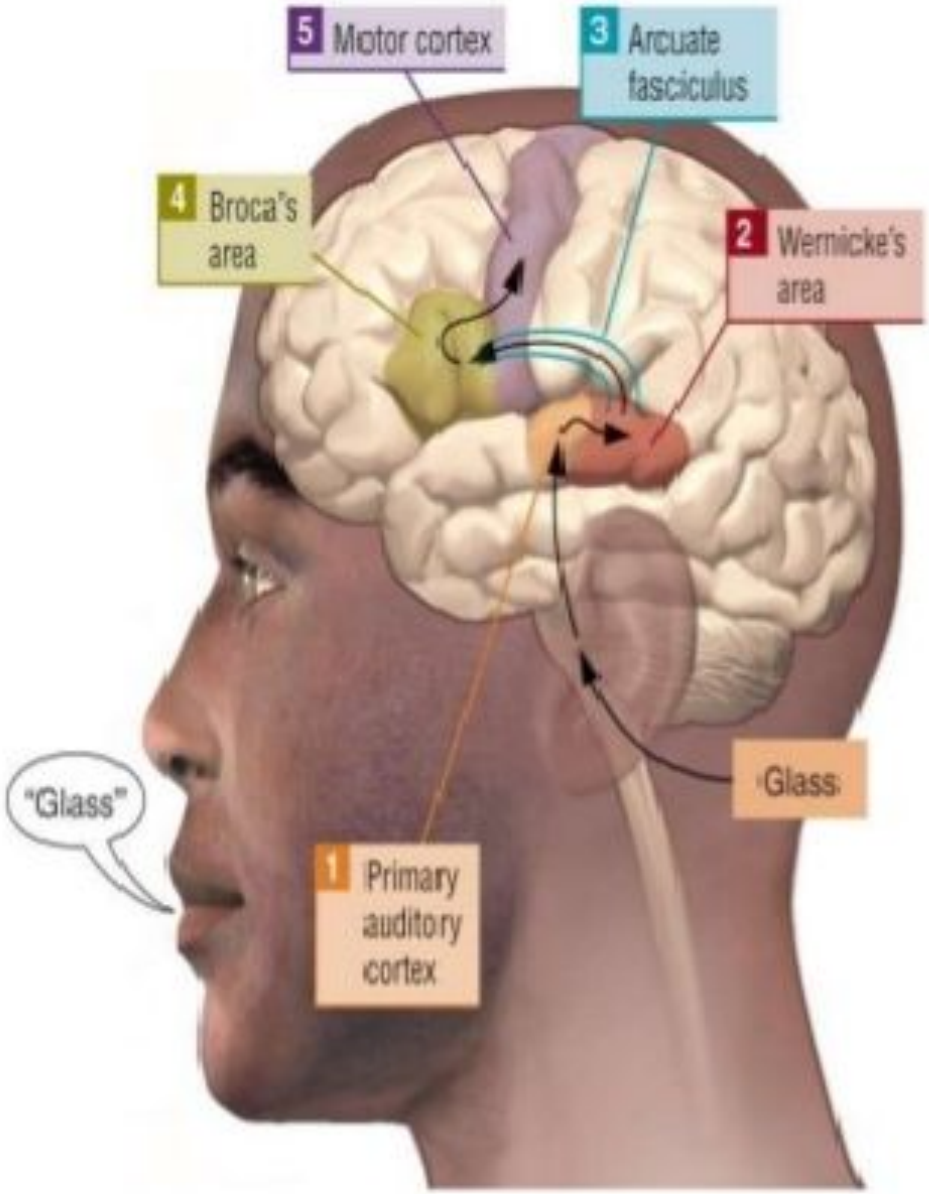
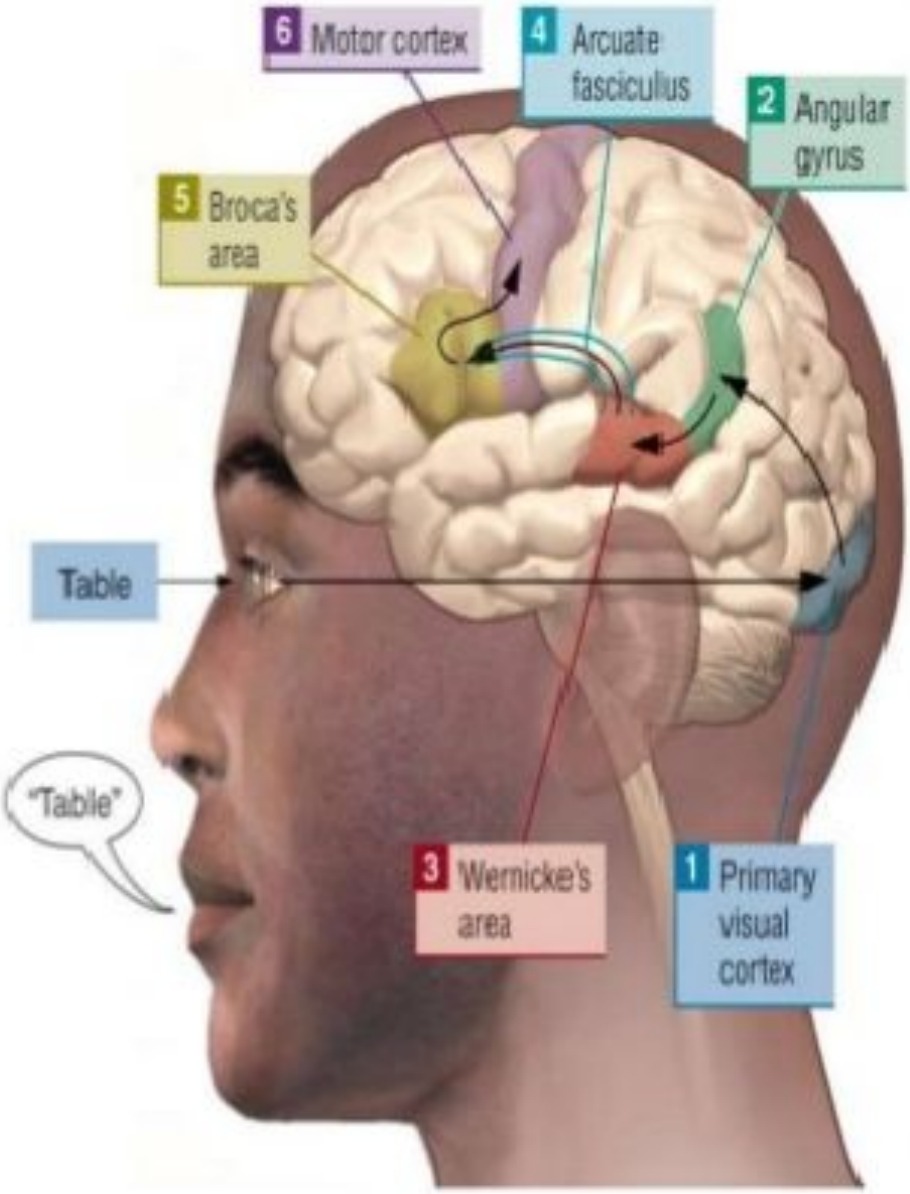
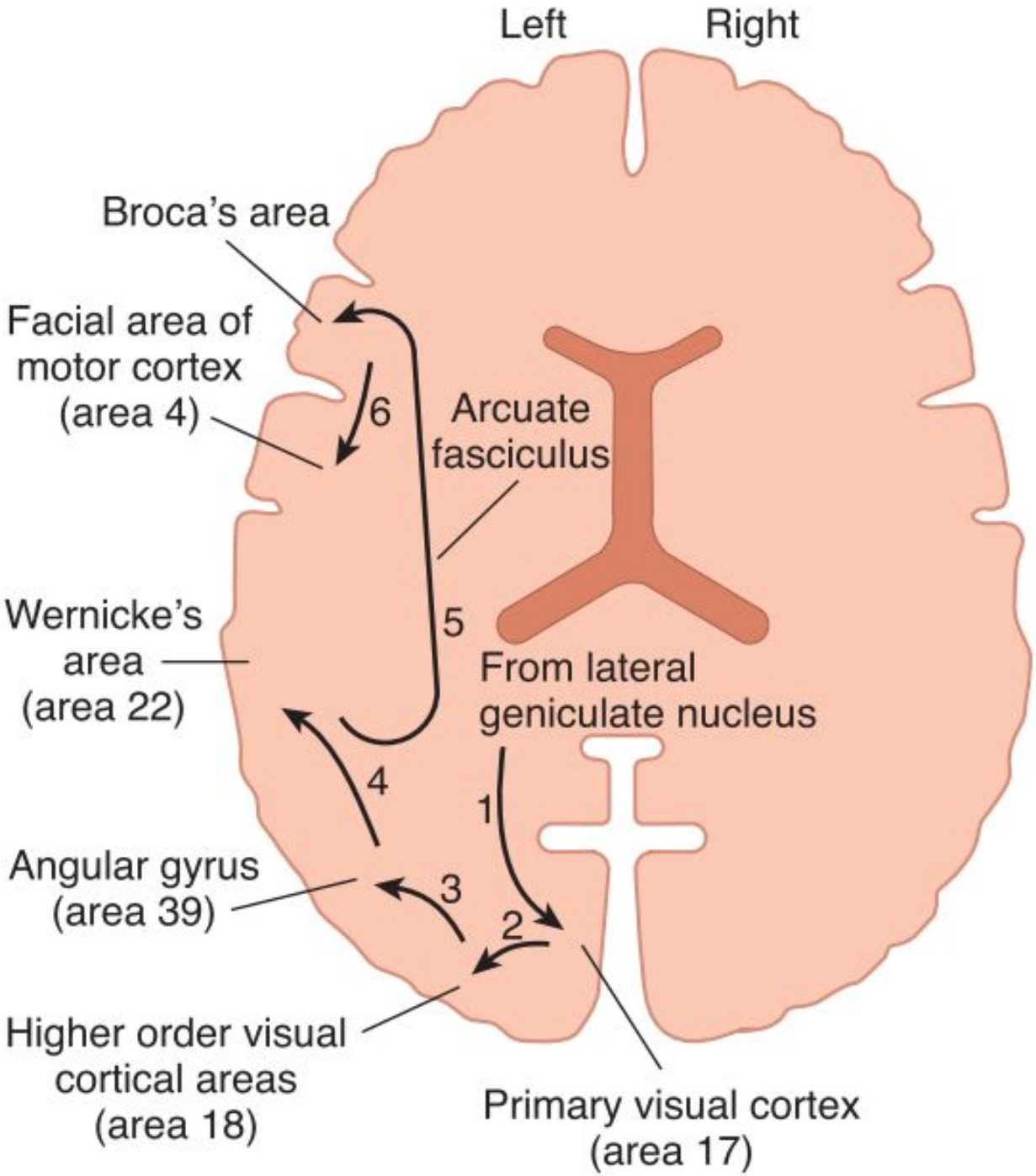
Высшая нервная деятельность человека. Физиологические основы памяти, сна и эмоций. Понятие о функциональных системах



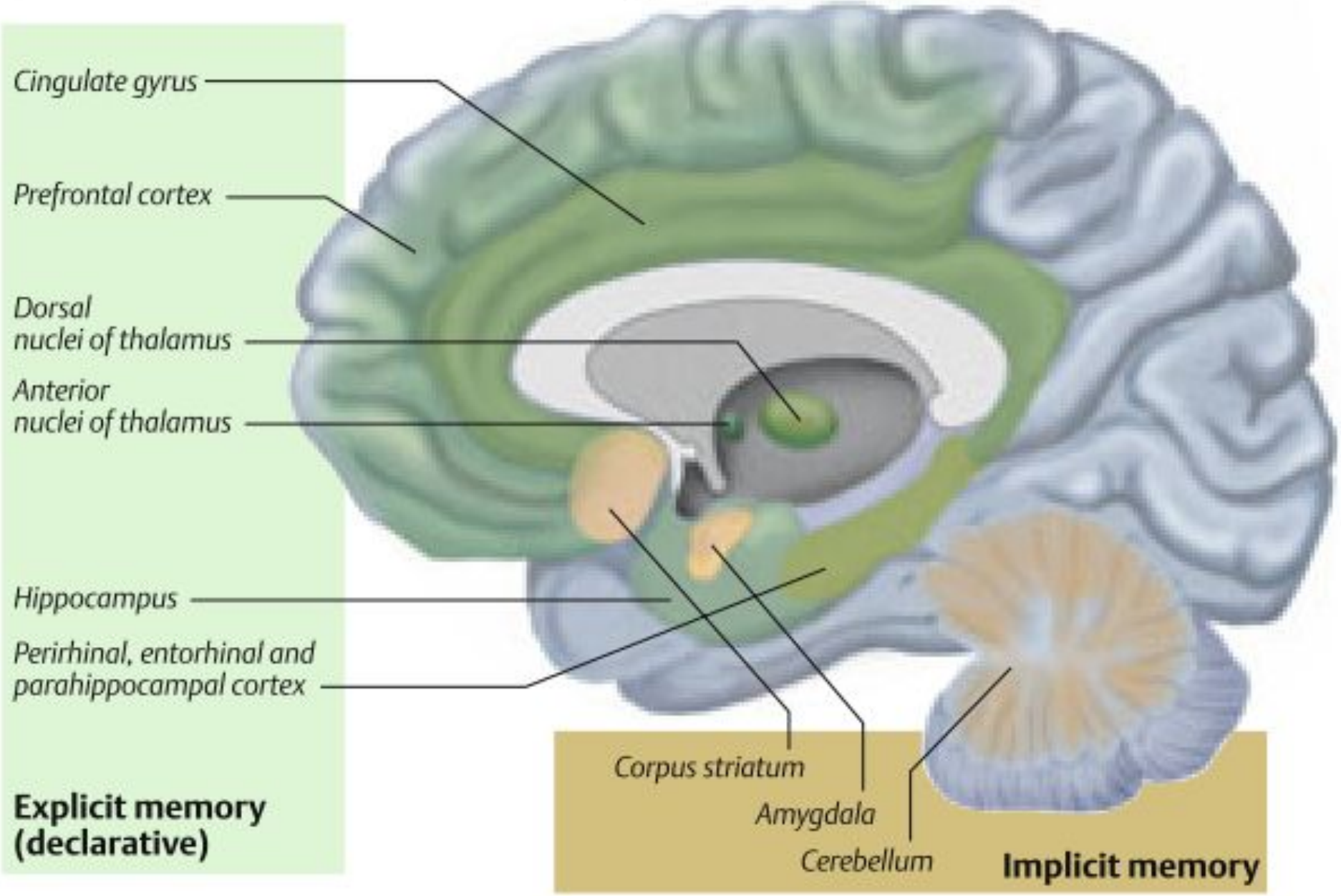
(a) Repeating a Spoken Word

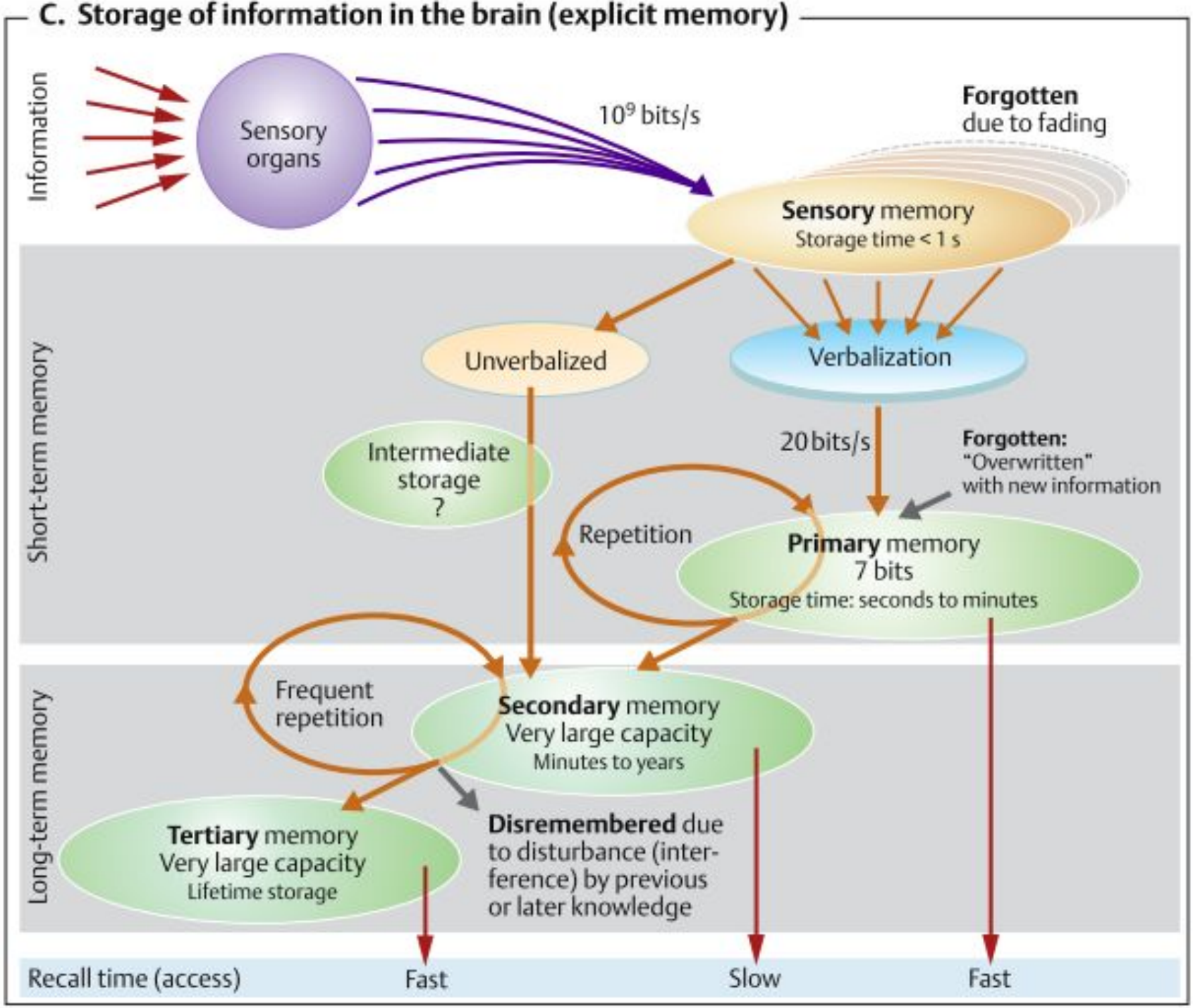


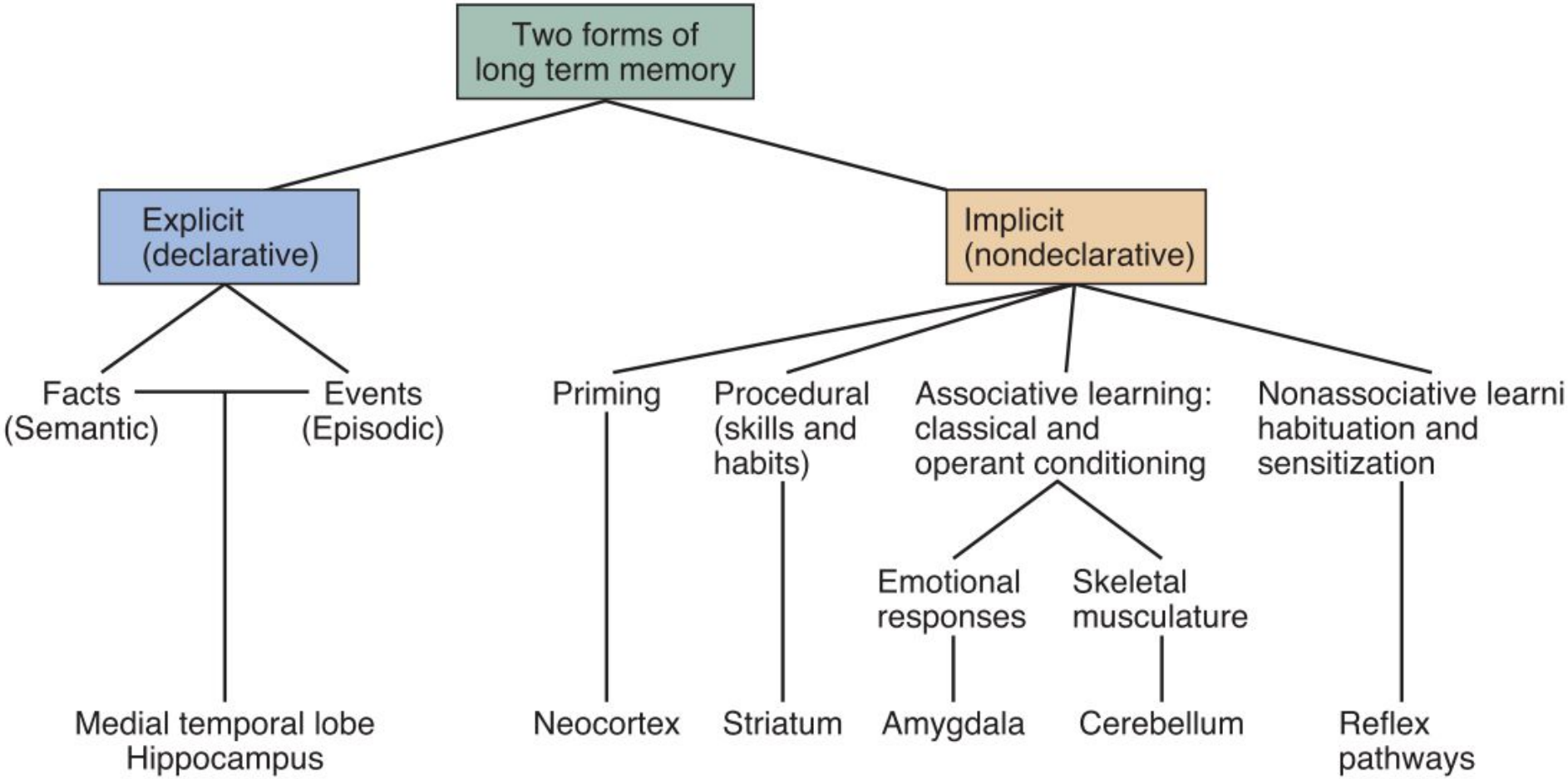
(b) Reading a Word Out Loud

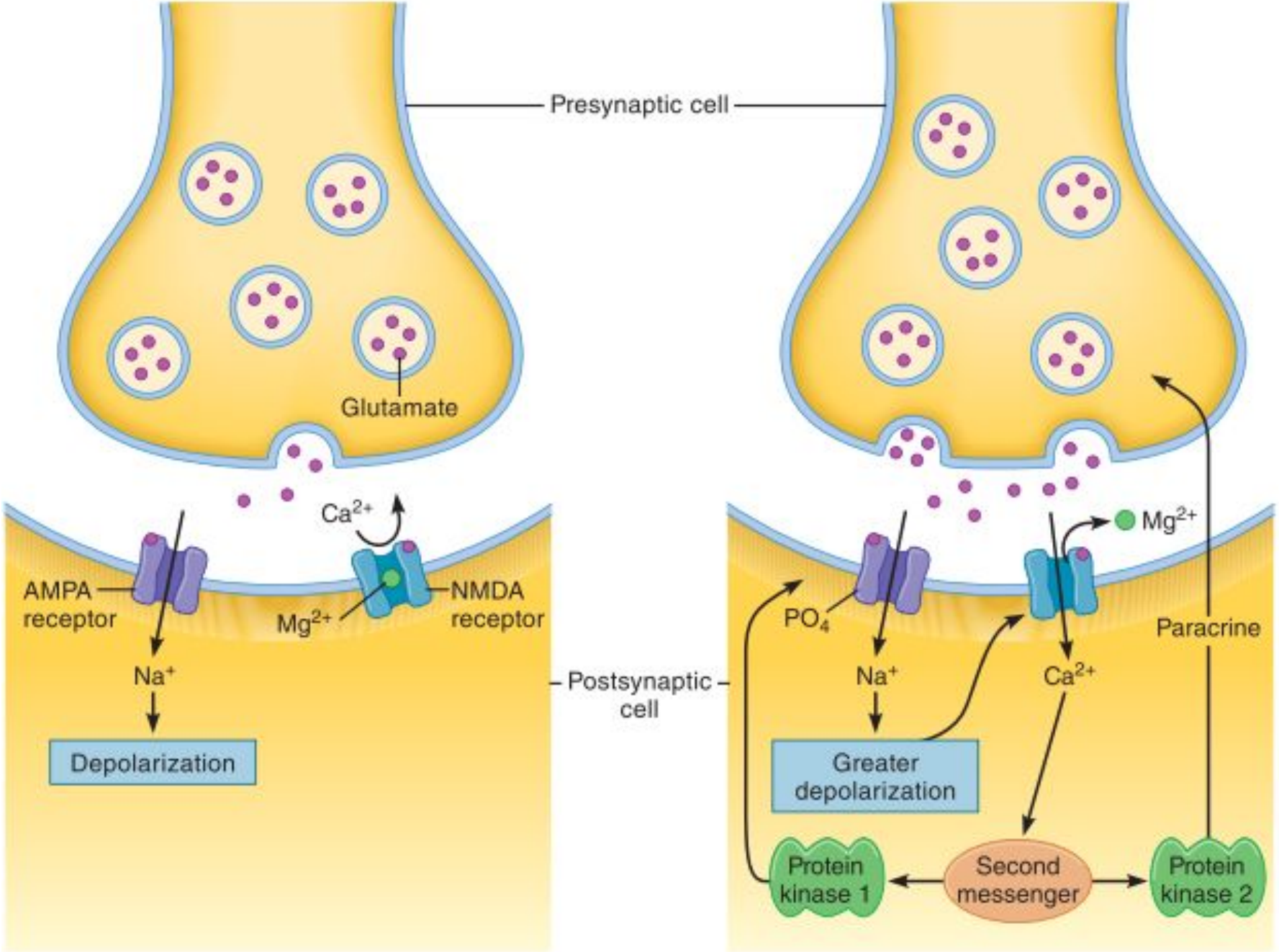

Left
Right
Broca's area
Facial area of motor cortex (area 4)
6
Arcuate fasciculus
5
Wernicke's area (area 22)
From lateral geniculate nucleus
4
1
Angular gyrus (area 39)
3
2
Higher order visual cortical areas (area 18)
Primary visual cortex (area 17)

B. Areas of the brain involved in memory



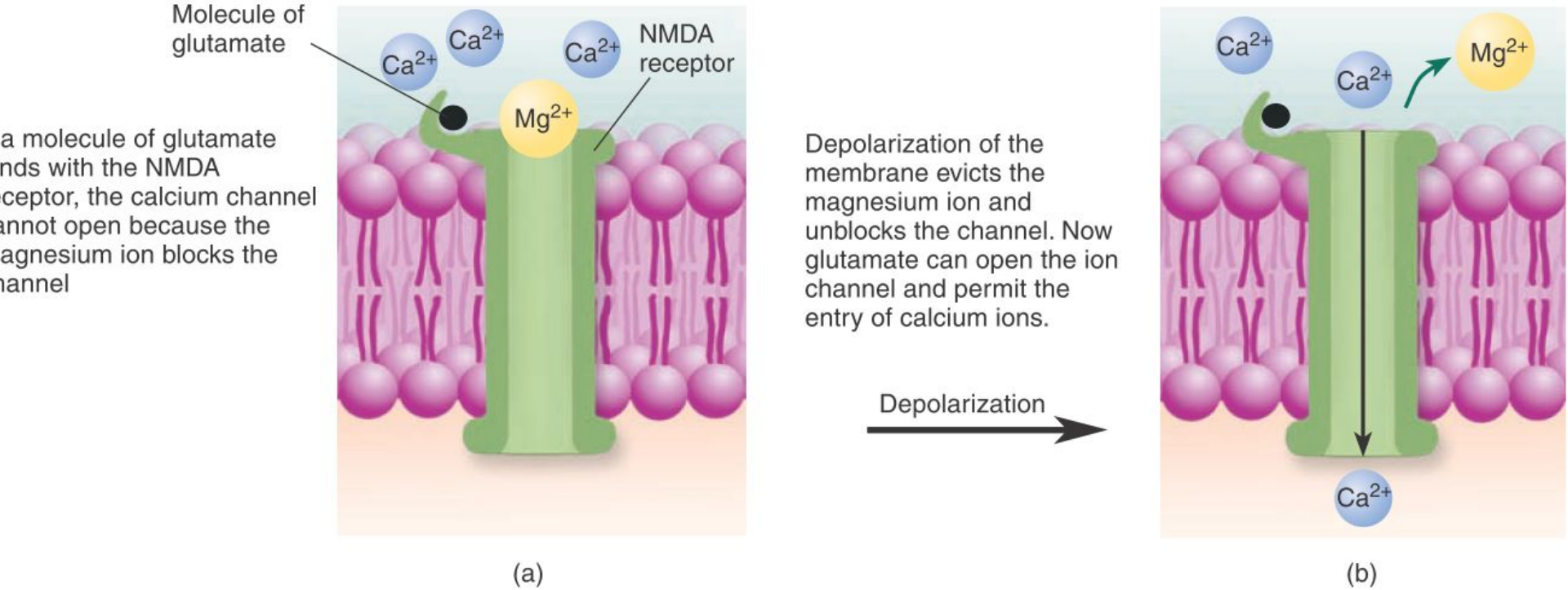

C. Storage of information in the brain (explicit memory)
Information
Sensory organs
10^9 bits/s
Forgotten due to fading
Sensory memory
Storage time < 1 s
Short-term memory
Unverbalized
Verbalization
20 bits/s
Forgotten: "Overwritten" with new information
Intermediate storage ?
Repetition
Primary memory
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

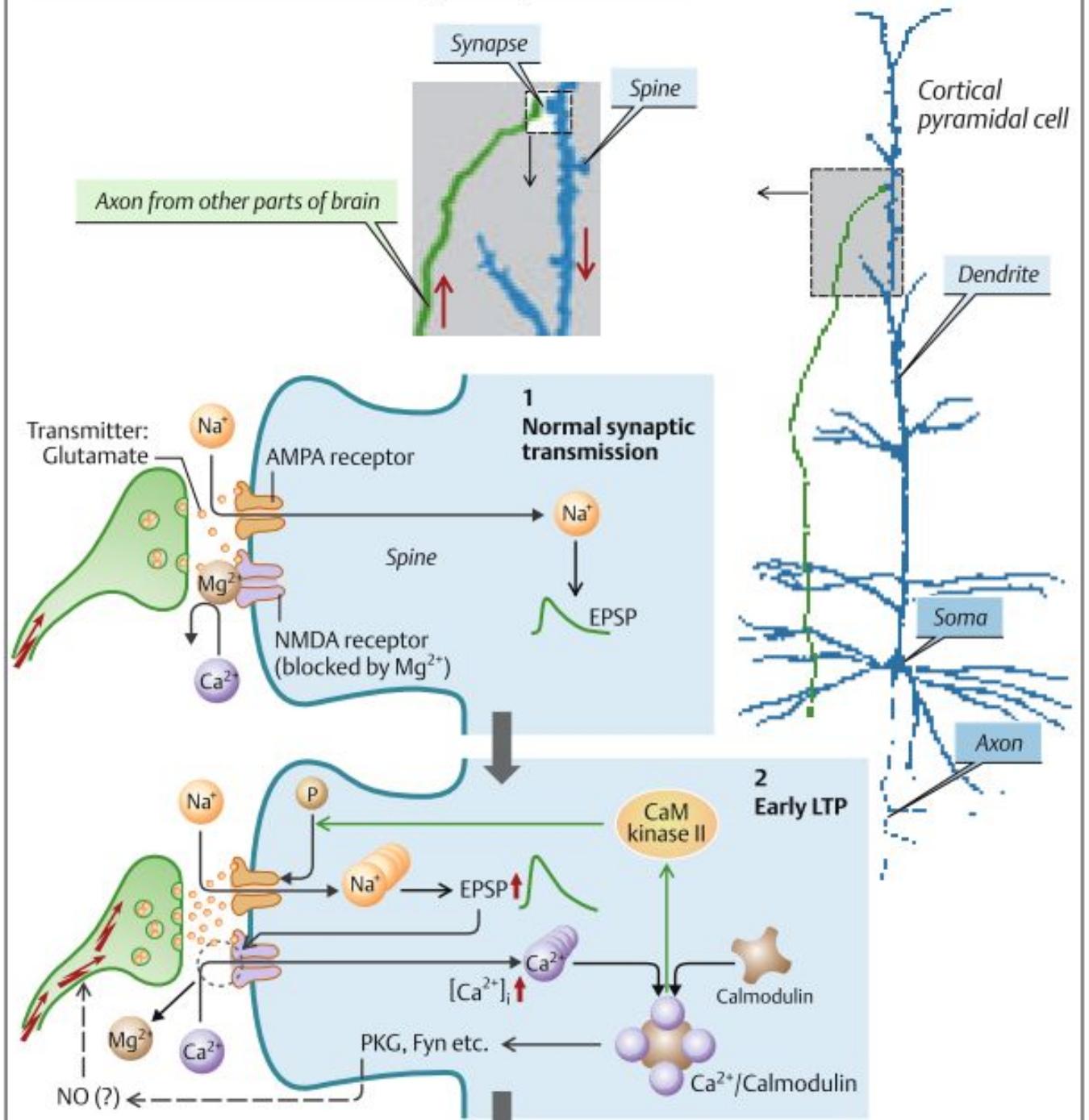


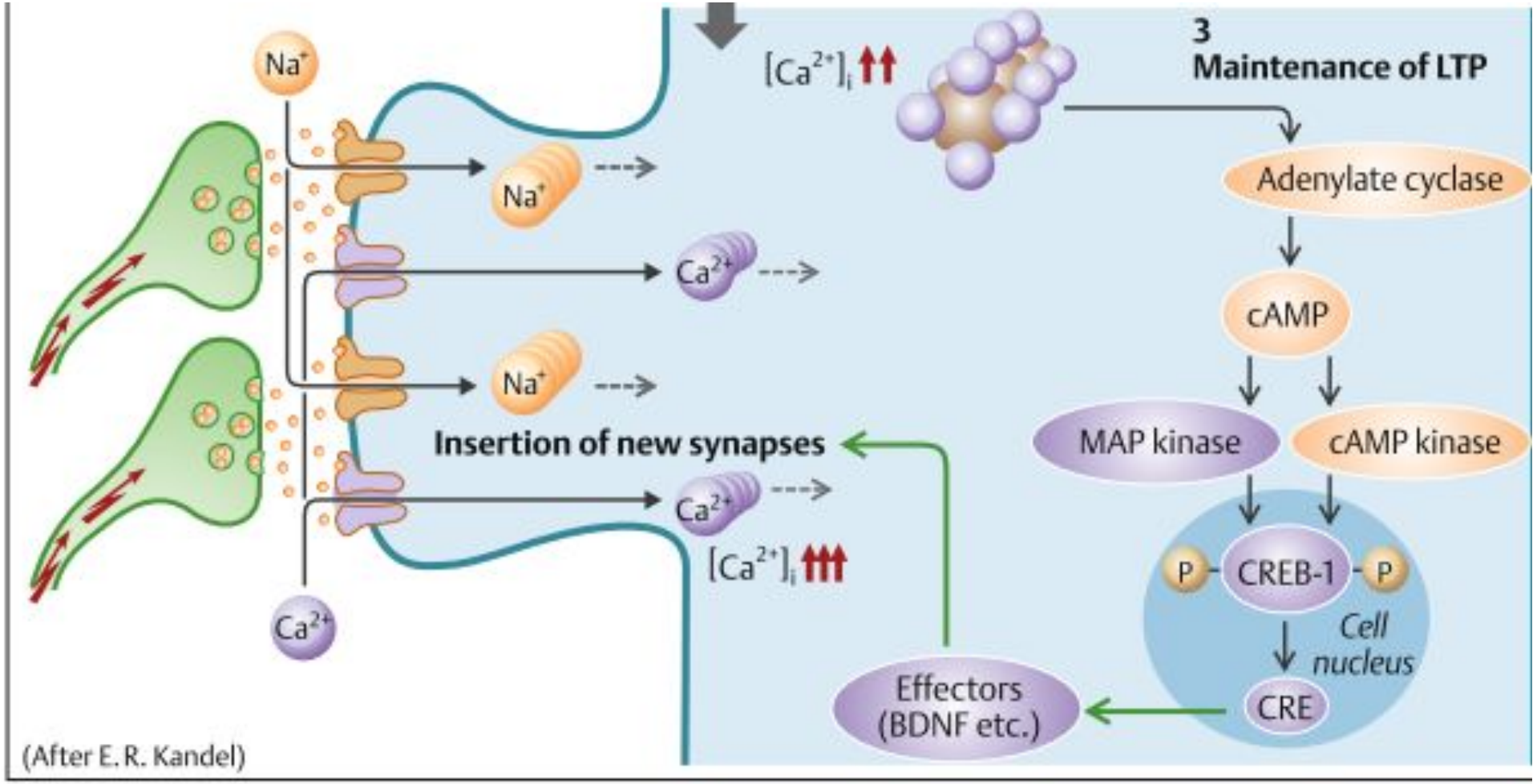
(a) Low levels of activity in presynaptic cell

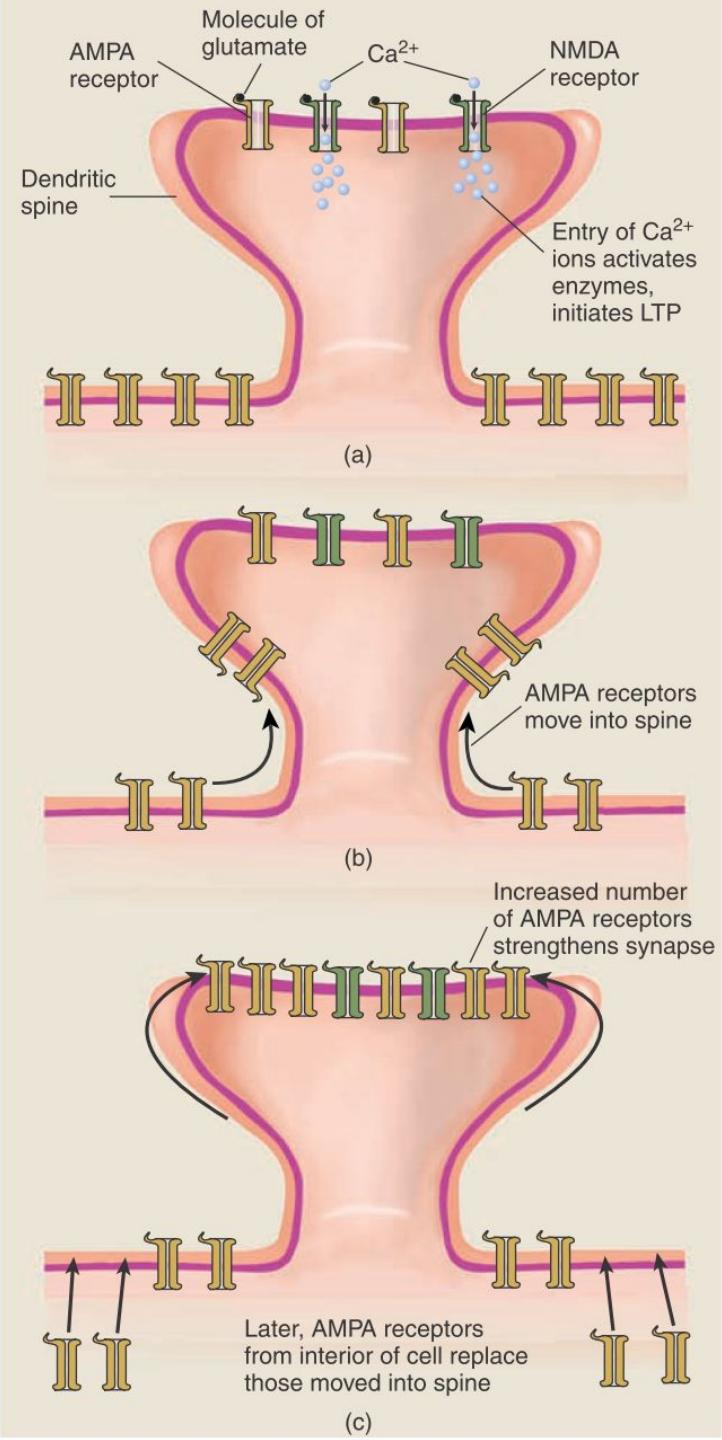
(b) High levels of activity in presynaptic cell

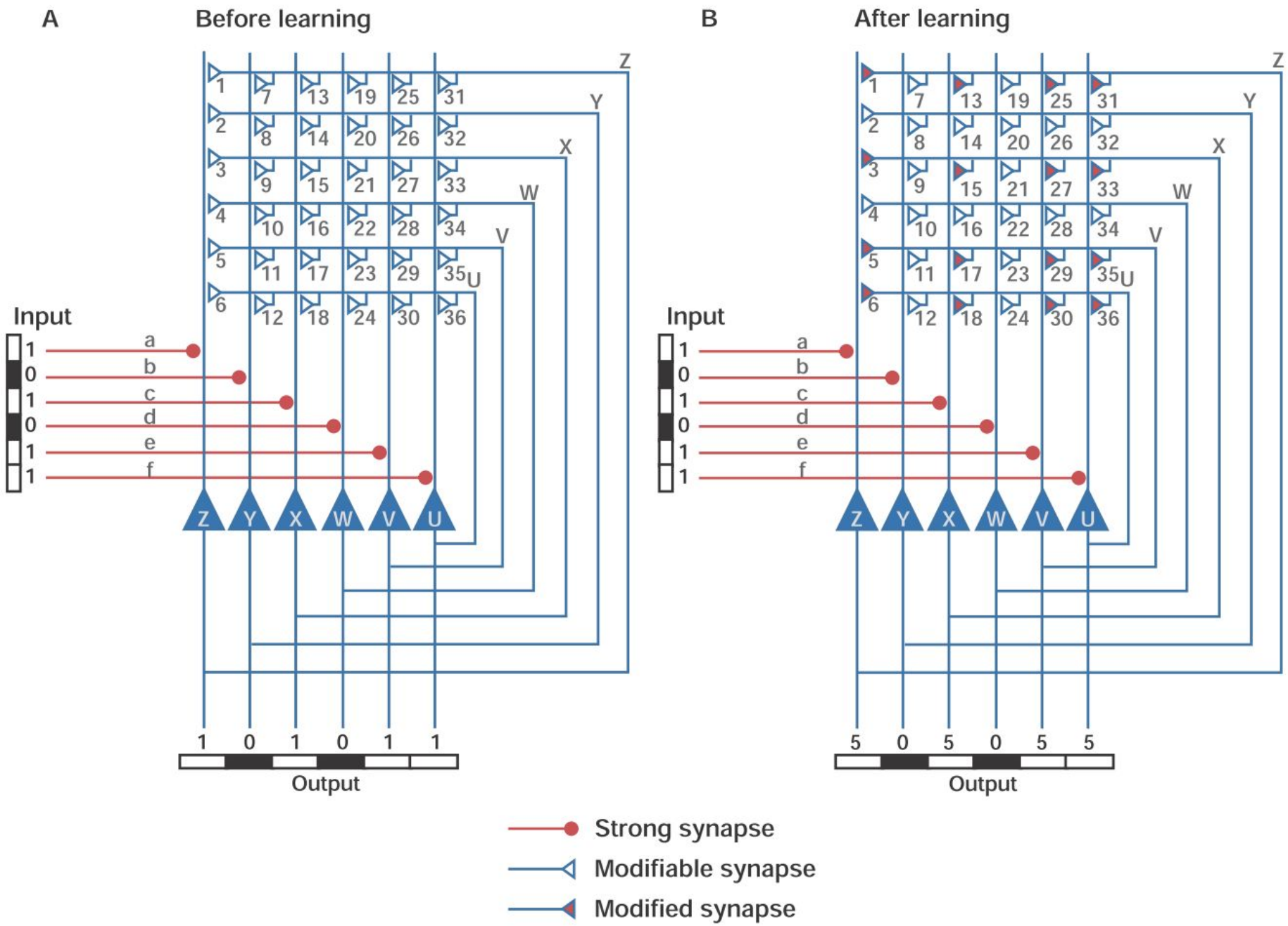

Molecule of glutamate
Ca^{2+}
Ca^{2+}
Ca^{2+}
NMDA receptor
Mg^{2+}
a molecule of glutamate nds with the NMDA ceptor, the calcium channel annot open because the agnesium ion blocks the hannel
(a)
Depolarization of the membrane evicts the magnesium ion and unblocks the channel. Now glutamate can open the ion channel and permit the entry of calcium ions.
Depolarization
Ca^{2+}
Ca^{2+}
Mg^{2+}
Ca^{2+}
(b)

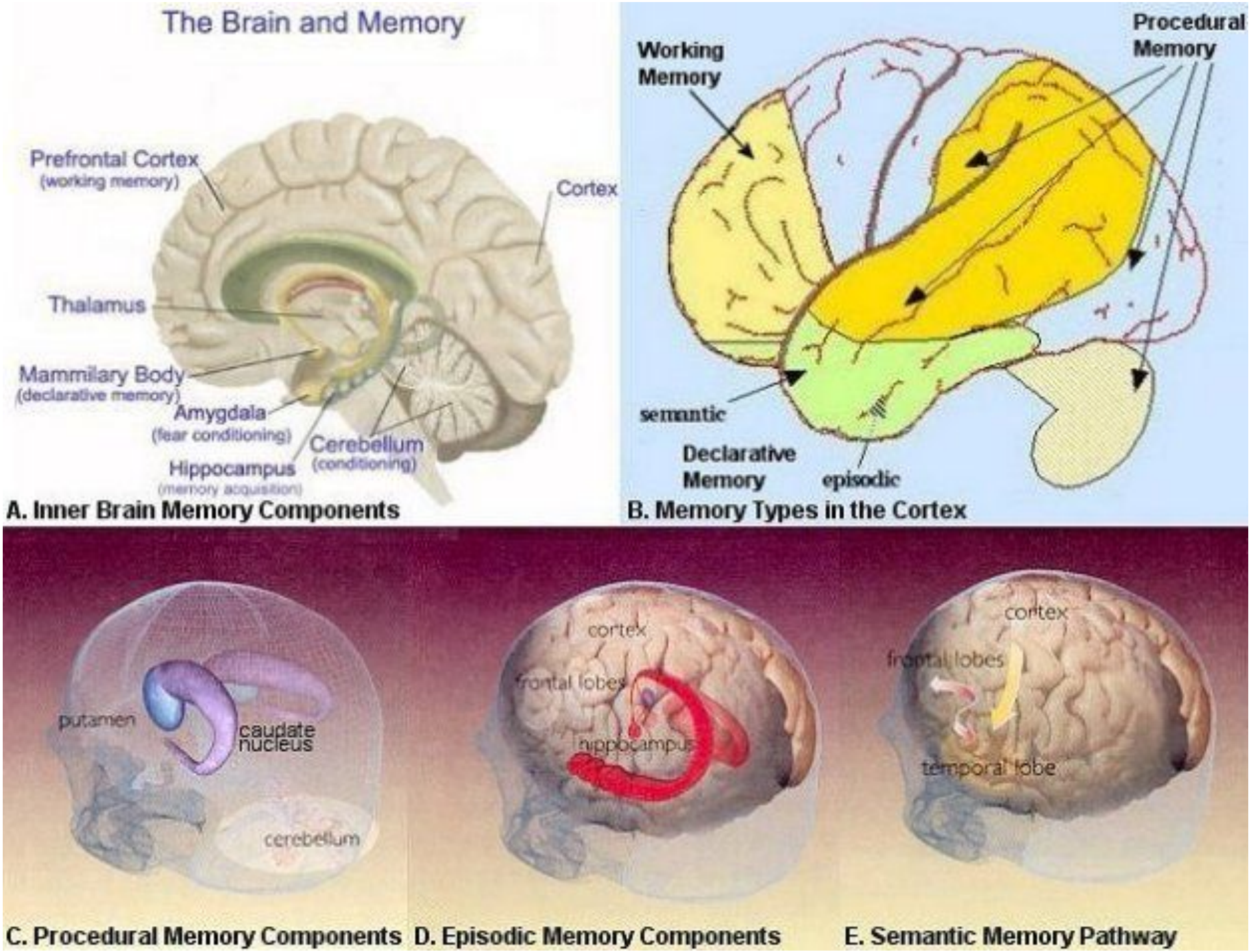
D. Molecular mechanisms of long-term potentiation



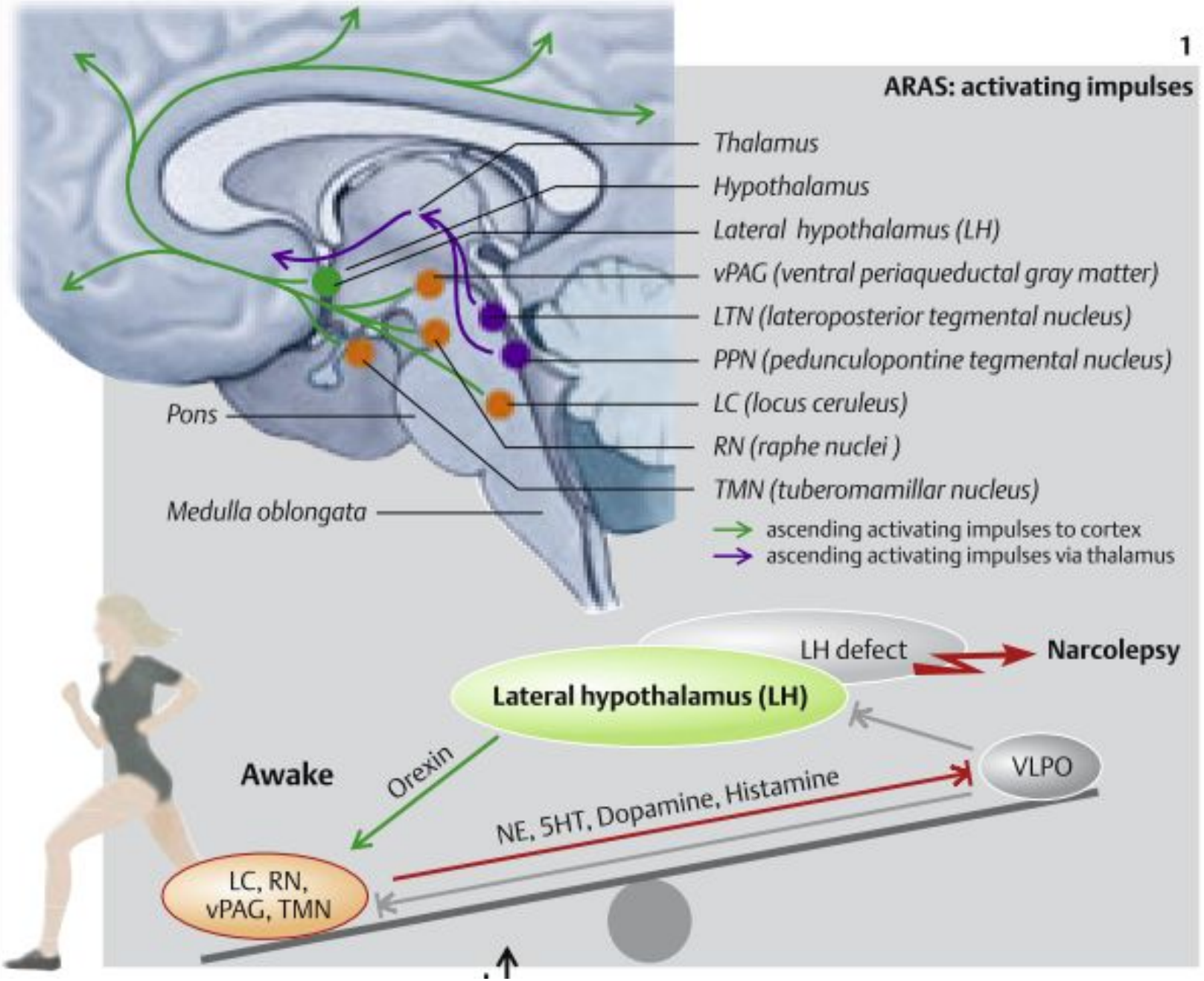

Na+
Na+
Ca2+
Na+
Insertion of new synapses
Ca2+
[Ca2+]i
Ca2+
[Ca2+]i
3
Maintenance of LTP
Adenylate cyclase
cAMP
MAP kinase
cAMP kinase
P
CREB-1
P
Cell nucleus
CRE
Effectors (BDNF etc.)
(After E. R. Kandel)

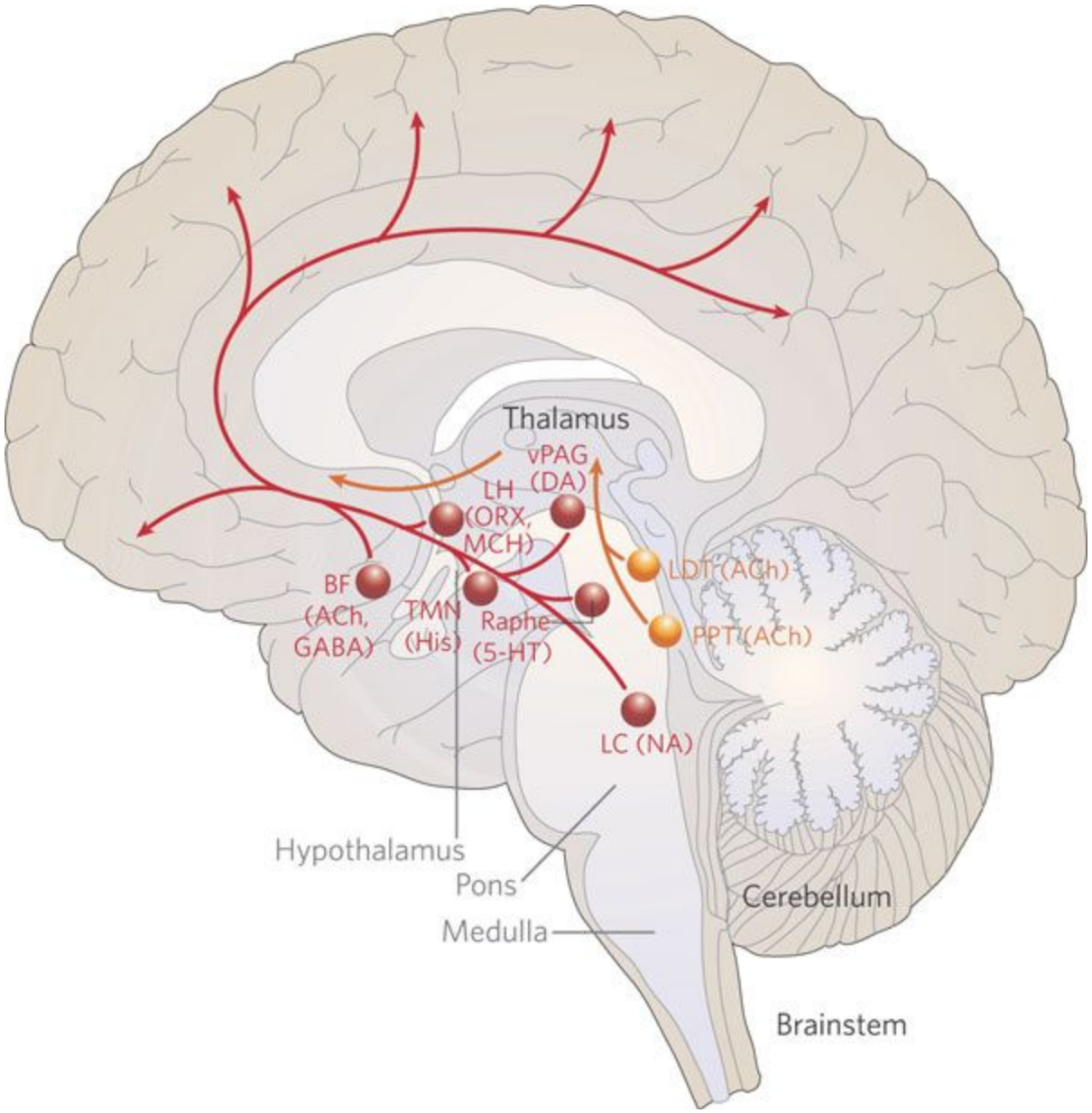

Molecule of glutamate
AMPA receptor
Ca^{2+}
NMDA receptor
Dendritic spine
Entry of Ca^{2+} ions activates enzymes, initiates LTP
(a)
AMPA receptors move into spine
(b)
Increased number of AMPA receptors strengthens synapse
Later, AMPA receptors from interior of cell replace those moved into spine
(c)

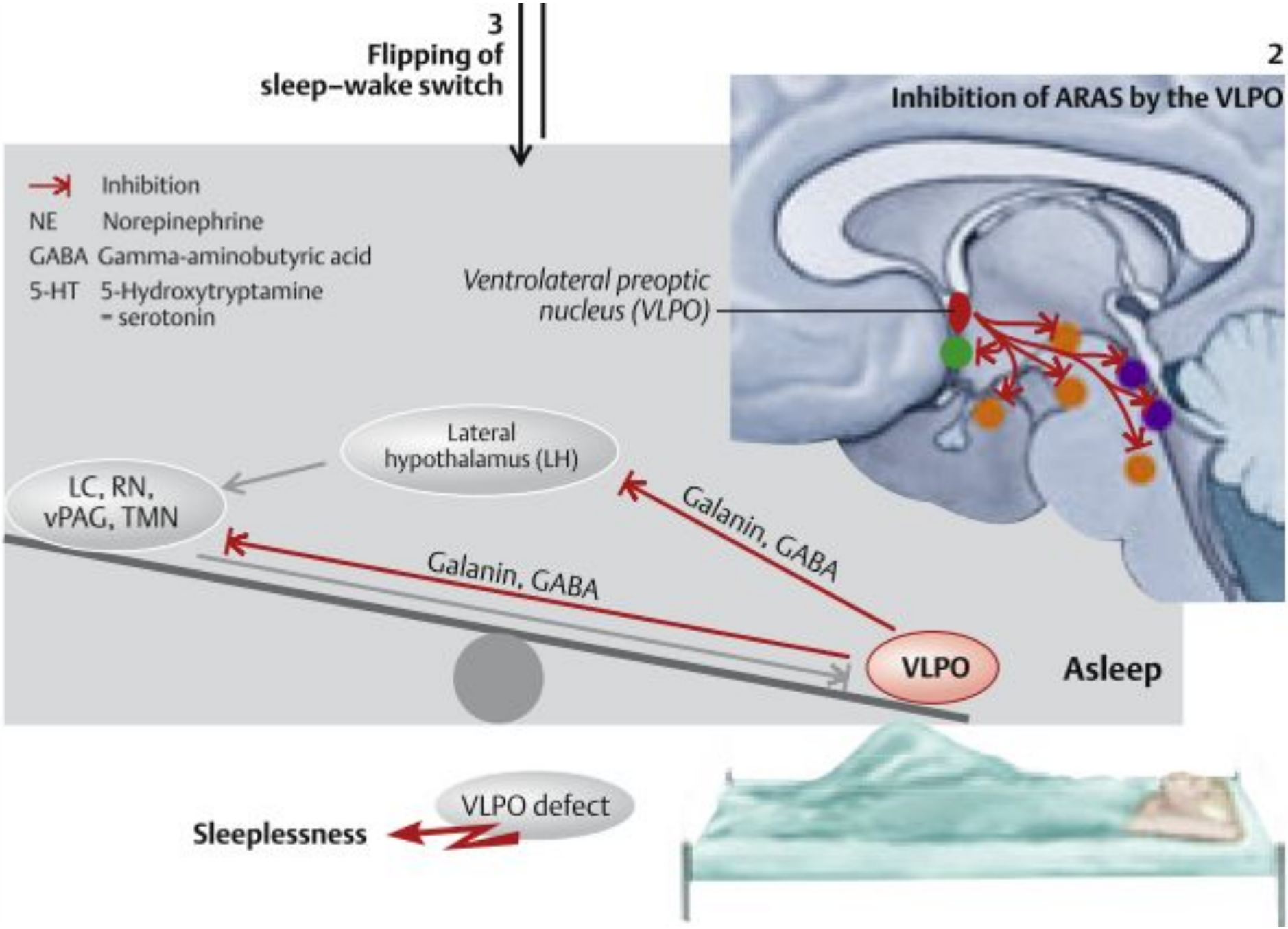

A
Before learning
B
After learning
Input
1
0
1
0
1
1
a
b
c
d
e
f
Z
Y
X
W
V
U
1 0 1 0 1 1
5 0 5 0 5 5
Output
Strong synapse
Modifiable synapse
Modified synapse

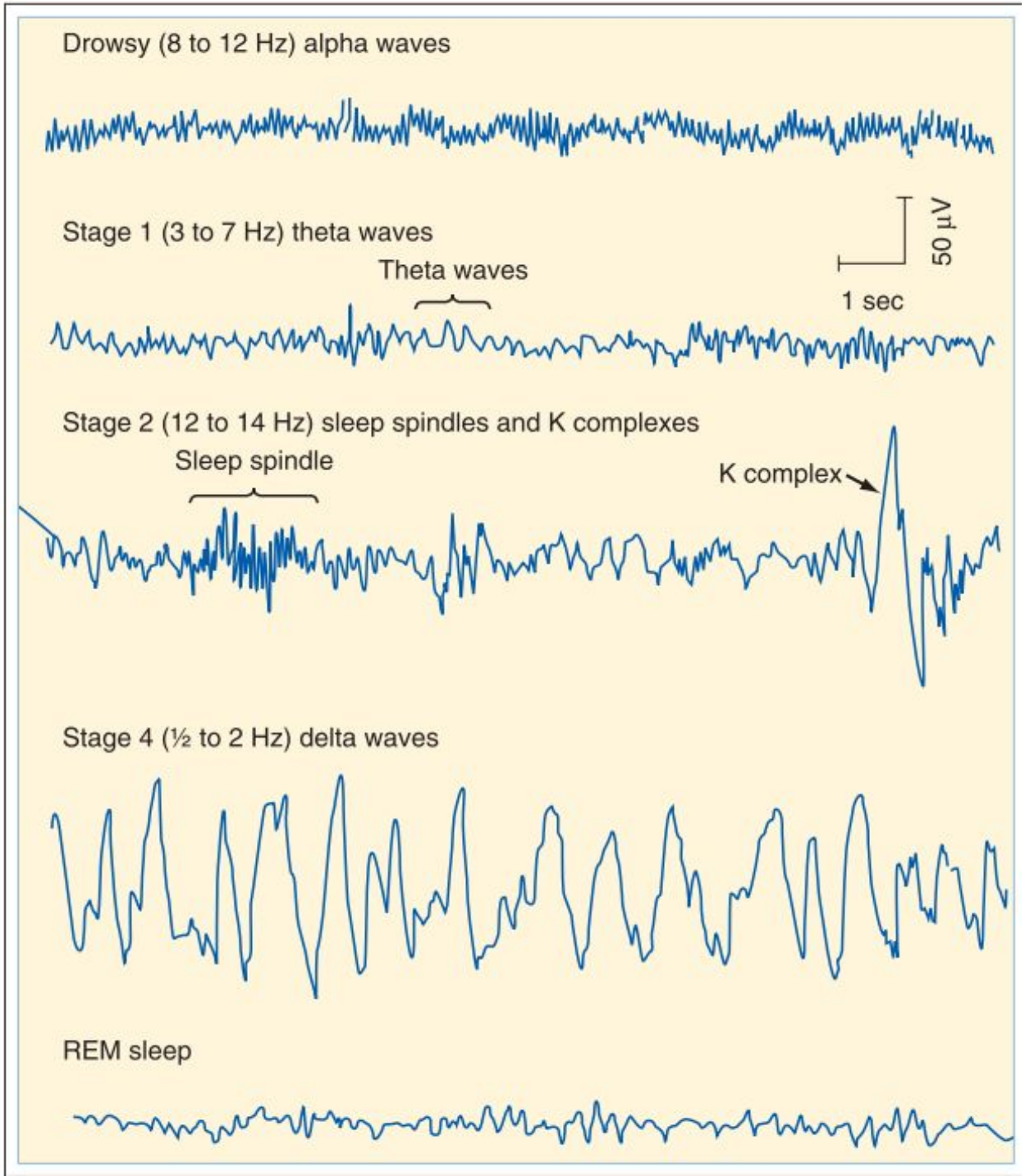

The Brain and Memory
Prefrontal Cortex
(working memory)
Cortex
Thalamus
Mammilary Body
(declarative memory)
Amygdala
(fear conditioning)
Cerebellum
(conditioning)
Hippocampus
(memory acquisition)
A. Inner Brain Memory Components
Working Memory
Procedural Memory
semantic
Declarative Memory
episodic
B. Memory Types in the Cortex
putamen
caudate nucleus
cerebellum
C. Procedural Memory Components
cortex
frontal lobes
hippocampus
D. Episodic Memory Components
cortex
frontal lobes
temporal lobe
E. Semantic Memory Pathway

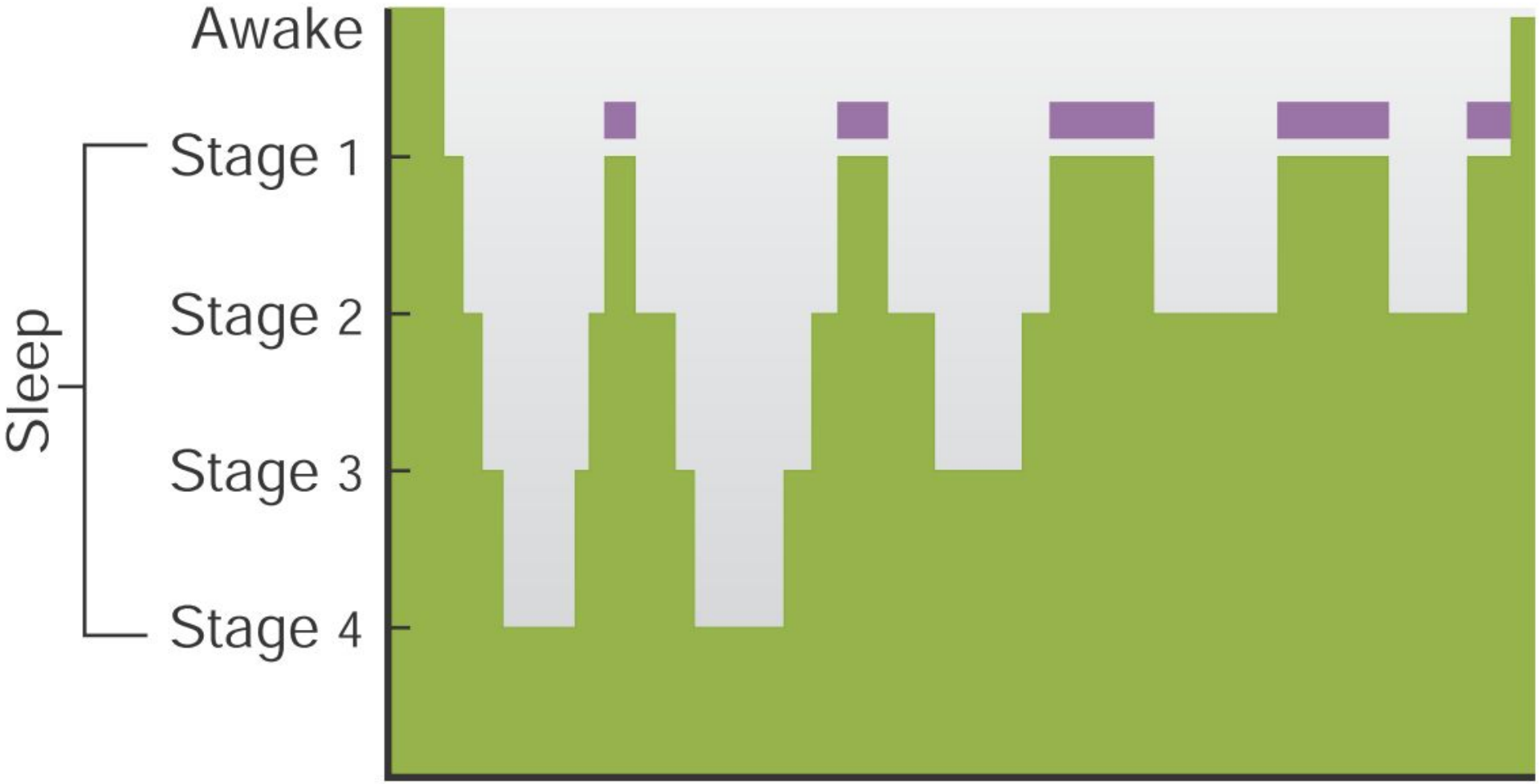
A. Control of sleep–wake cycle

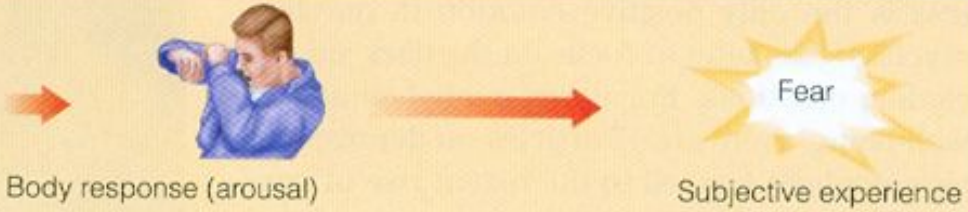
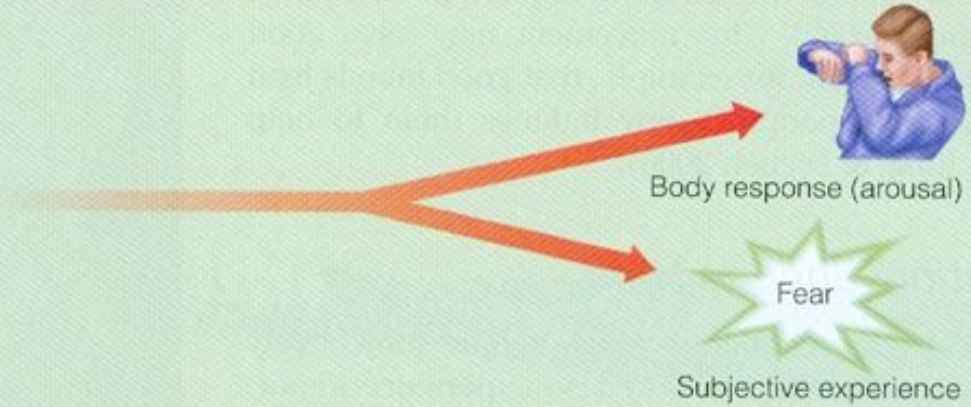
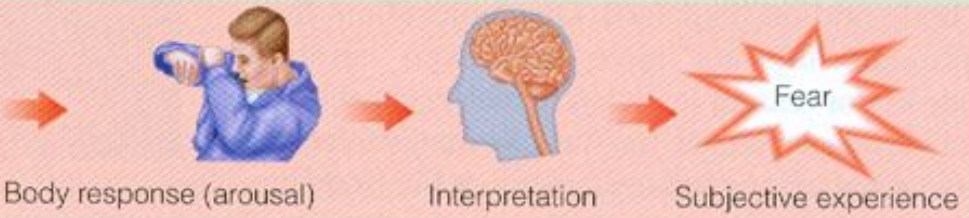


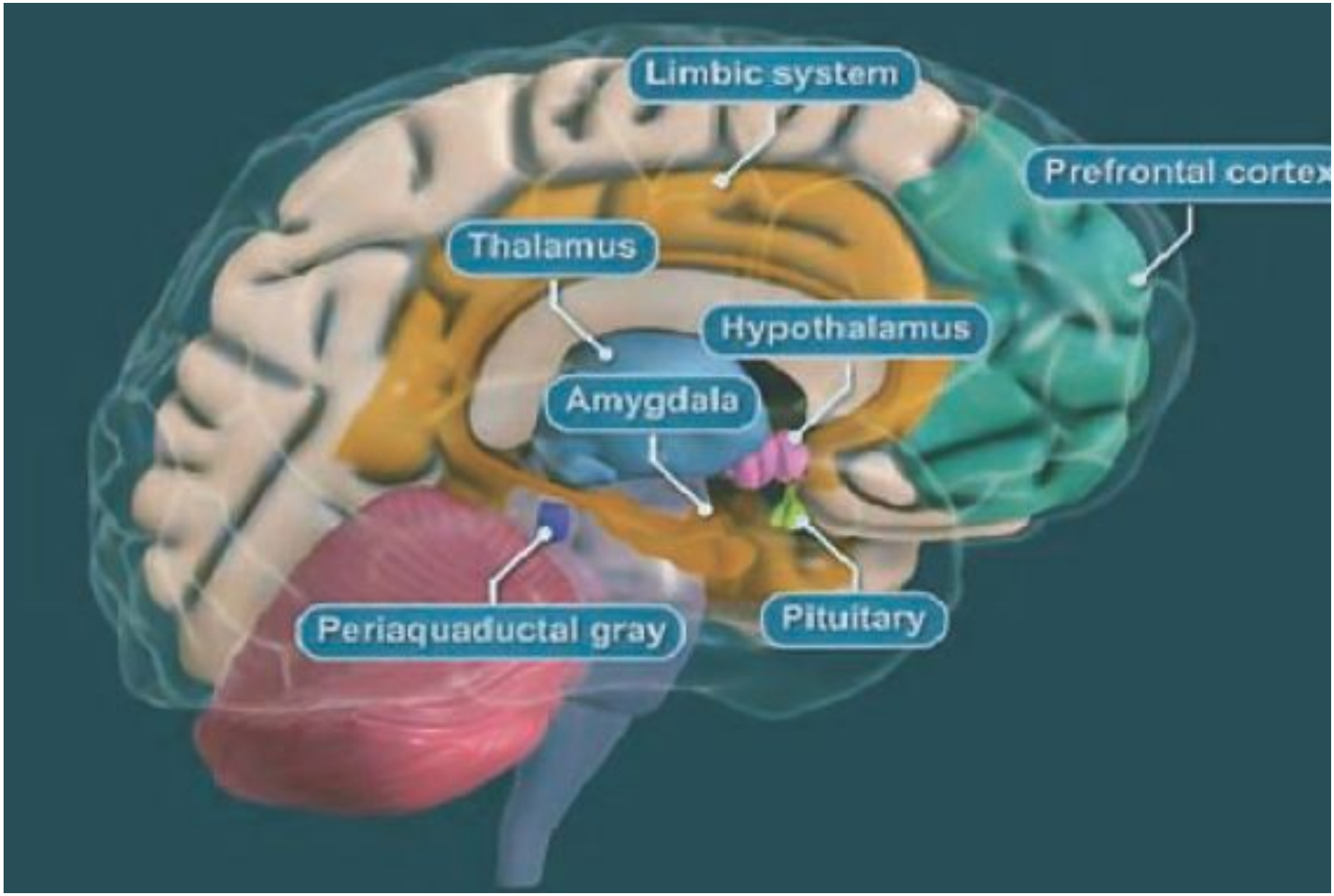

Thalamus
vPAG
(DA)
LH
(ORX,
MCH)
BF
(ACh,
GABA)
TMN
(His)
Raphe
(5-HT)
LDT (ACh)
PPT (ACh)
LC (NA)
Hypothalamus
Pons
Medulla
Cerebellum
Brainstem

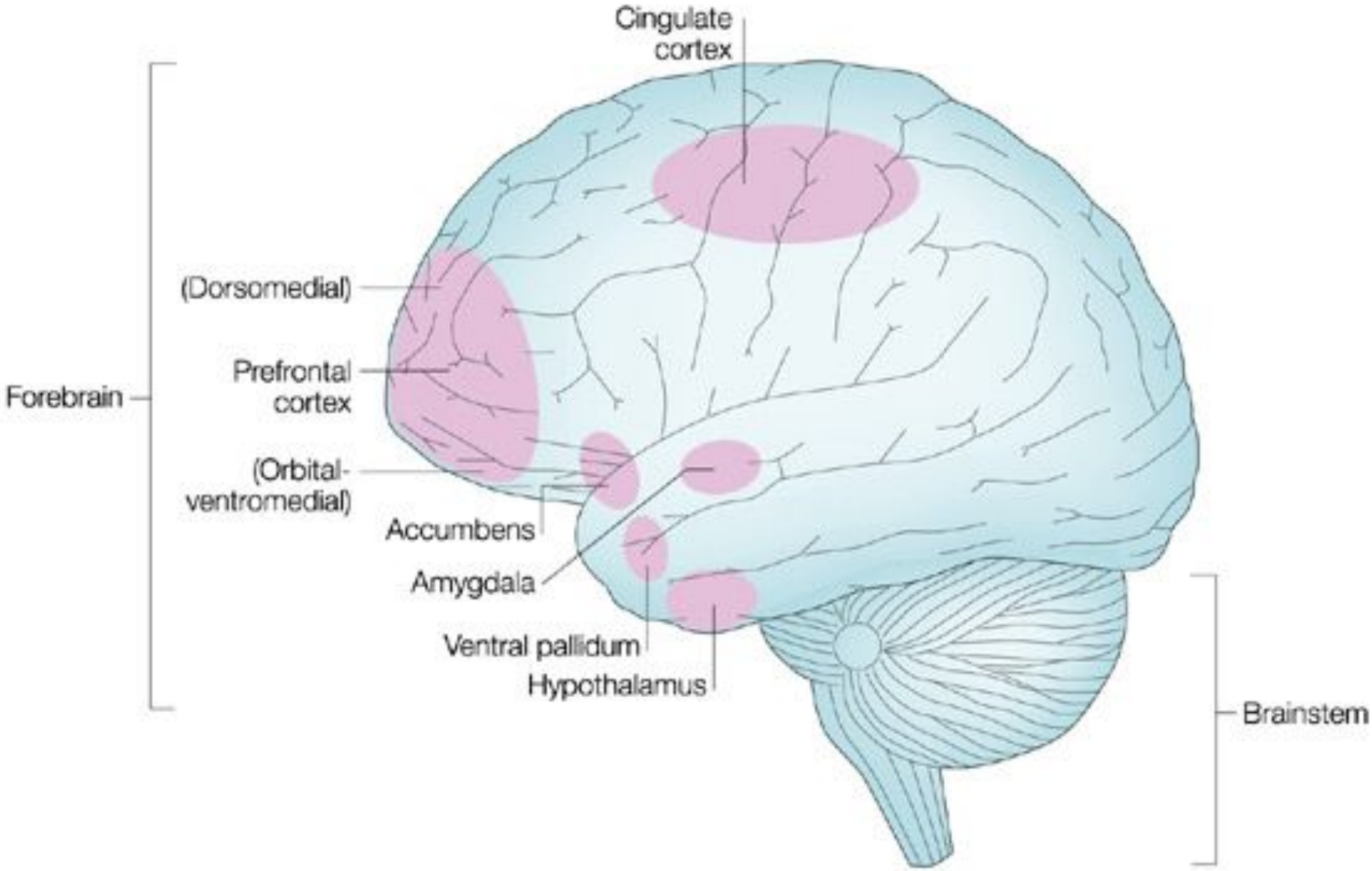

3
Flipping of
sleep–wake switch
2
Inhibition of ARAS by the VLPO
Inhibition
NE Norepinephrine
GABA Gamma-aminobutyric acid
5-HT 5-Hydroxytryptamine
= serotonin
Ventrolateral preoptic
nucleus (VLPO)
Lateral
hypothalamus (LH)
LC, RN,
vPAG, TMN
Galanin, GABA
Galanin, GABA
VLPO
Asleep
VLPO defect
Sleeplessness


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

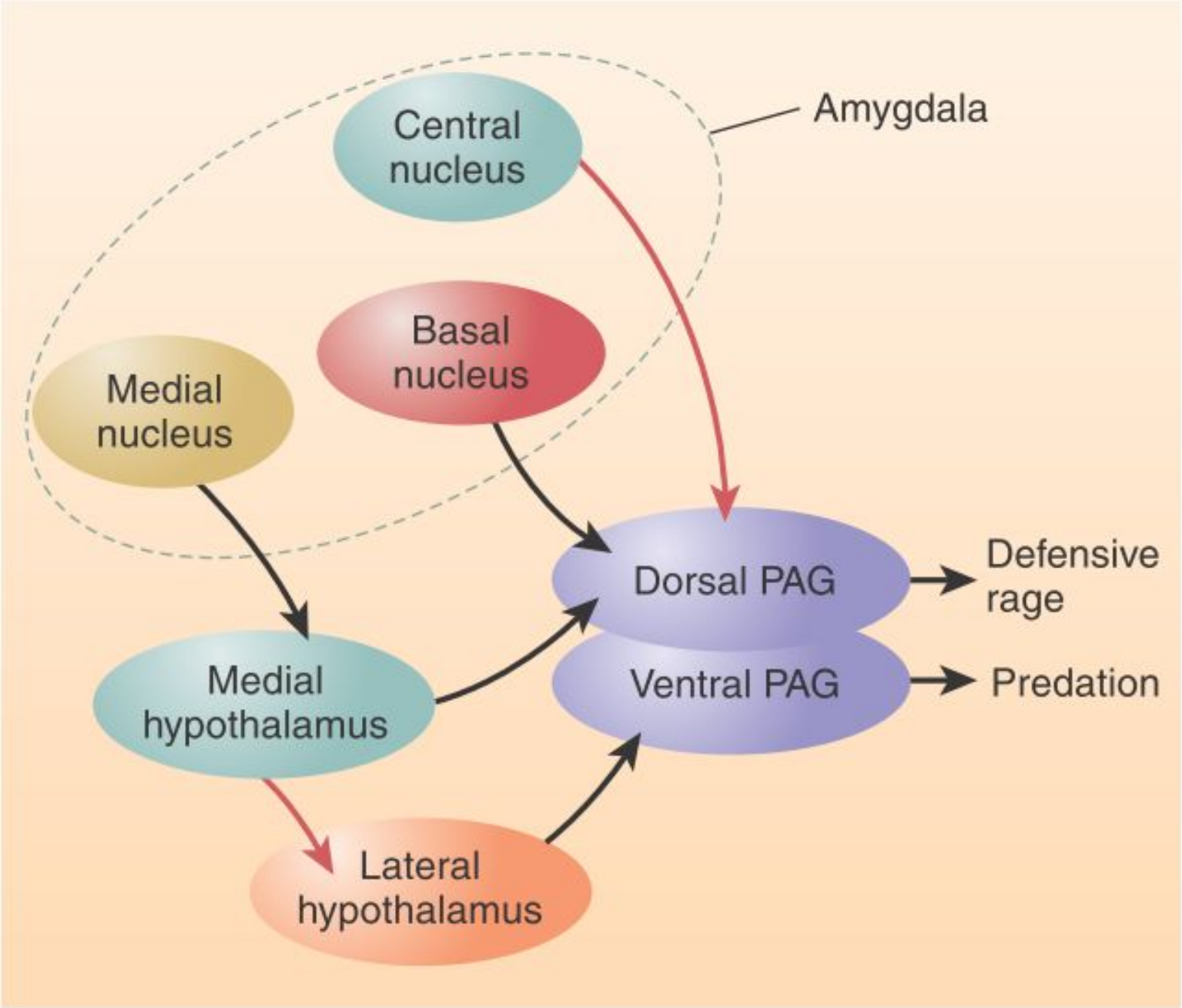

Awake
Stage 1
Stage 2
Stage 3
Stage 4
Sleep

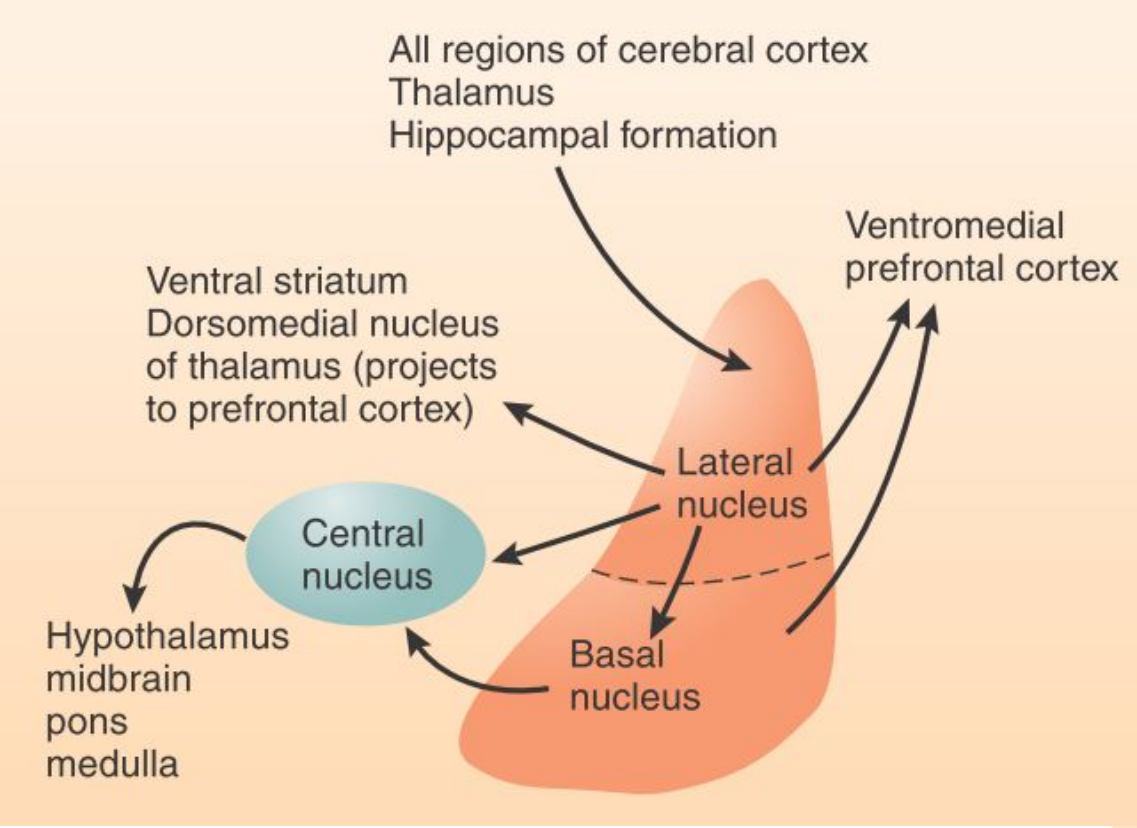
Theory	Stimulus	Response	Report
Common sense			"My heart is pounding because I feel afraid."
James-Lange			"I feel afraid because my heart is pounding."
Cannon-Bard			"The dog makes me feel afraid and my heart pounds."
Schachter			"My pounding heart means I'm afraid because I interpret the situation as dangerous."


Limbic system
Prefrontal cortex
Thalamus
Hypothalamus
Amygdala
Periaquaductal gray
Pituitary



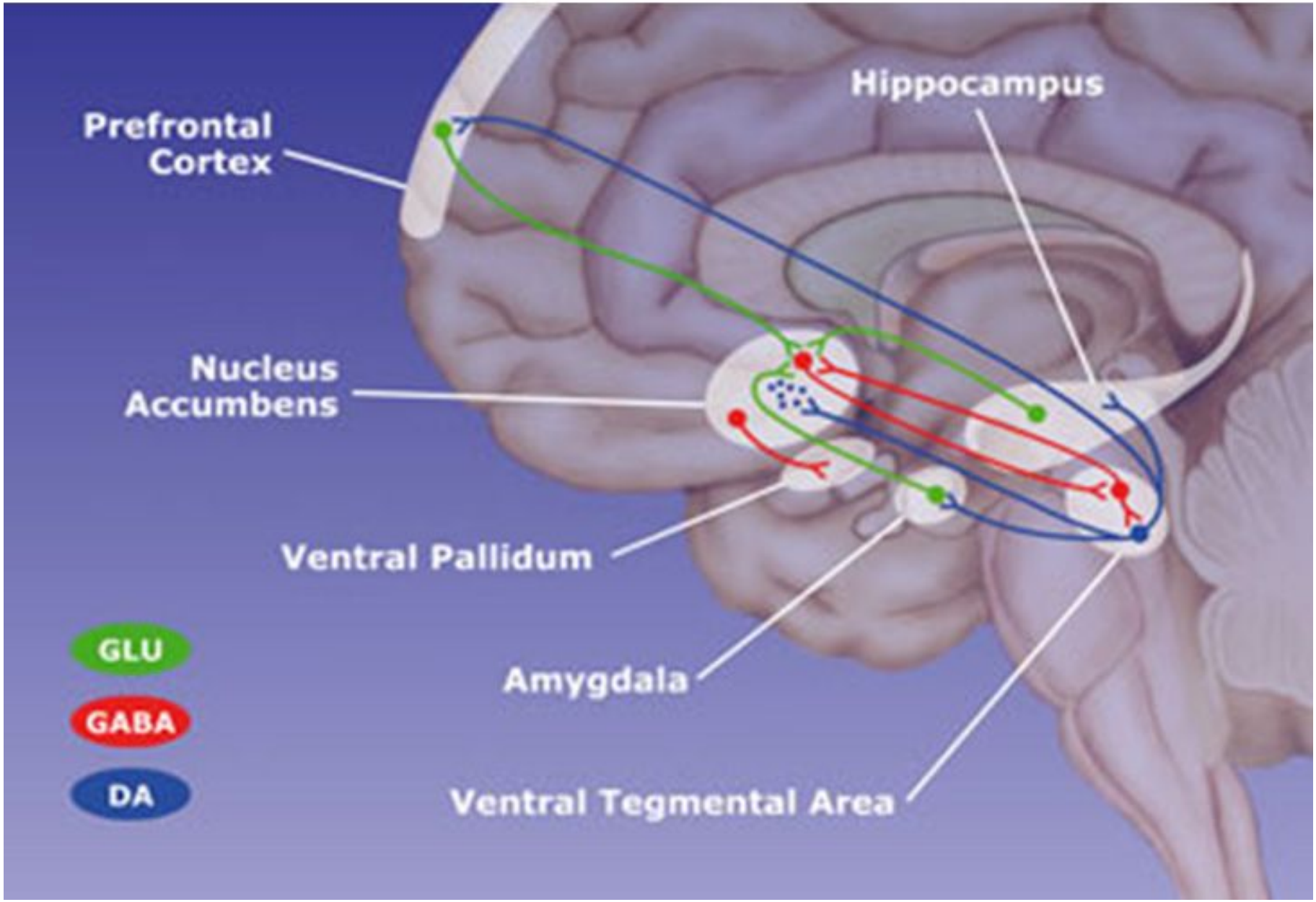
Nature Reviews | Neuroscience

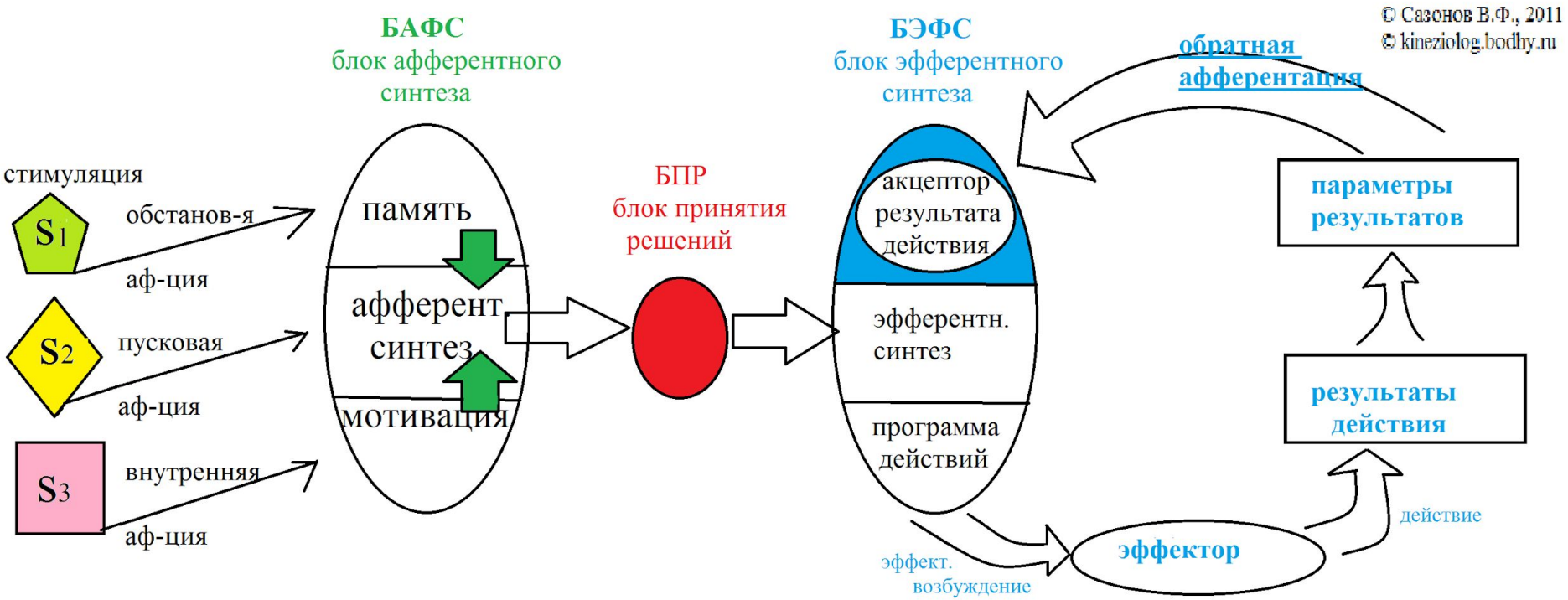

Amygdala
Central nucleus
Basal nucleus
Medial nucleus
Dorsal PAG
Ventral PAG
Defensive rage
Predation
Medial hypothalamus
Lateral hypothalamus



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




© Сазонов В.Ф., 2011
© kineziolog.bodhy.ru
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
действие
эффектор
эффект. возбуждение