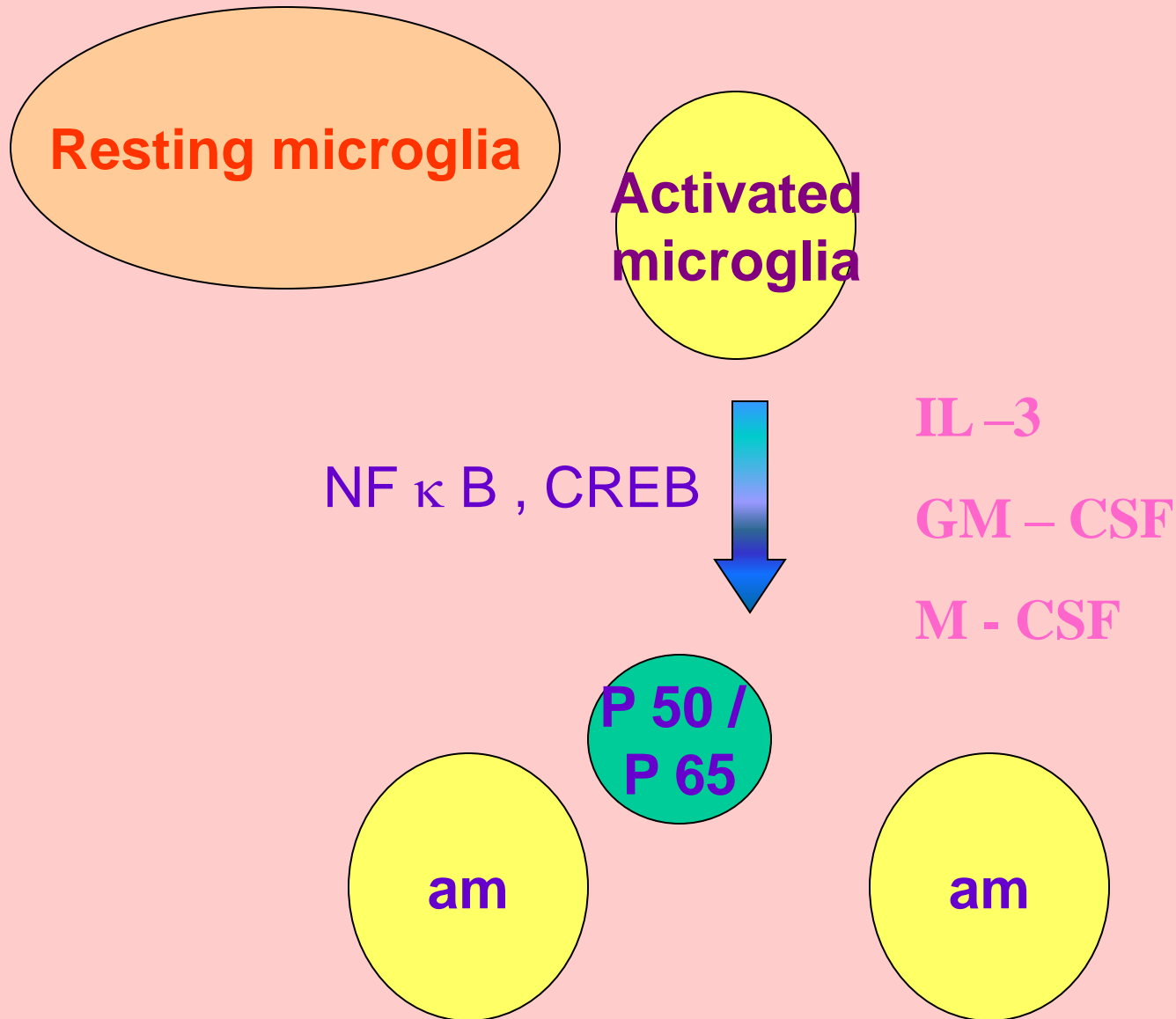
Activated glia



Receptors on microglial cell surface



Mitosis of microglia



Microglia in CNS inflammation

Microglia

↓
1. IL-1, TNF α , IL-12

(proinfl)

→ IL-10, TGF β ,
PGE2

(antiinfl)

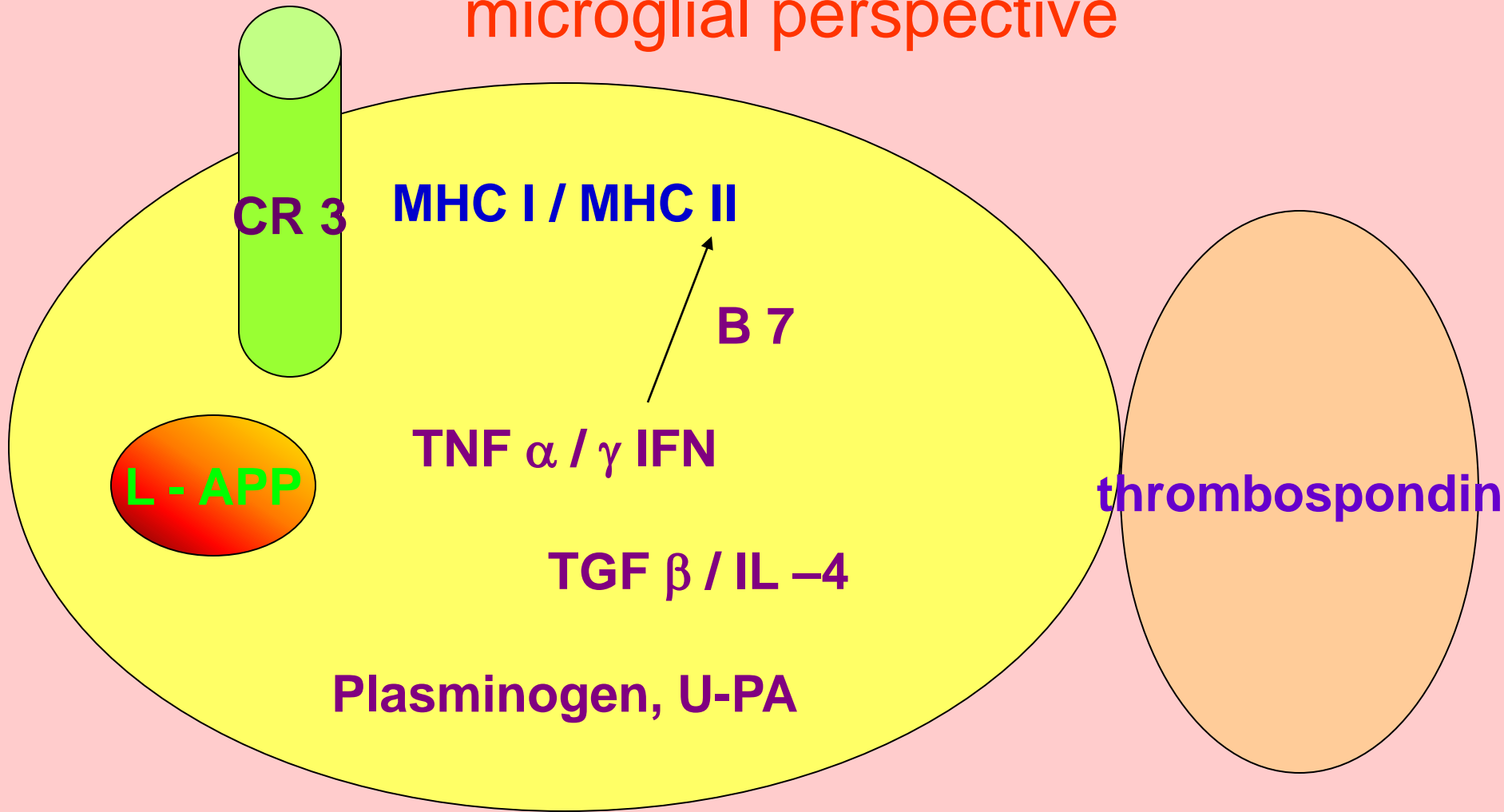
2. Recruitment of leukocyte

3. Class II MHC / CD 11a, CD 40, CD 54, CD
80, CD 86

↓
T cell restimulation

Cytotoxicity vs. tissue remodelling

microglial perspective



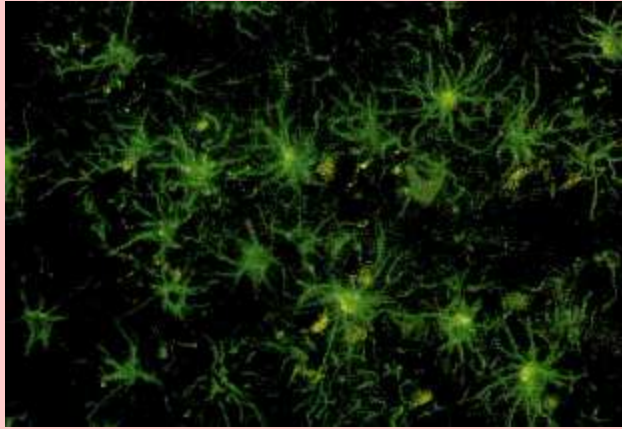
Functions of microglia

1. Professional phagocytes – ORF, NO, proteases

(microorganisms, debris)
2. Wound healing
2. Demyelinating diseases
3. ? Alzheimer's disease
4. Delayed hypersensitivity

Astrocyte in CNS inflammation

- PGE2, TGF β – **Th 2 response**
 - limit inflammation & support
neuron survival
- IL – 4 --- NGF
- MCP –1, IP- 10, RANTES
 - recruitment of cells



Gliosis vs . fibrosis

↑ GFAP expression by astrocytes in brain damage

IL - 1β → astrocyte mitosis if BBB disrupted

Scrapie → IL -1 / TNF α – intense gliosis

Glial scar & epileptogenesis

Gliosis

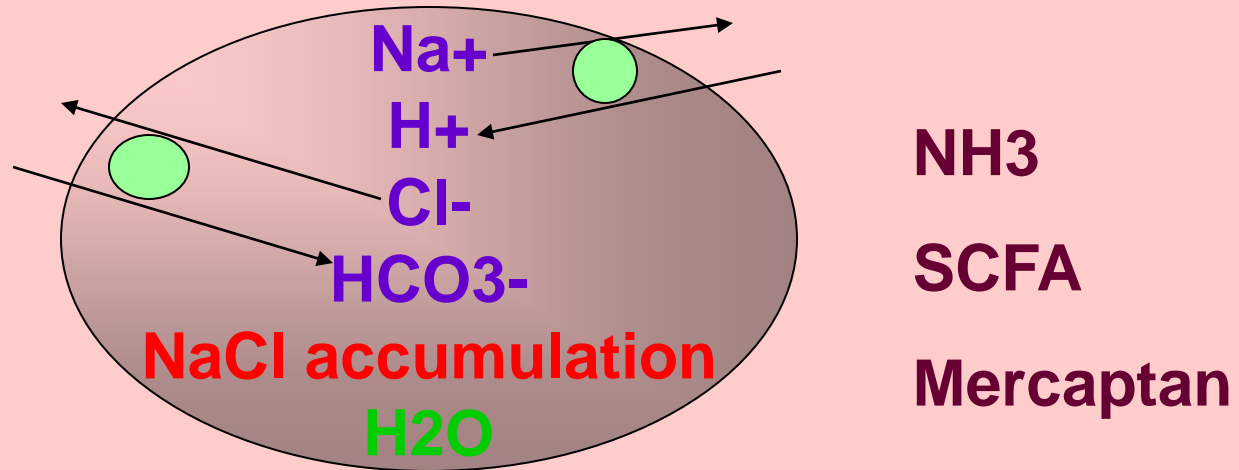
- During fibrillogenesis, is uptake of glutamate inhibited?
- ECF excitotoxicity & penumbra in infarcted area
- Are the glial cells derived from site of injury or have they migrated?
- Can the glial cells secrete stromelysin to digest brain versican?

Injury to brain

- MPTP-----→ MPP+ (Parkinson's disease)
- 3-HAO (in astrocyte) --- quinolinic acid

damages neurons in Huntington's disease

Brain edema in hepatic encephalopathy



Cirrhosis of liver

Reye's syndrome

**Alzheimer's type II
astrocytes**

**(cerebral cortex, basal
ganglia)**

Role of astrocytes in regeneration in CNS

GDNF - regeneration of dopaminergic neurons

Olfactory glia – role in CNS regeneration

A scenic landscape featuring a large body of water in the foreground, with sunlight reflecting off its surface, creating a shimmering path. In the background, there are rolling hills or mountains under a clear blue sky. The text "Thank You" is overlaid in the center of the image.

Thank You