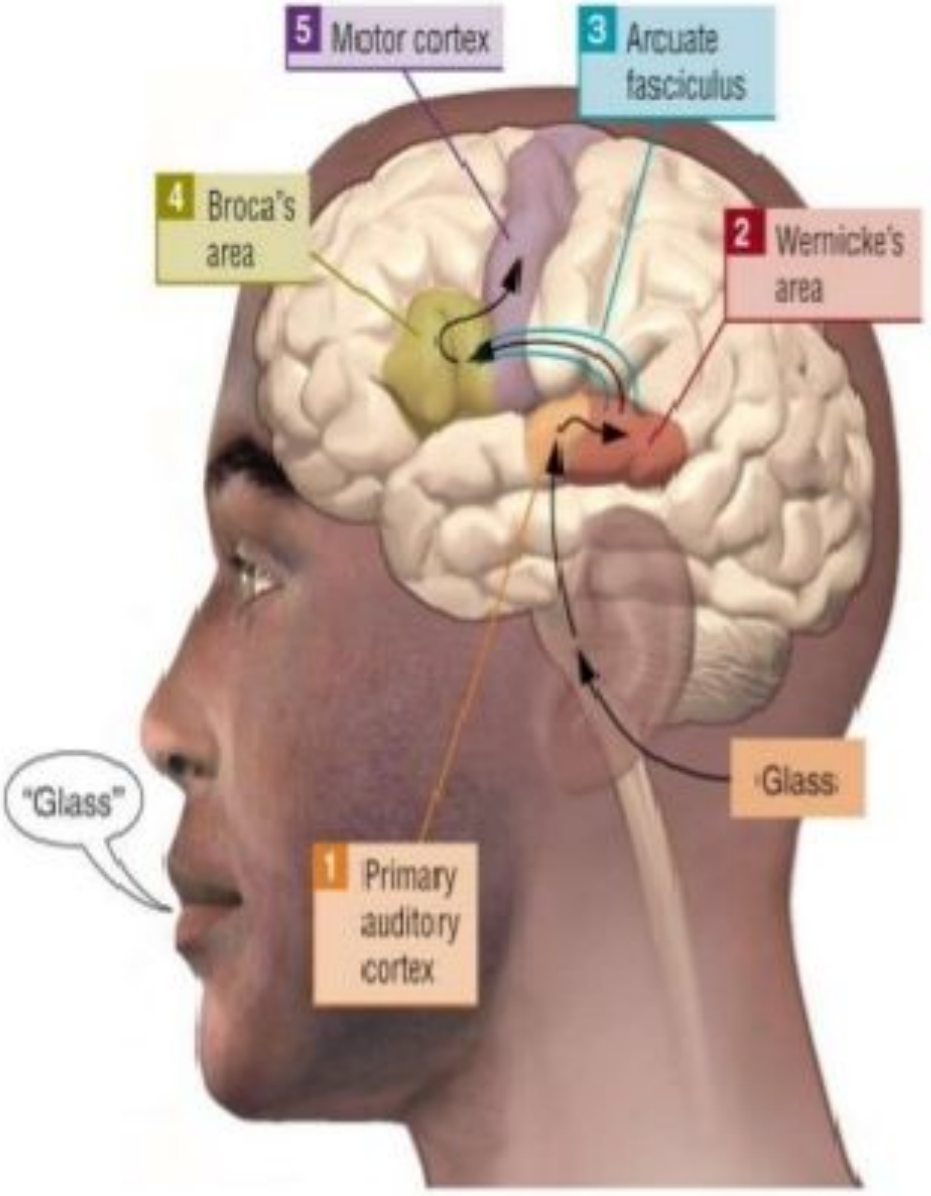
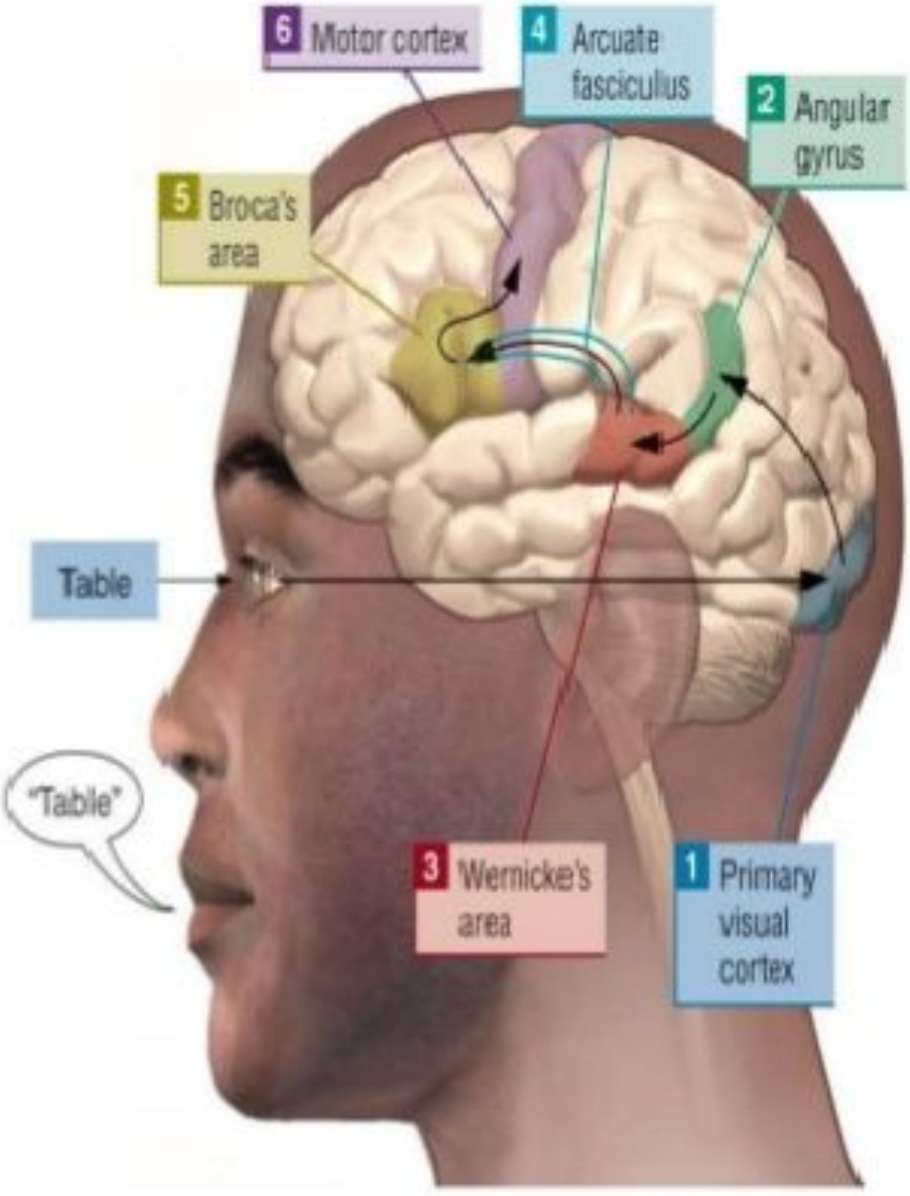
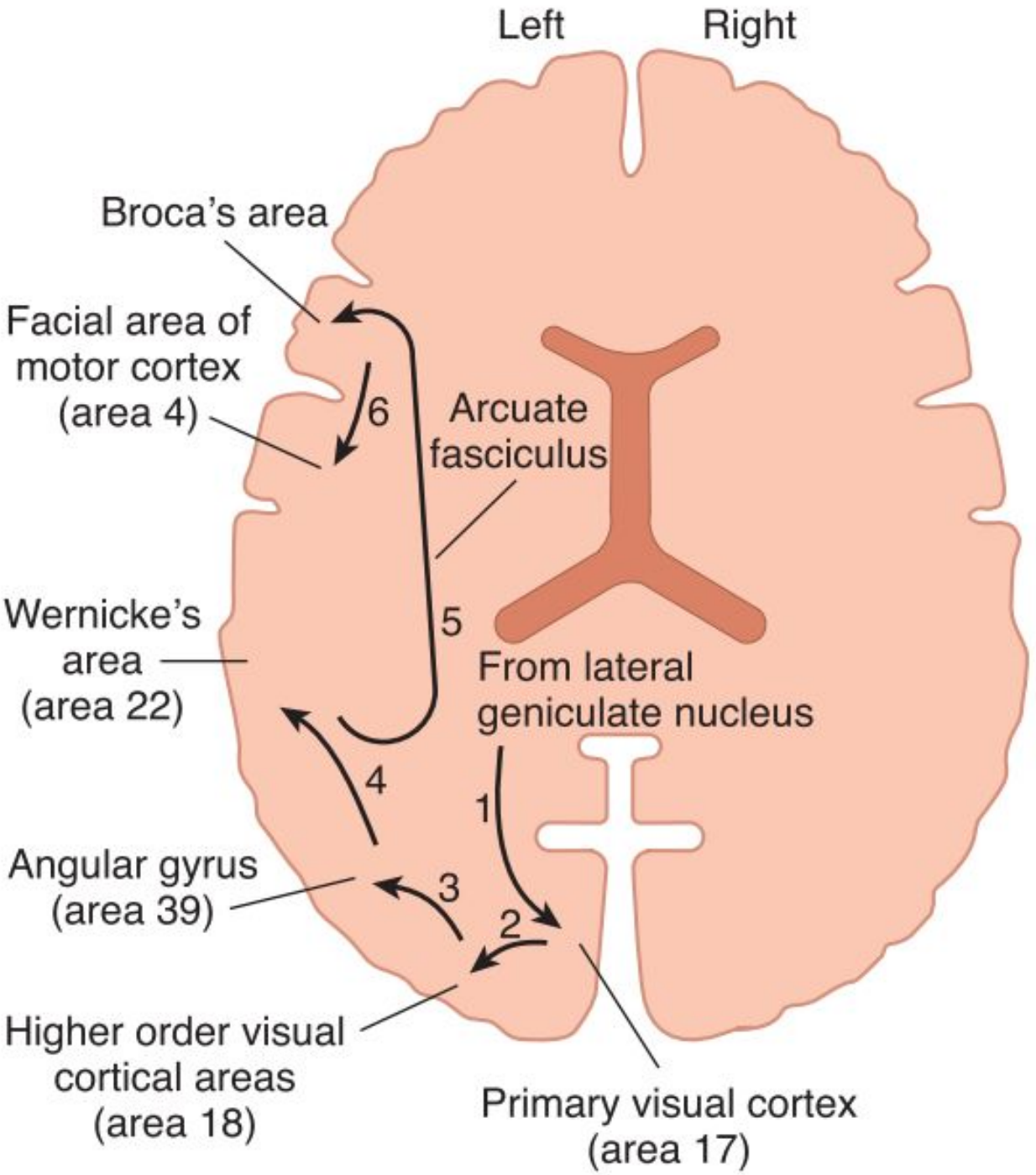
# Высшая нервная деятельность человека. Физиологические основы памяти, сна и эмоций. Понятие о функциональных системах



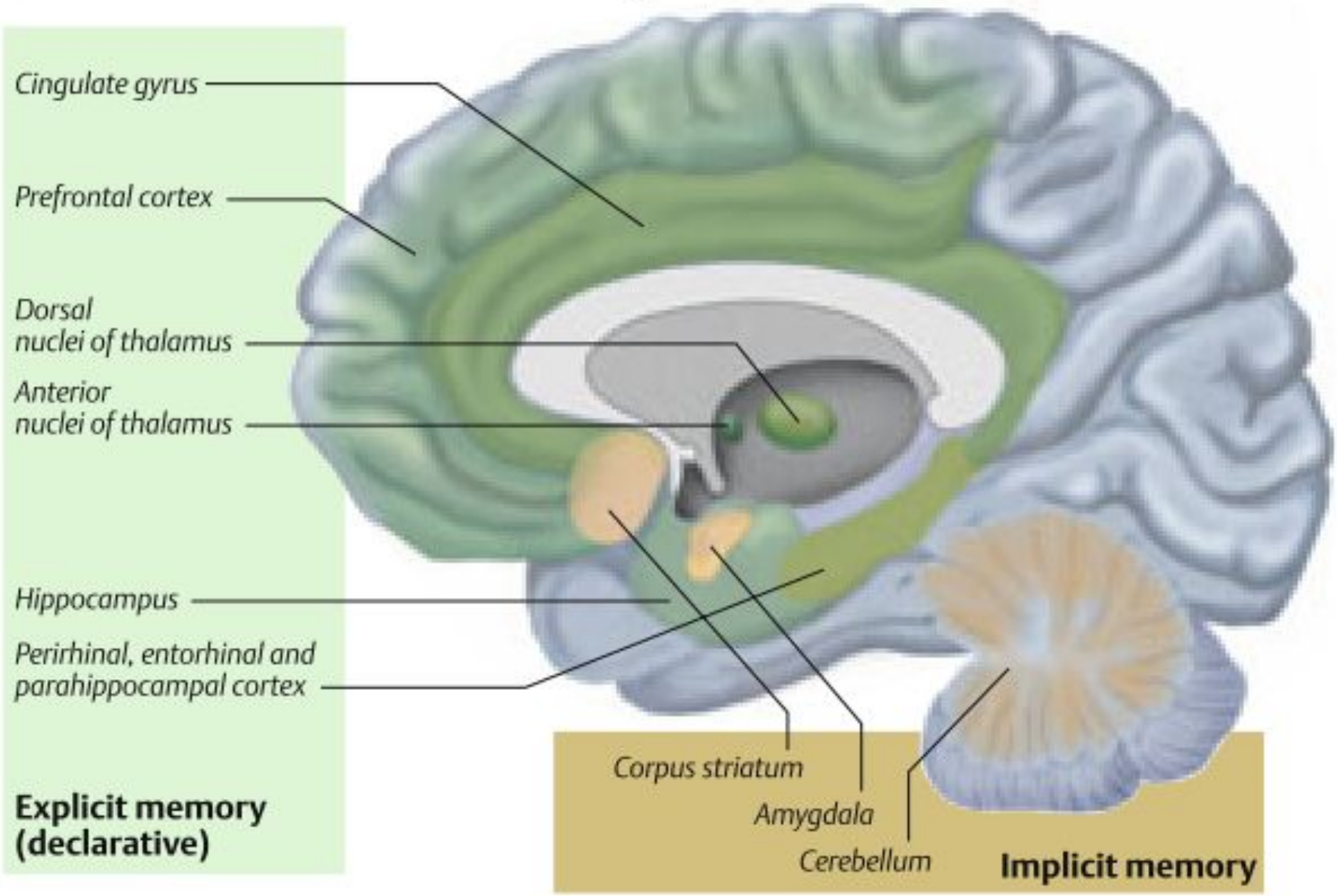

(a) Repeating a Spoken Word

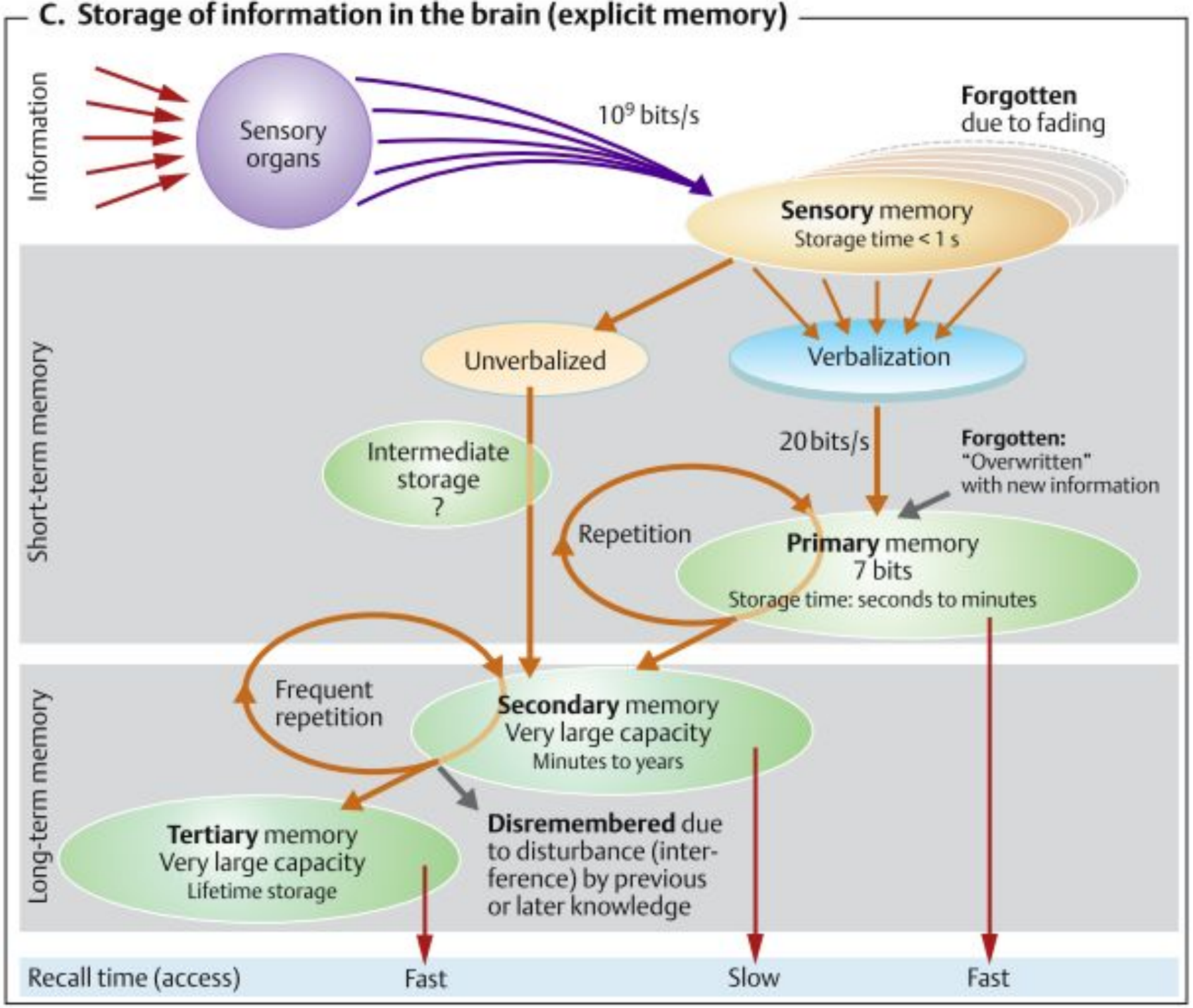


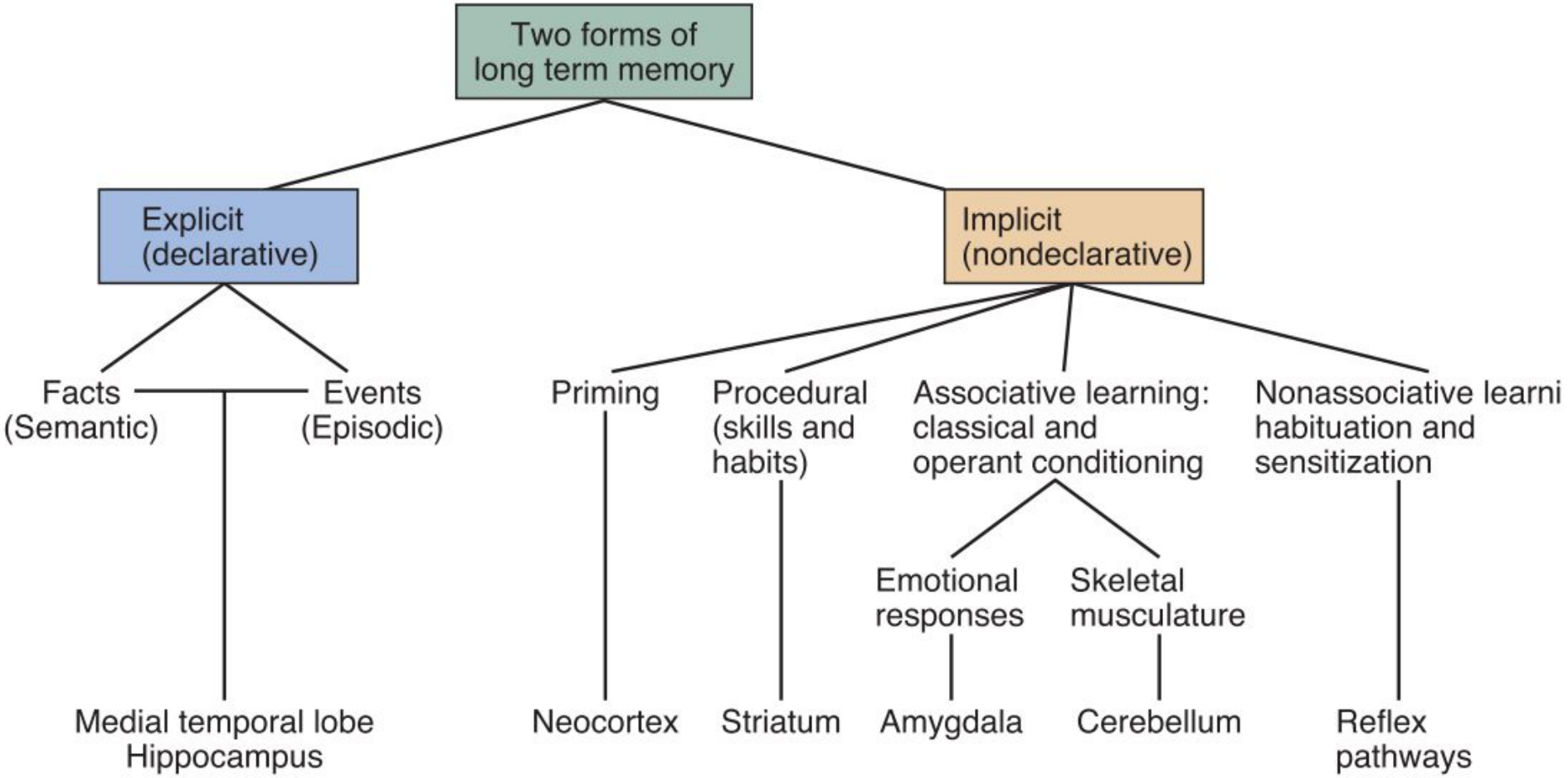

(b) Reading a Word Out Loud

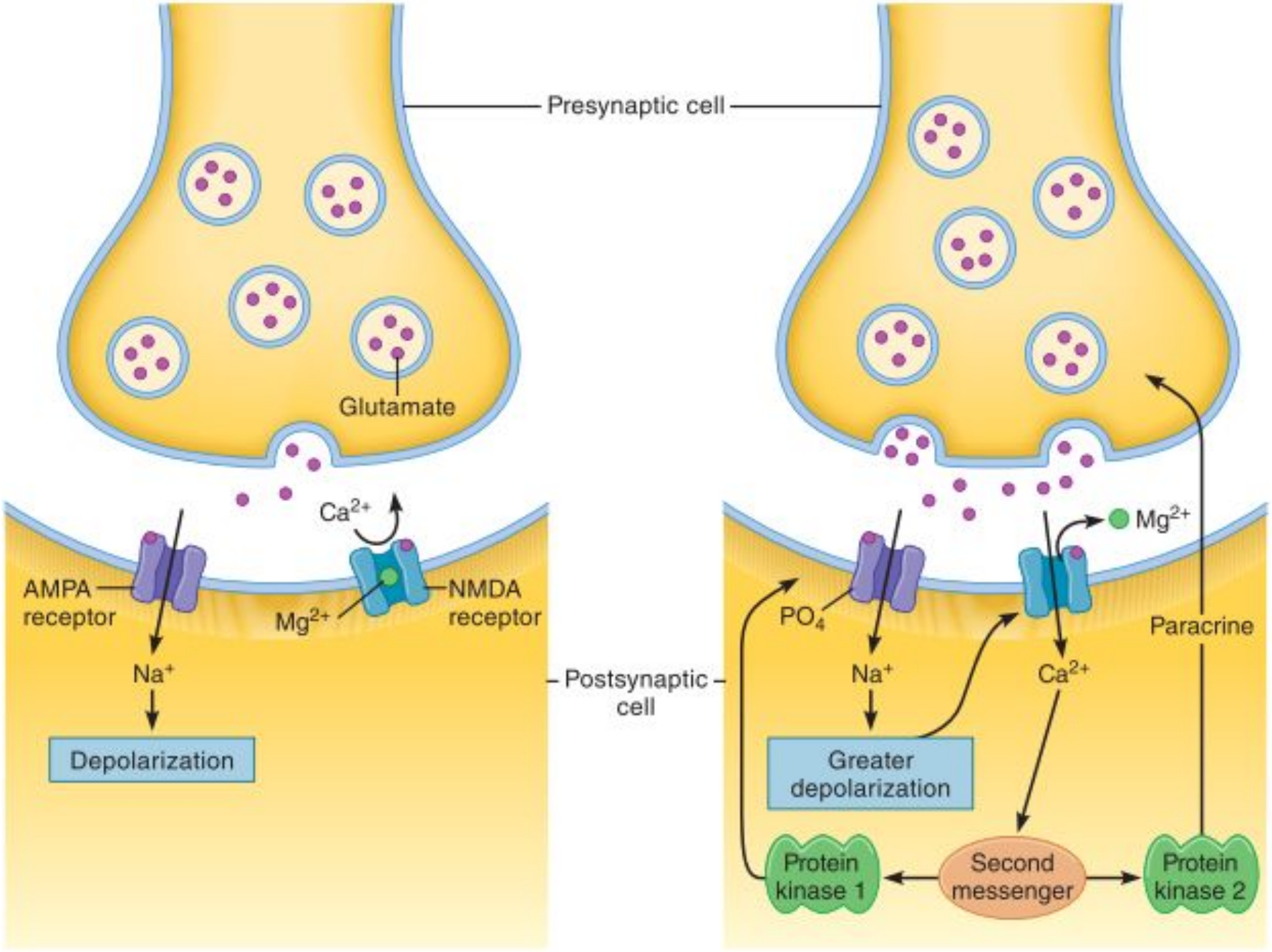

Left
Right
Broca's area
Facial area of motor cortex (area 4)
6
Arcuate fasciculus
5
Wernicke's area (area 22)
From lateral geniculate nucleus
4
1
Angular gyrus (area 39)
3
2
Higher order visual cortical areas (area 18)
Primary visual cortex (area 17)

## B. Areas of the brain involved in memory




C. Storage of information in the brain (explicit memory)
Information
Sensory organs
$10^9$ bits/s
Forgotten due to fading
Sensory memory
Storage time < 1 s
Short-term memory
Unverbalized
Verbalization
Intermediate storage ?
20 bits/s
Forgotten: "Overwritten" with new information
Repetition
Primary memory
7 bits
Storage time: seconds to minutes
Long-term memory
Frequent repetition
Secondary memory
Very large capacity
Minutes to years
Tertiary memory
Very large capacity
Lifetime storage
Disremembered due to disturbance (interference) by previous or later knowledge
Recall time (access)
Fast
Slow
Fast

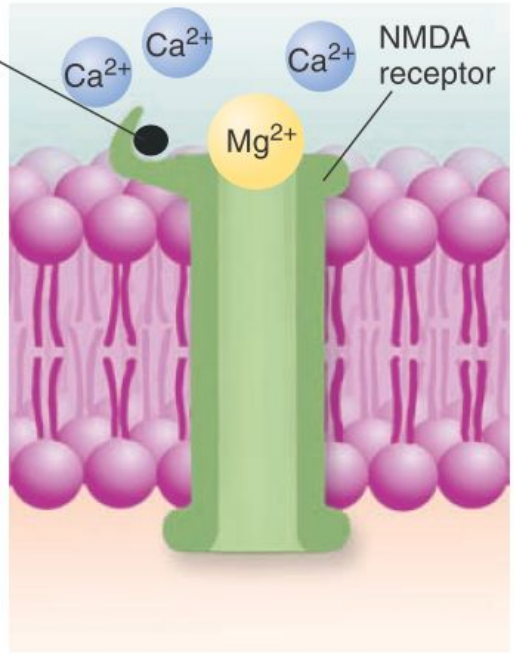

Two forms of long term memory
Explicit (declarative)
Implicit (nondeclarative)
Facts (Semantic)
Events (Episodic)
Priming
Procedural (skills and habits)
Associative learning: classical and operant conditioning
Nonassociative learni habituation and sensitization
Emotional responses
Skeletal musculature
Medial temporal lobe Hippocampus
Neocortex
Striatum
Amygdala
Cerebellum
Reflex pathways




**(a)** Low levels of activity in presynaptic cell

**(b)** High levels of activity in presynaptic cell

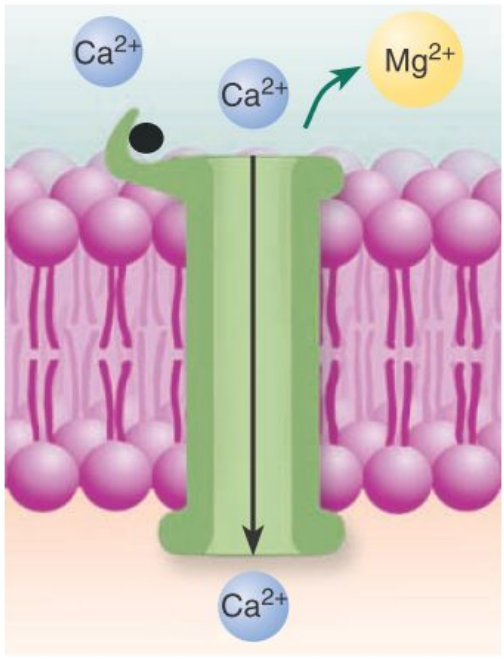
a molecule of glutamate
nds with the NMDA
ceptor, the calcium channel
annot open because the
agnesium ion blocks the
hannel




(a)

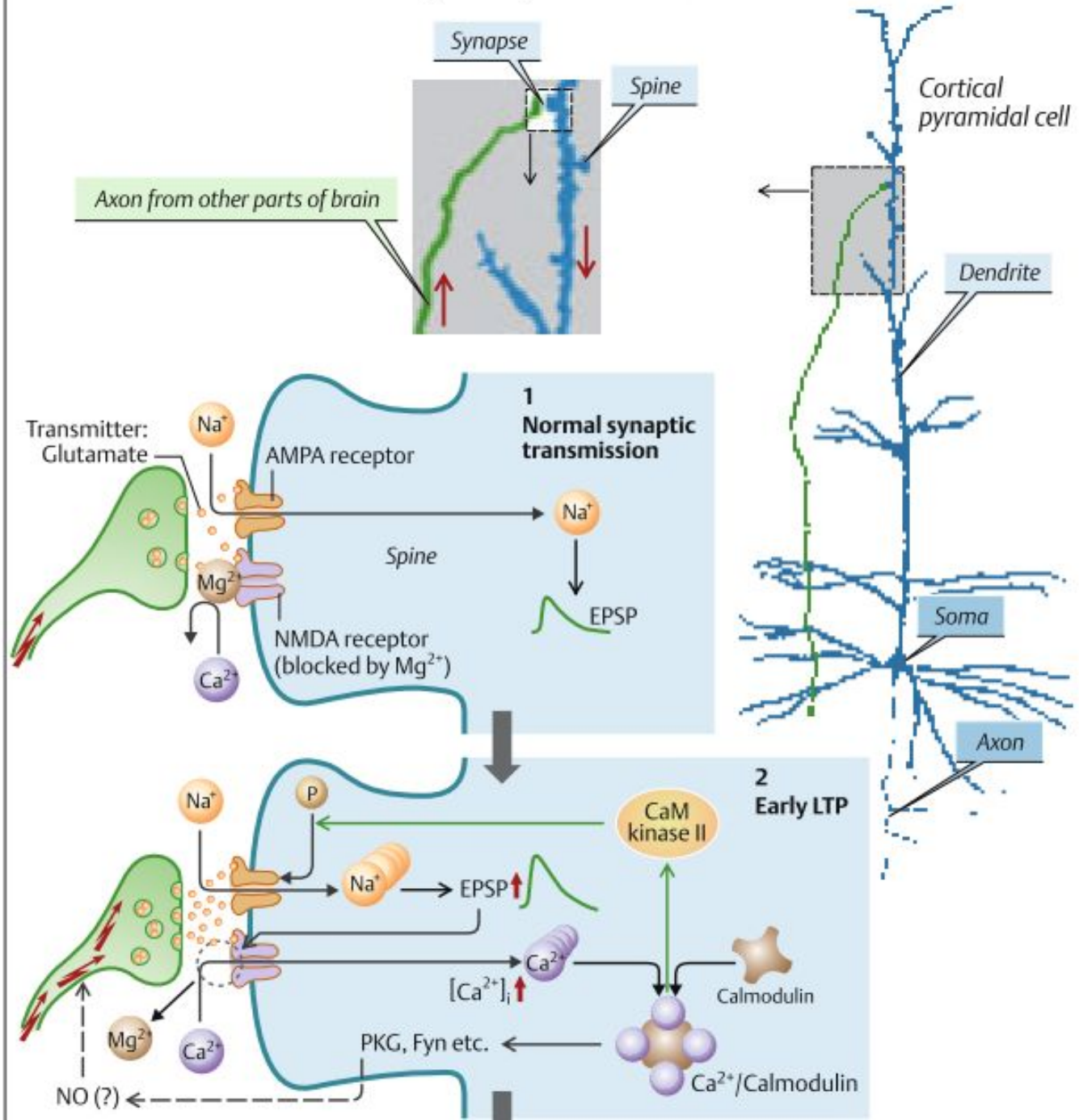
Depolarization of the membrane evicts the magnesium ion and unblocks the channel. Now glutamate can open the ion channel and permit the entry of calcium ions.

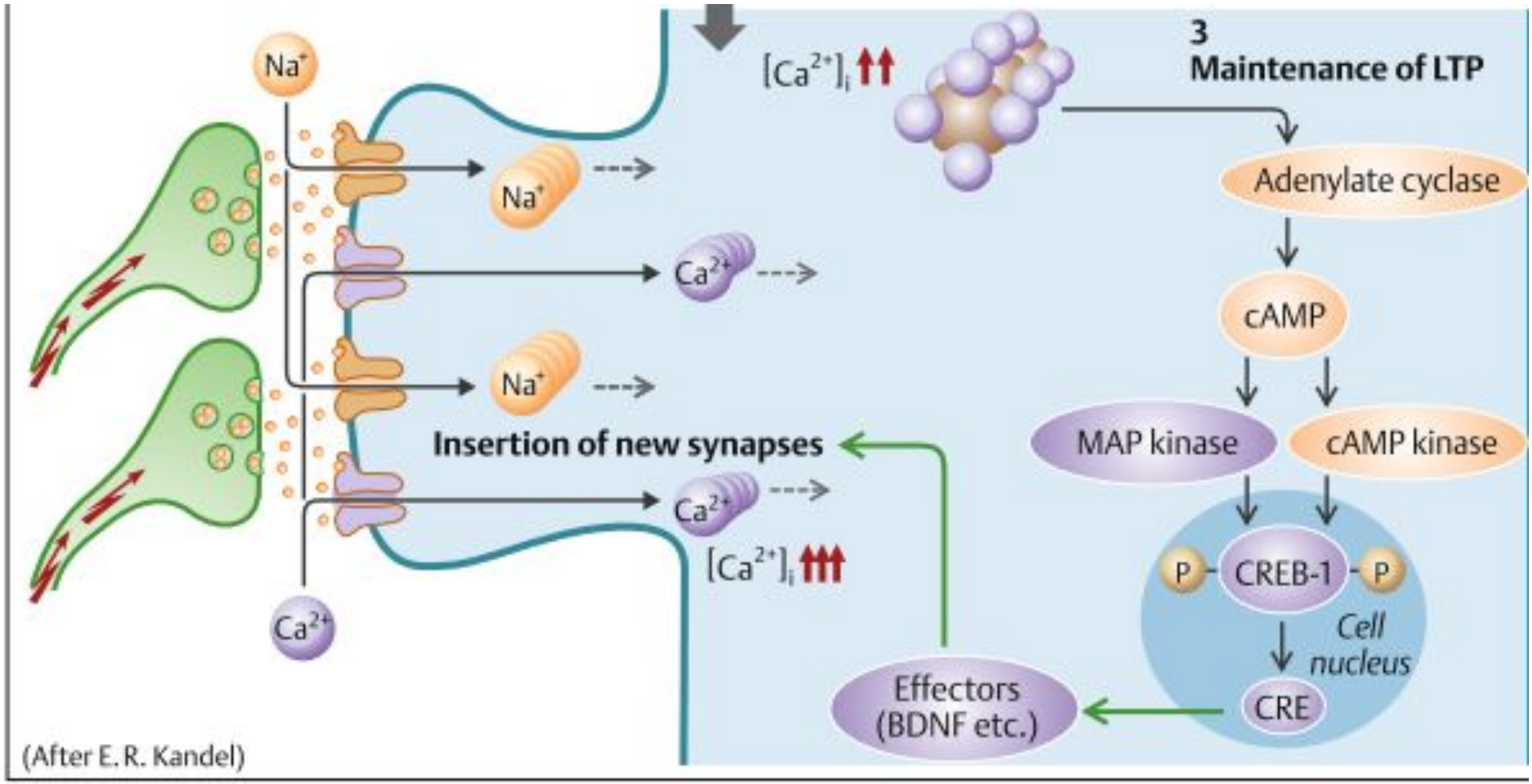
Depolarization

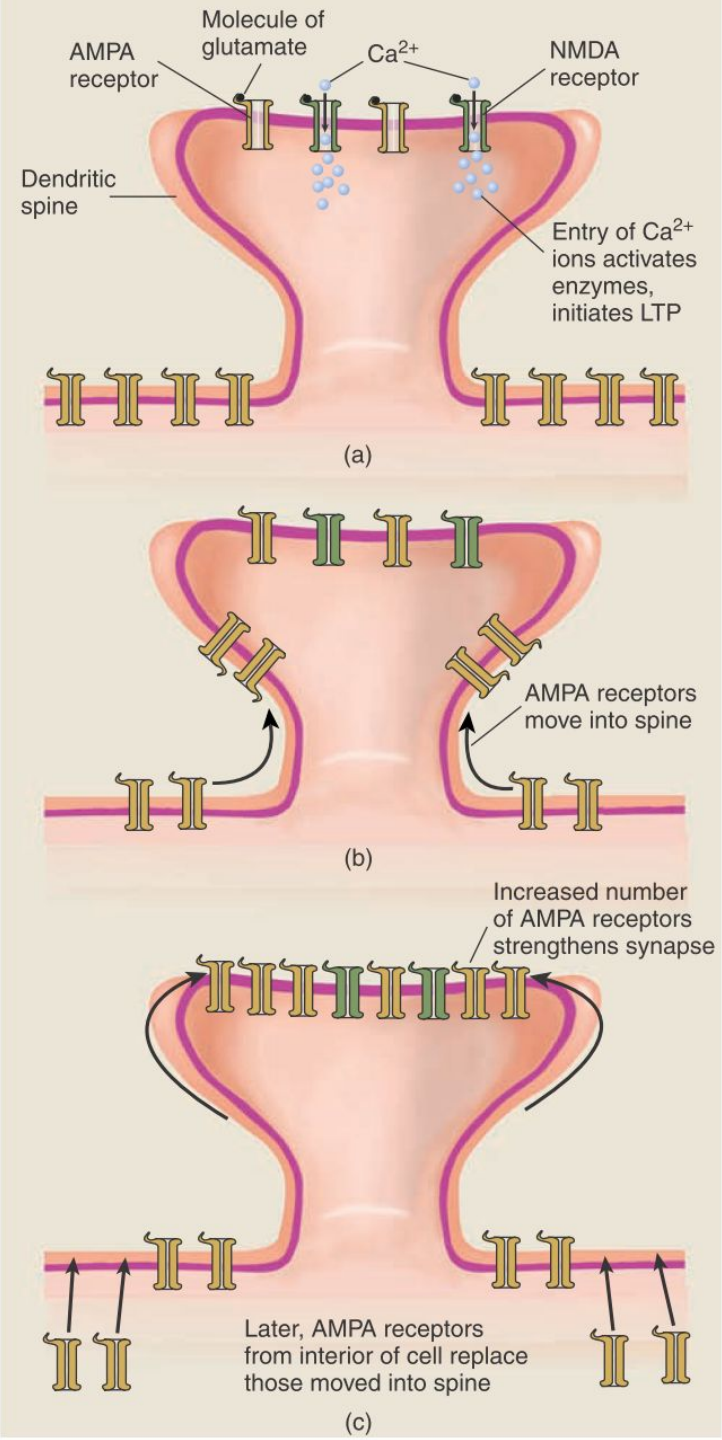


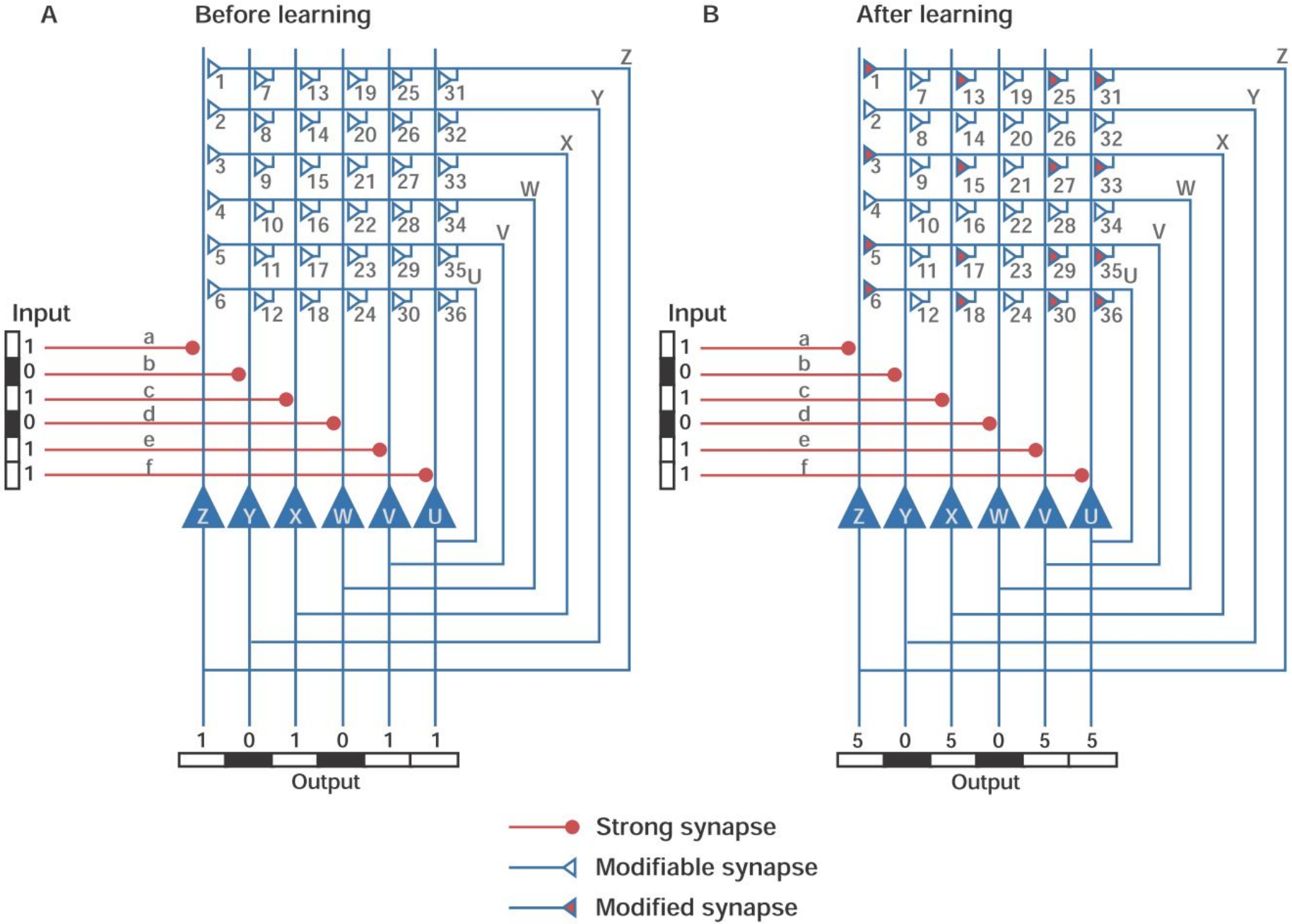

(b)

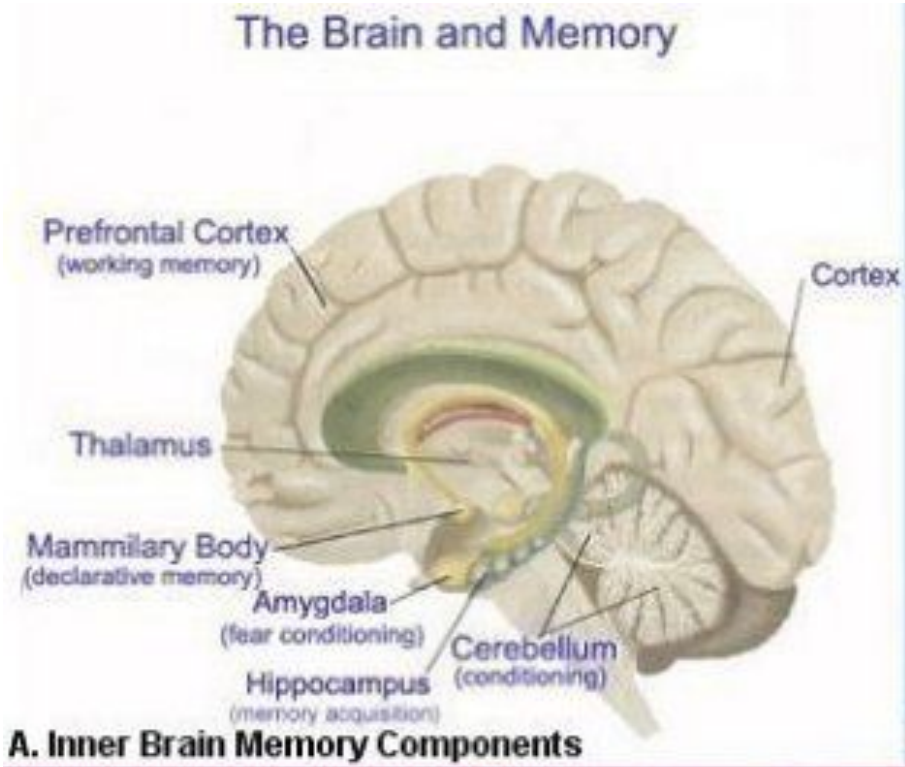
## D. Molecular mechanisms of long-term potentiation



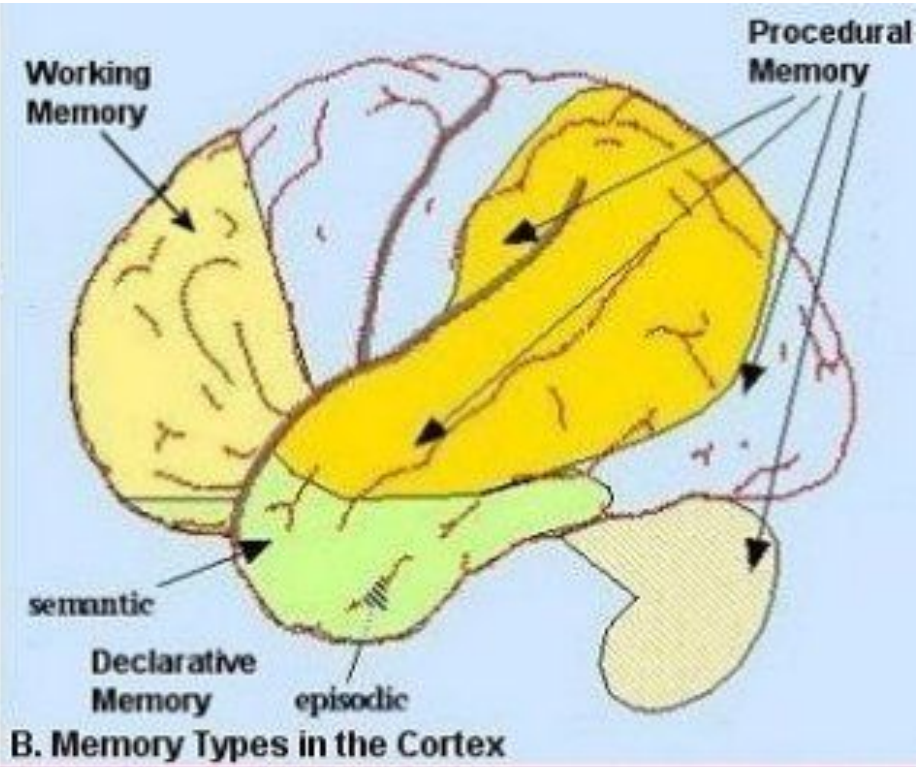

Na+
Na+
Ca2+
Na+
Ca2+
Ca2+
[Ca2+]i
[Ca2+]i
Insertion of new synapses
3
Maintenance of LTP
Adenylate cyclase
cAMP
MAP kinase
cAMP kinase
P
CREB-1
P
Cell nucleus
CRE
Effectors (BDNF etc.)
(After E. R. Kandel)


Molecule of glutamate
AMPA receptor
$Ca^{2+}$
NMDA receptor
Dendritic spine
Entry of $Ca^{2+}$ ions activates enzymes, initiates LTP
(a)
AMPA receptors move into spine
(b)
Increased number of AMPA receptors strengthens synapse
Later, AMPA receptors from interior of cell replace those moved into spine
(c)

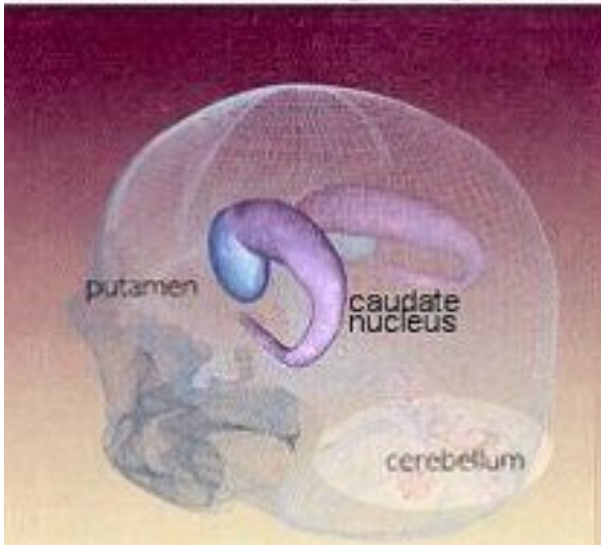

A
Before learning
B
After learning
Input
a
b
c
d
e
f
1
0
1
0
1
1
Z
Y
X
W
V
U
1 0 1 0 1 1
5 0 5 0 5 5
Output
Strong synapse
Modifiable synapse
Modified synapse



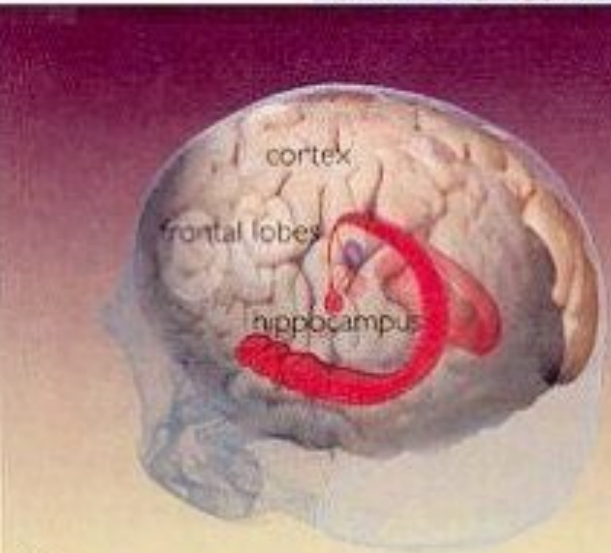
A. Inner Brain Memory Components



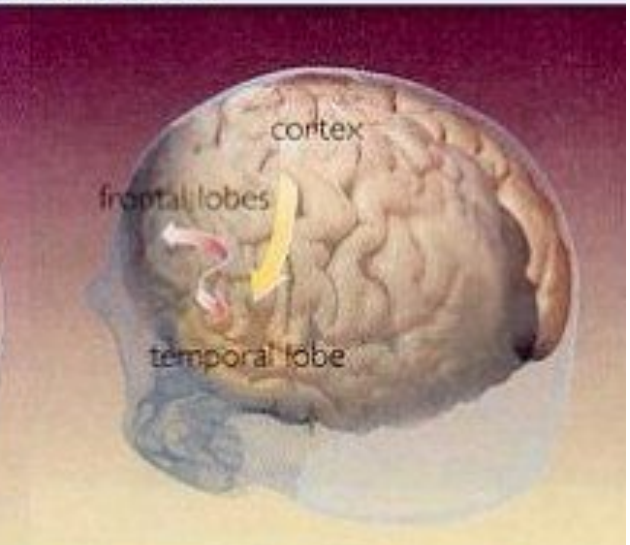
B. Memory Types in the Cortex



C. Procedural Memory Components

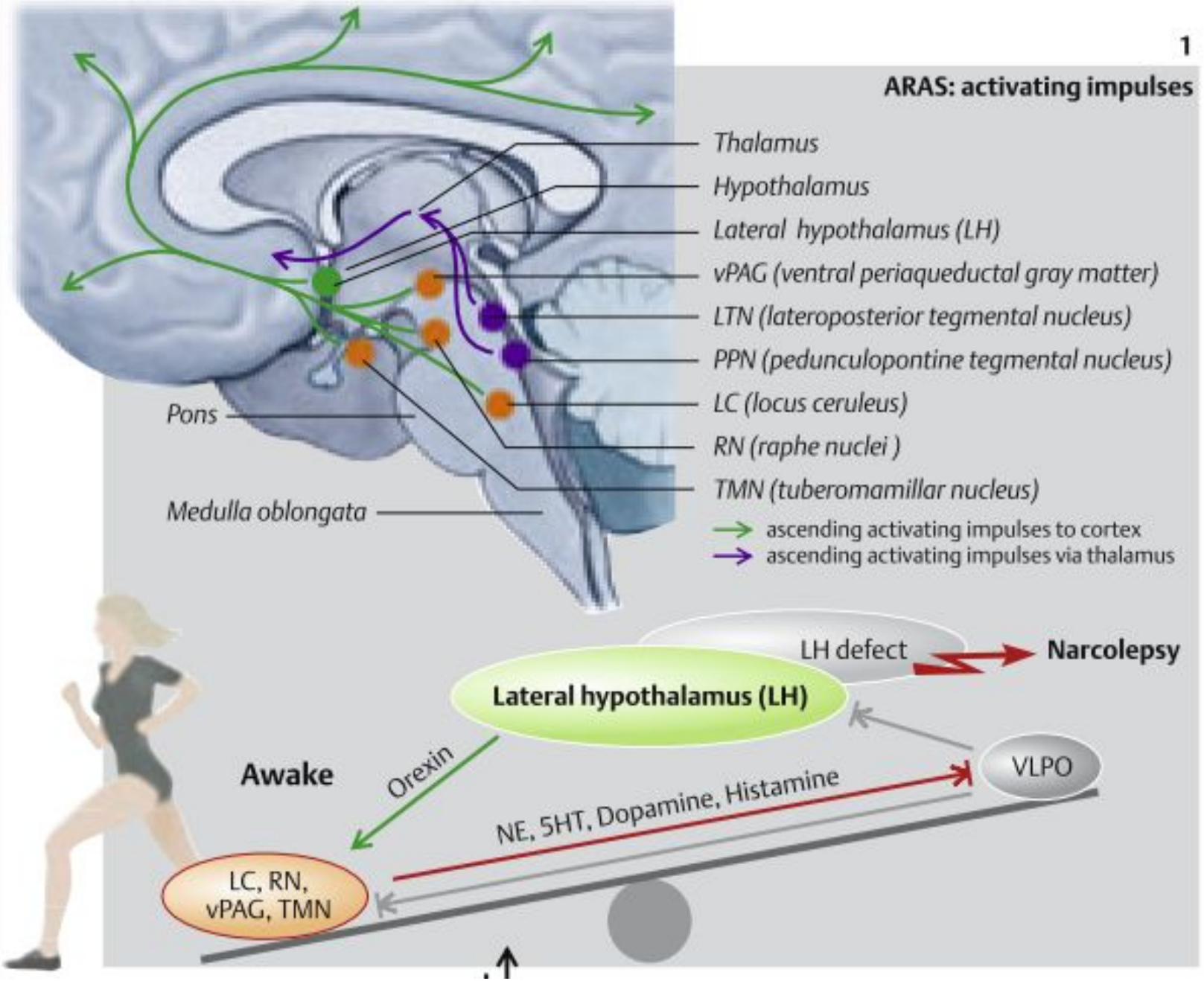


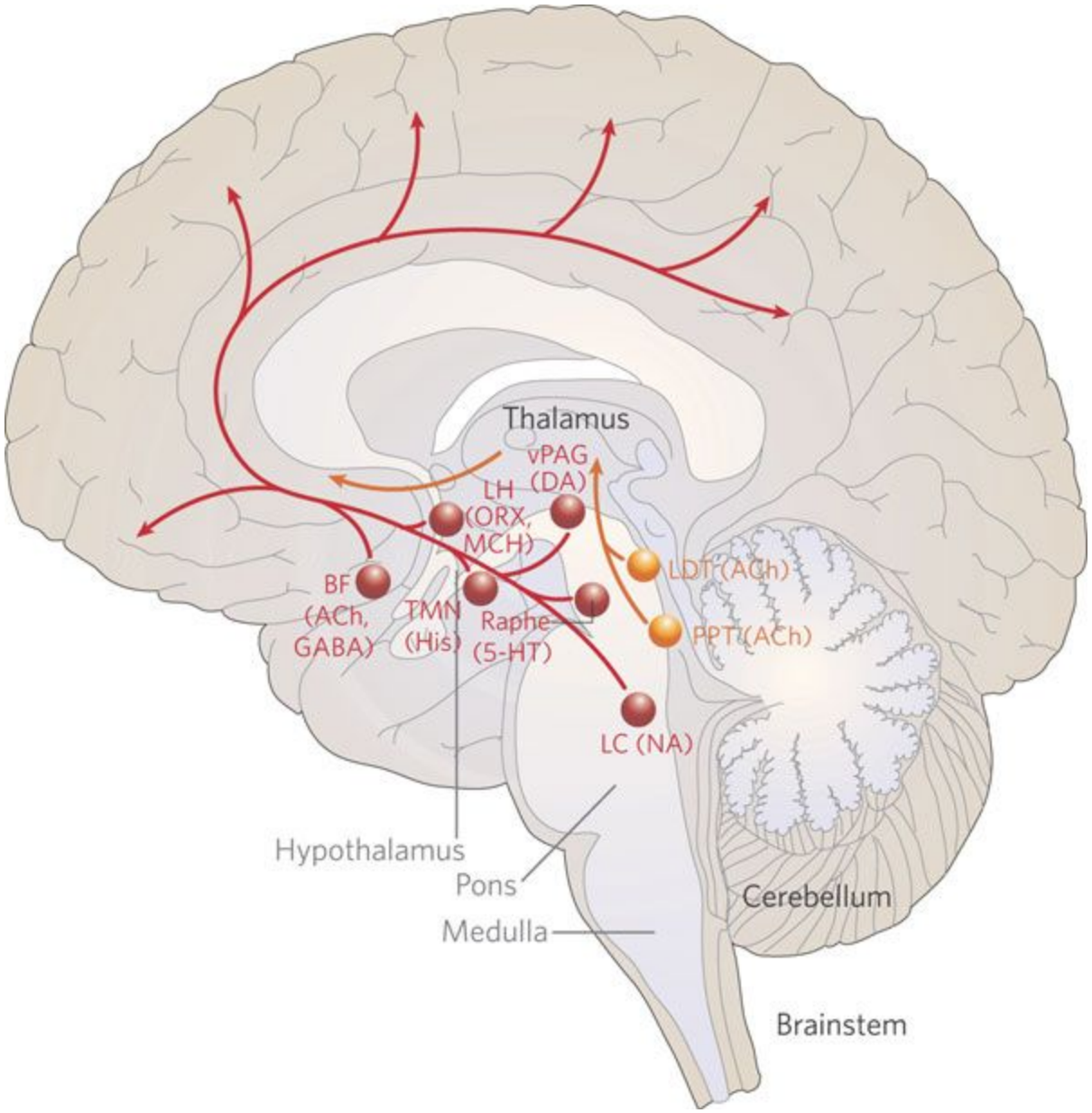
D. Episodic Memory Components

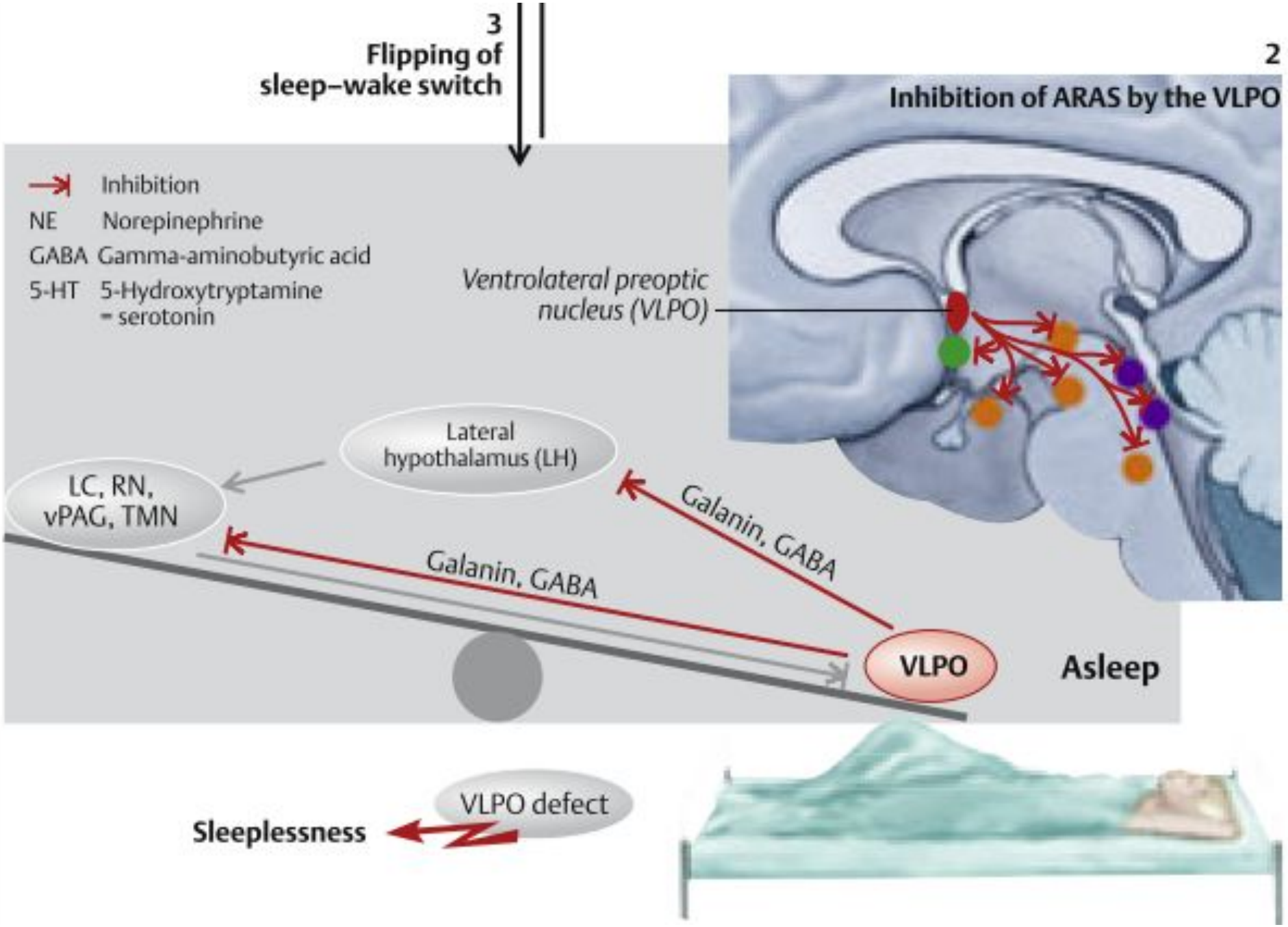


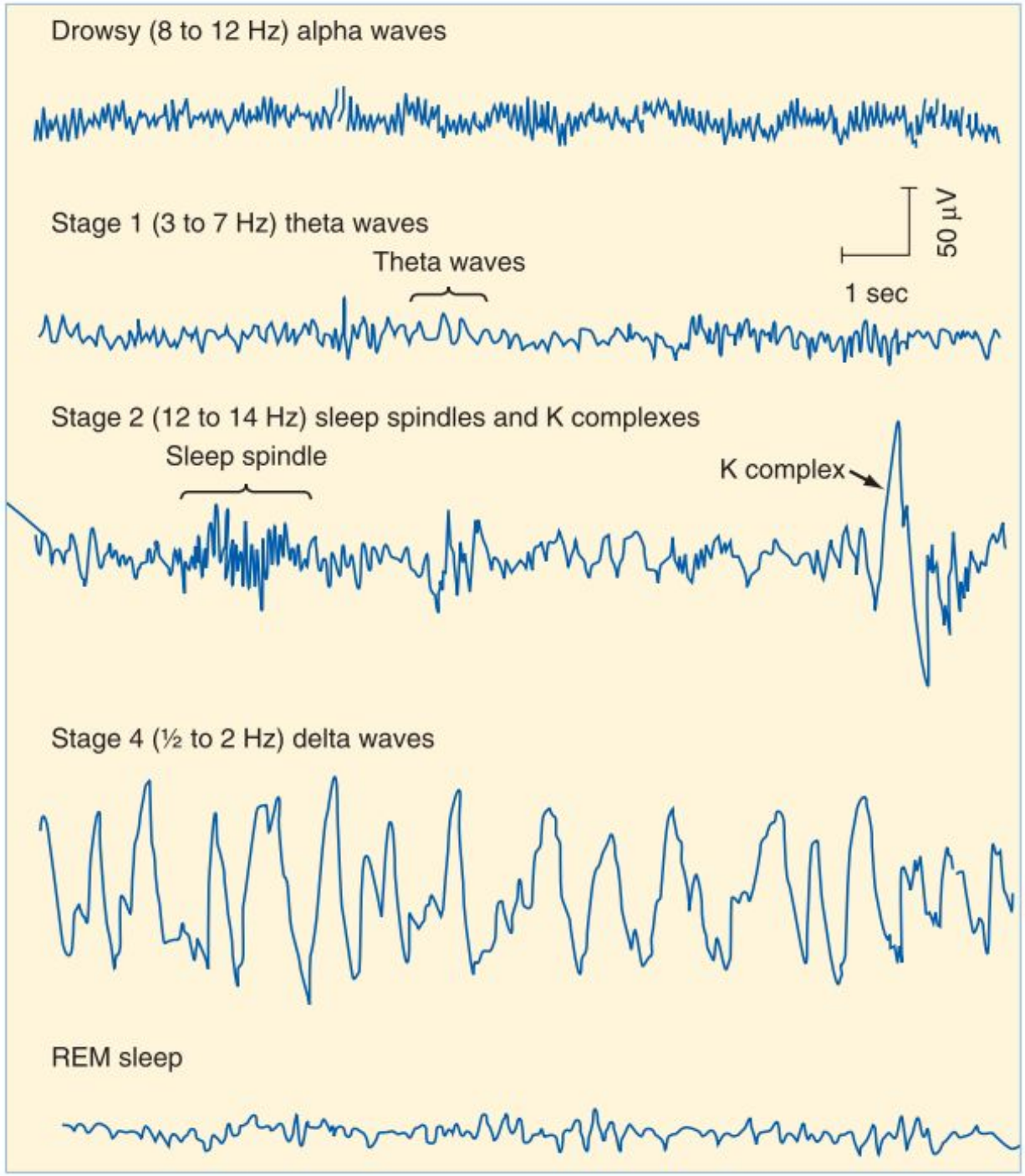
E. Semantic Memory Pathway

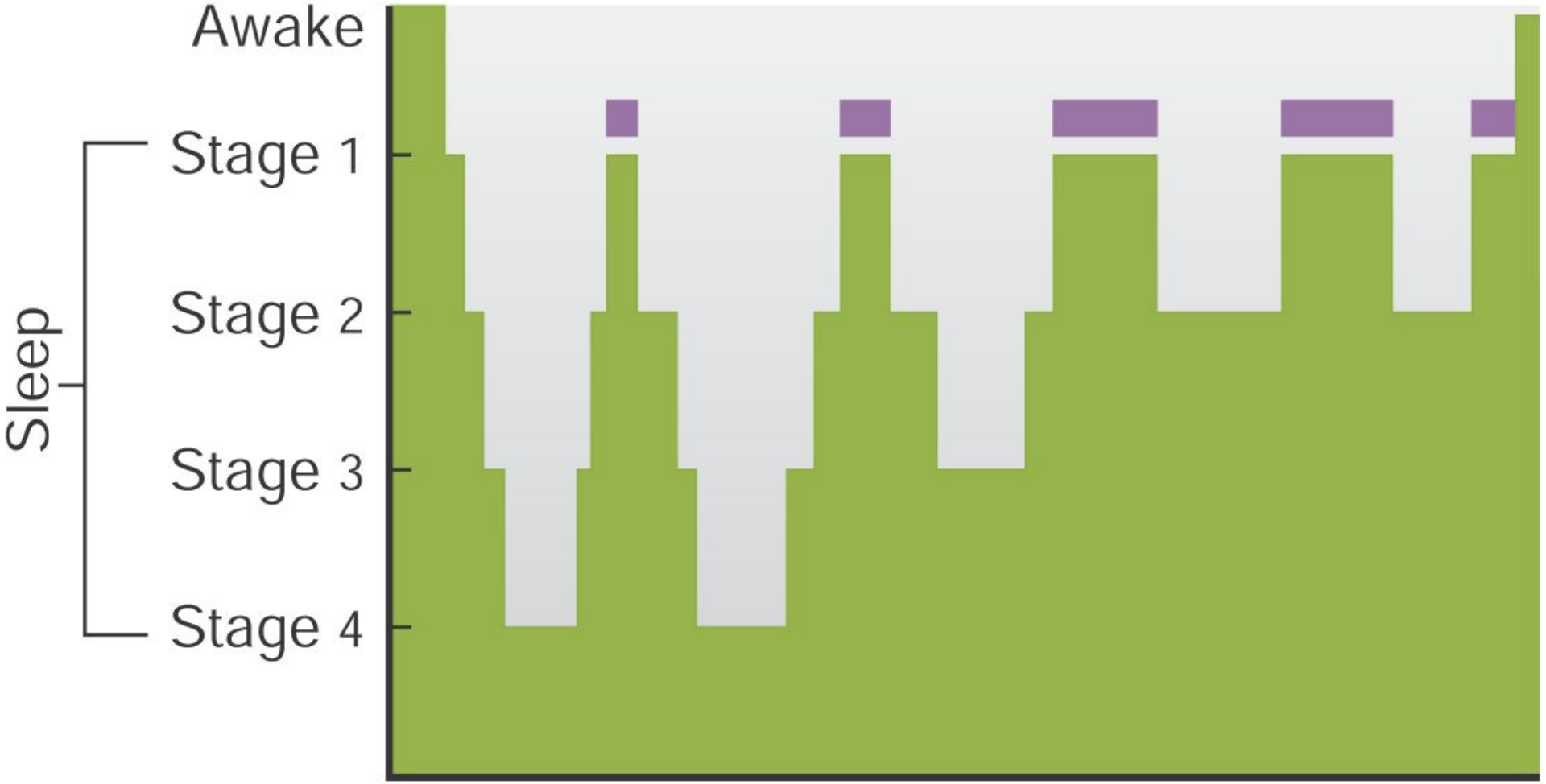
## A. Control of sleep–wake cycle



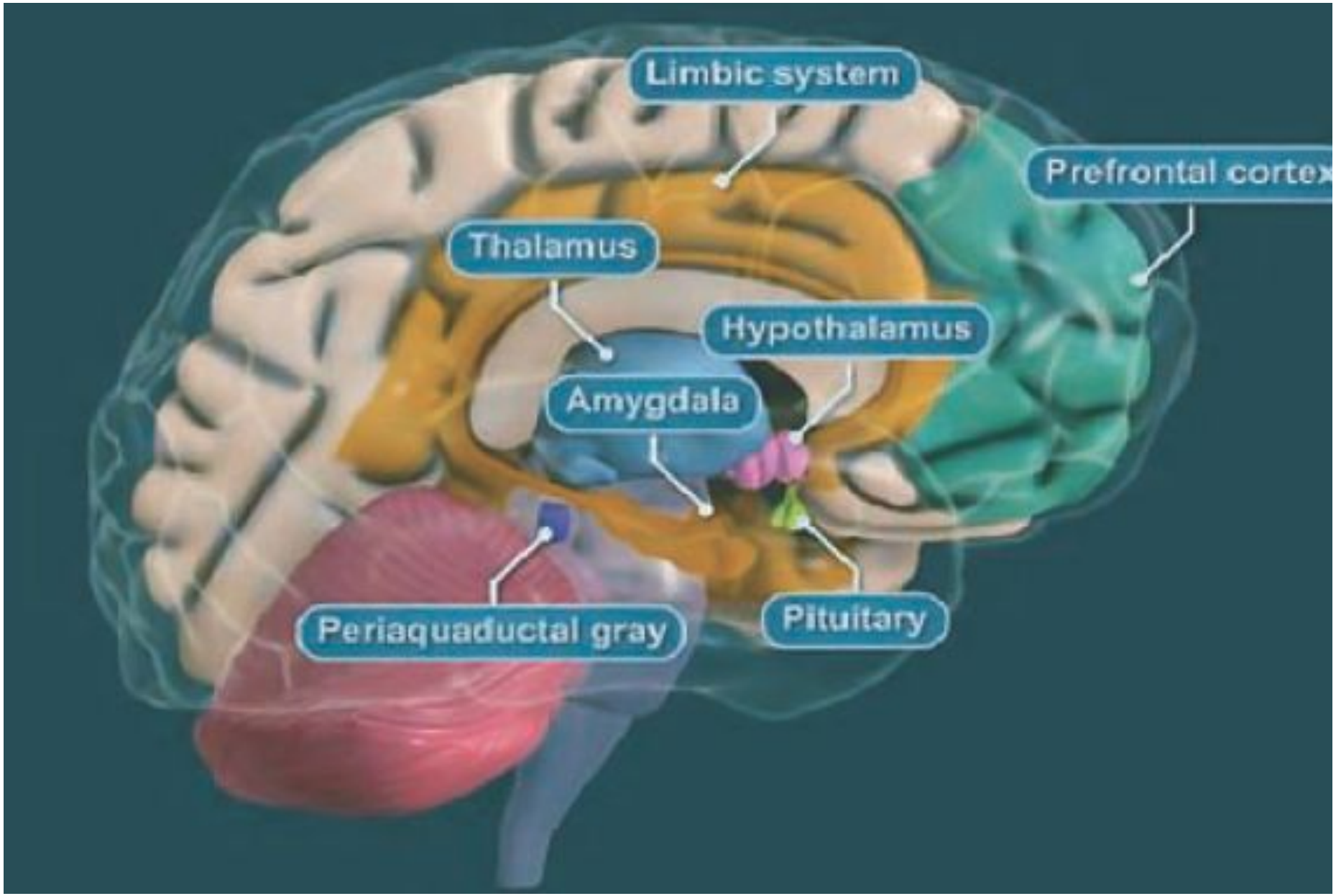

Thalamus
vPAG
(DA)
LH
(ORX,
MCH)
BF
(ACh,
GABA)
TMN
(His)
Raphe
(5-HT)
LDT (ACh)
PPT (ACh)
LC (NA)
Hypothalamus
Pons
Medulla
Cerebellum
Brainstem

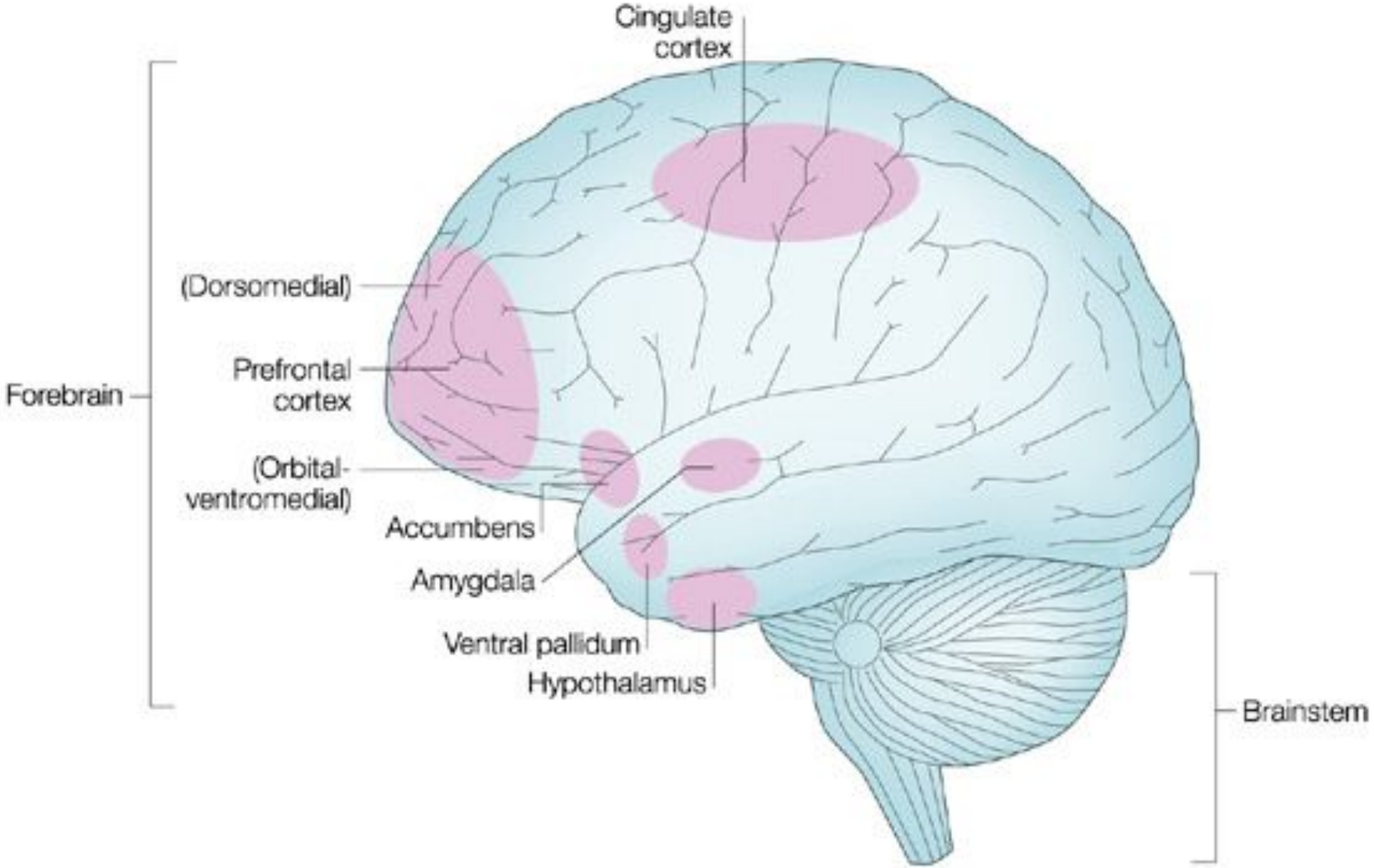

3
Flipping of
sleep–wake switch
2
Inhibition of ARAS by the VLPO
Inhibition
NE Norepinephrine
GABA Gamma-aminobutyric acid
5-HT 5-Hydroxytryptamine
= serotonin
Ventrolateral preoptic
nucleus (VLPO)
Lateral
hypothalamus (LH)
LC, RN,
vPAG, TMN
Galanin, GABA
Galanin, GABA
VLPO
Asleep
VLPO defect
Sleeplessness


Drowsy (8 to 12 Hz) alpha waves
Stage 1 (3 to 7 Hz) theta waves
Theta waves
50 μV
1 sec
Stage 2 (12 to 14 Hz) sleep spindles and K complexes
Sleep spindle
K complex
Stage 4 (½ to 2 Hz) delta waves
REM sleep


Awake
Stage 1
Stage 2
Stage 3
Stage 4
Sleep

| Theory | Stimulus | Response | Report |
|---|---|---|---|
| Common sense |  | Fear → Subjective experience;  Body response (arousal) | "My heart is pounding because I feel afraid." |
| James-Lange |  |  Body response (arousal) → Fear → Subjective experience | "I feel afraid because my heart is pounding." |
| Cannon-Bard |  |  Body response (arousal); Fear → Subjective experience | "The dog makes me feel afraid and my heart pounds." |
| Schachter |  |  Body response (arousal) →  Interpretation → Fear → Subjective experience | "My pounding heart means I'm afraid because I interpret the situation as dangerous." |


Limbic system
Prefrontal cortex
Thalamus
Hypothalamus
Amygdala
Periaquaductal gray
Pituitary

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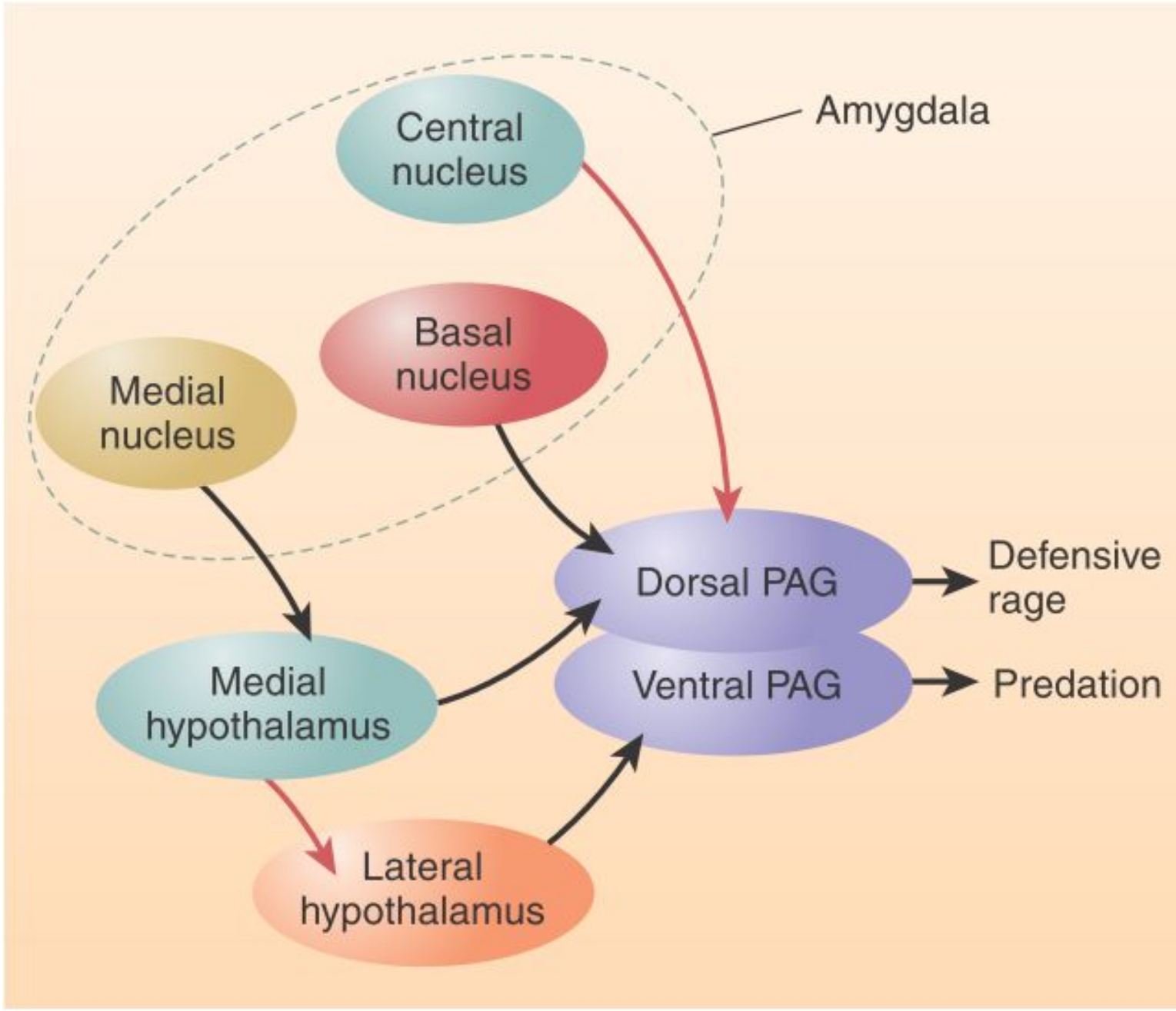
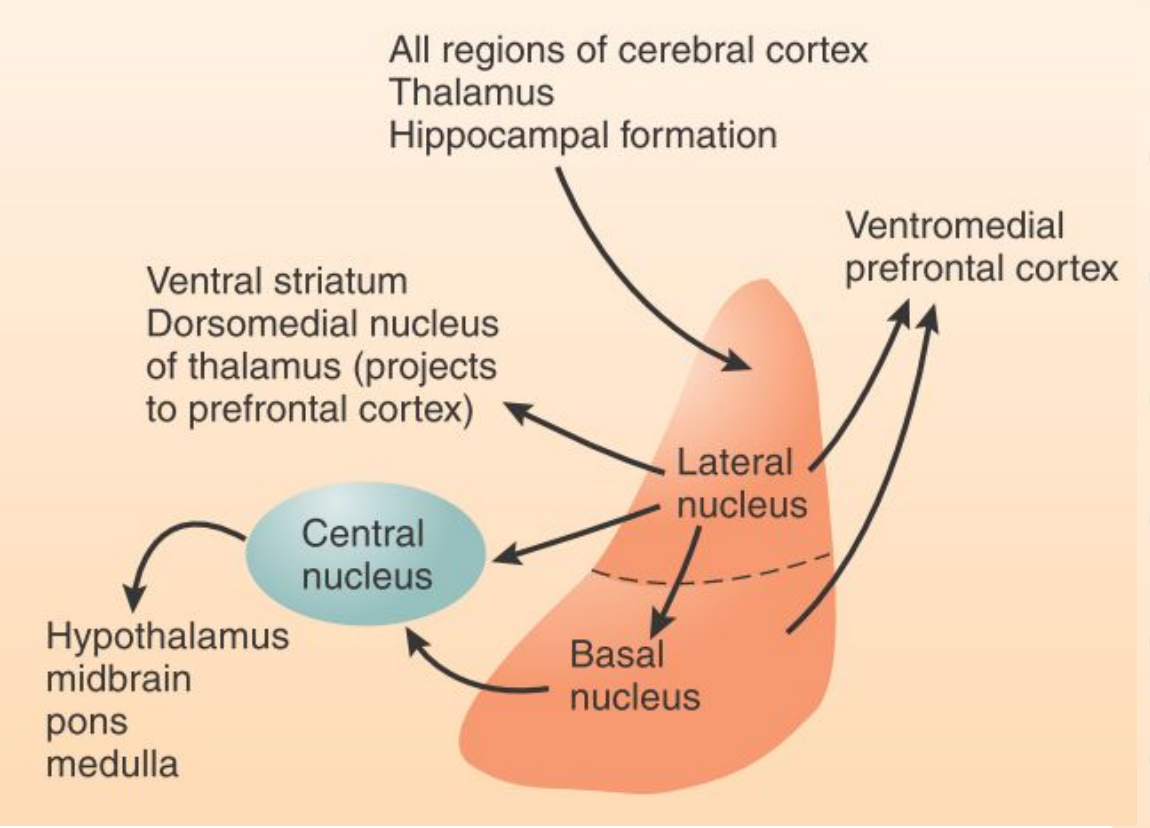
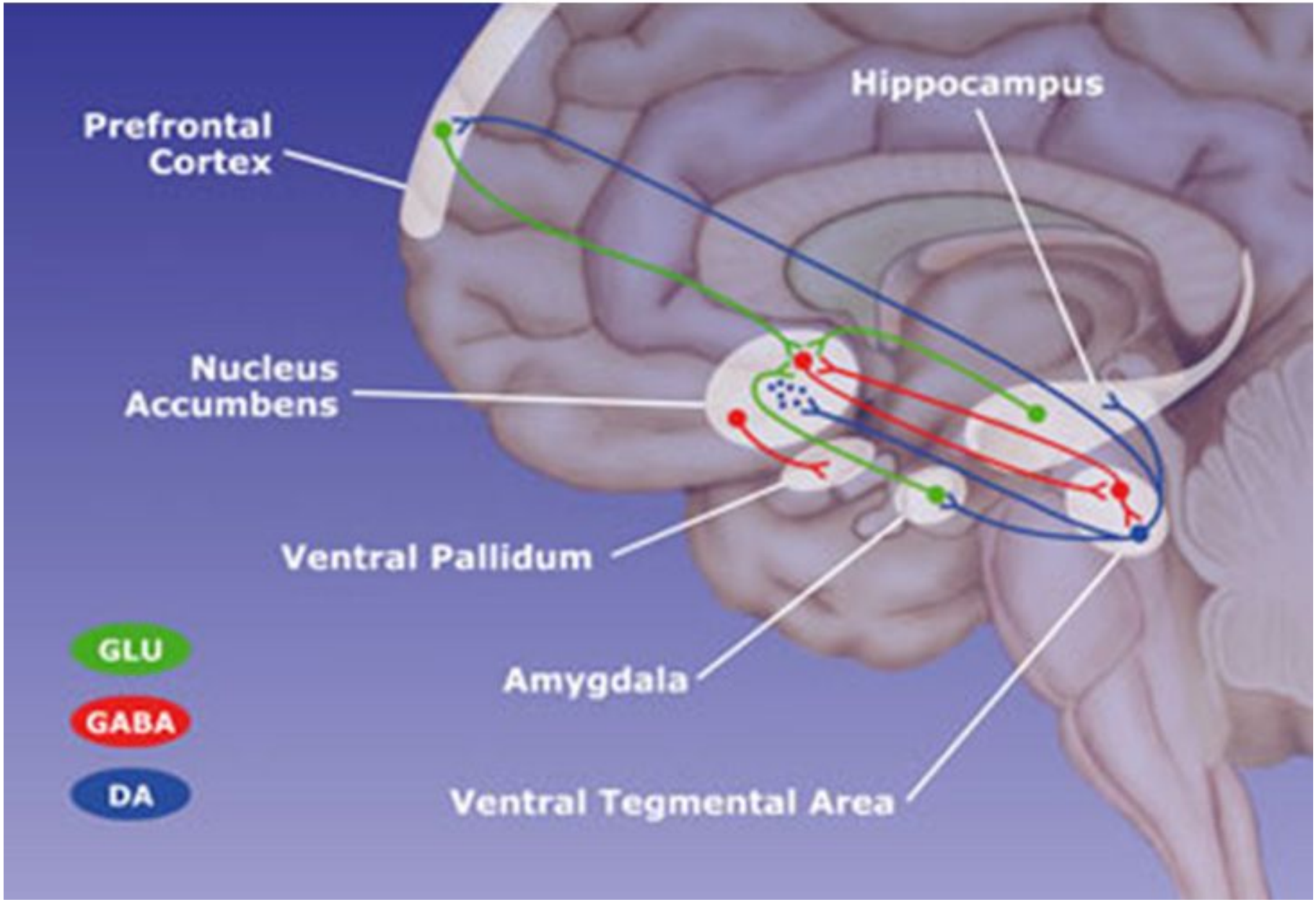
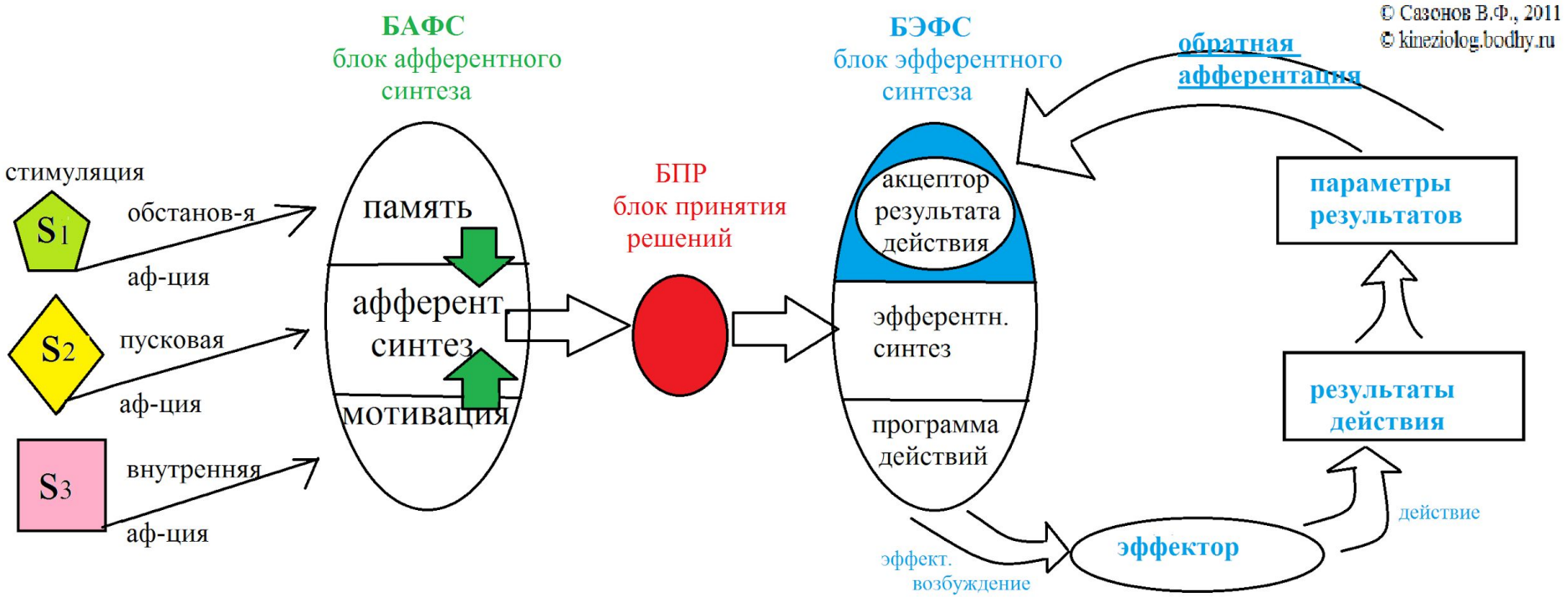

Amygdala
Central nucleus
Basal nucleus
Medial nucleus
Dorsal PAG
Defensive rage
Ventral PAG
Predation
Medial hypothalamus
Lateral hypothalamus




| *Brain Regions* | *Behavioral and Physiological Responses* |
|---|---|
| Lateral hypothalamus | Sympathetic activation: increased heart rate and blood pressure, paleness |
| Dorsal motor nucleus of vagus | Parasympathetic activation: ulcers, urination, defecation |
| Parabrachial nucleus | Increased respiration |
| Ventral tegmental area | Behavioral arousal (dopamine) |
| Locus coeruleus | Increased vigilance (norepinephrine) |
| Dorsal lateral tegmental nucleus | Cortical activation (acetylcholine) |
| Nucleus reticularis pontis caudalis | Augmented startle response |
| Periaqueductal gray matter | Behavioral arrest (freezing) |
| Trigeminal, facial motor nuclei | Facial expressions of fear |
| Paraventricular nucleus | ACTH, glucocorticoid secretion |
| Nucleus basalis | Cortical activation |

# The Reward Circuit

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БАФС
блок афферентного синтеза
БЭФС
блок эфферентного синтеза
обратная афферентация
стимуляция
S1
обстанов-я
аф-ция
S2
пусковая
аф-ция
S3
внутренняя
аф-ция
память
афферент. синтез
мотивация
БПР
блок принятия решений
акцептор результата действия
эфферентн. синтез
программа действий
параметры результатов
результаты действия
эффект. возбуждение
эффектор
действие