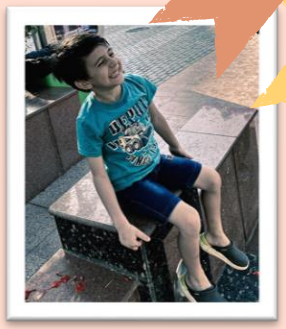


Hello Everyone

Hope You Are Having
A Wonderful Physiological Day
☺☺☺


ARE YOU
READY ?
LET'S GET STARTED!

Sleep & Memory

Sem 4

Mahmoud El Tohamy

M.D, Ph.D.

Lecturer of Medical Physiology

Faculty of Medicine, MNU

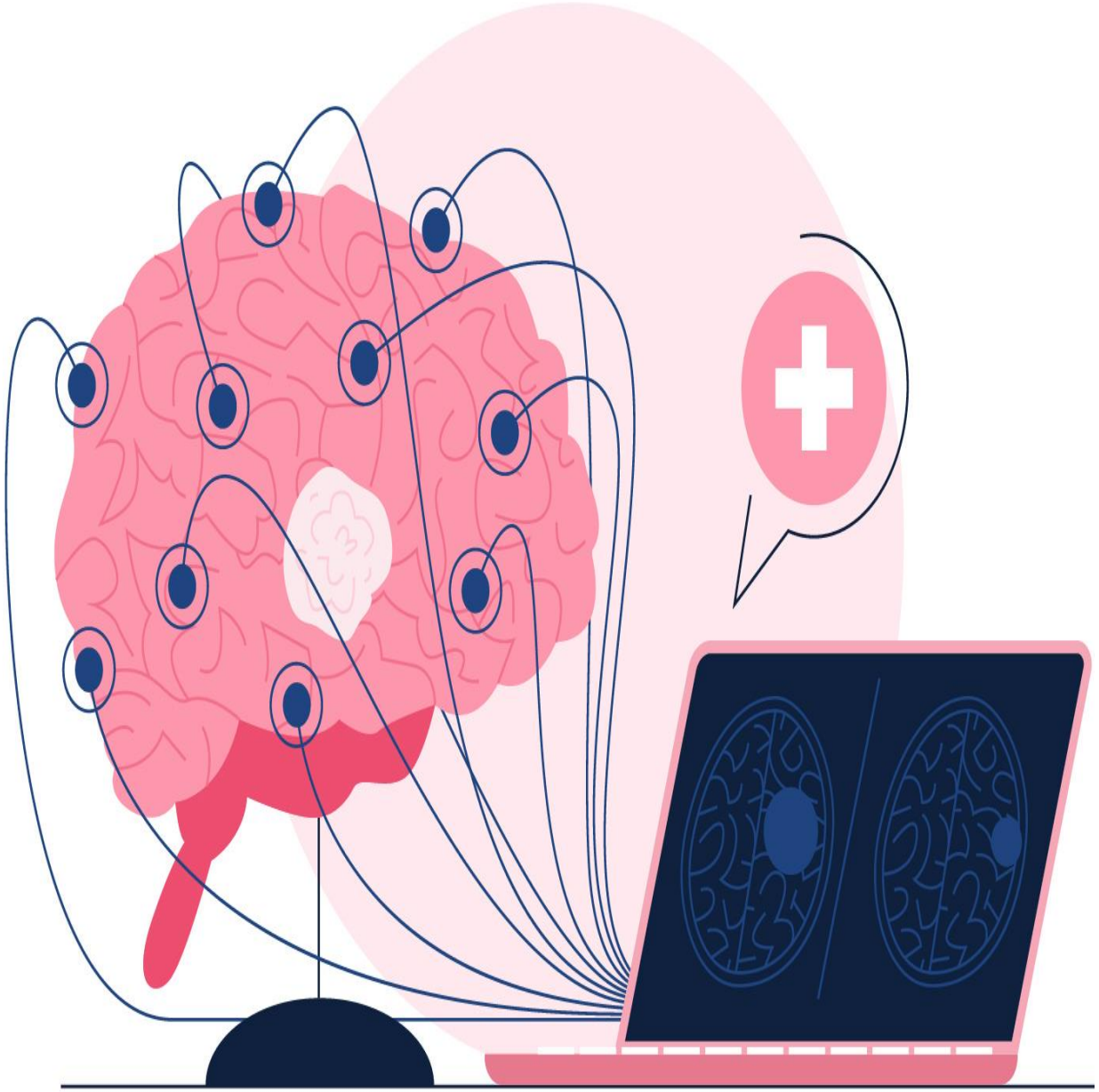
Dr.m.eltohamy@mans.edu.eg

Electrical Activity of the Brain

Brain contains 10-20 billions of neurons, and their summated activity generates electric potential that can be recorded by placing suitable electrodes on the outer surface of the head.

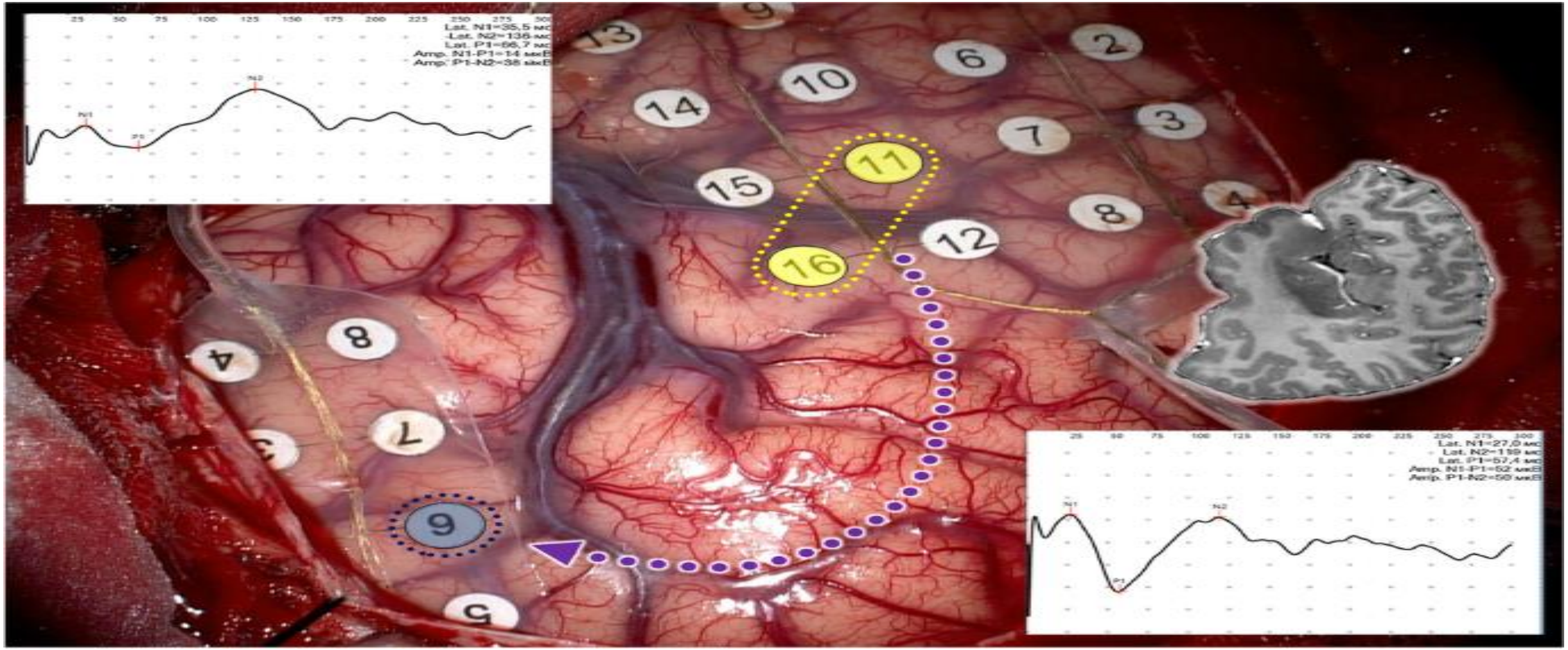
The recorded electric activity shows two types of responses:

1. **Evoked potential:** is generated following stimulation o f sensory receptor
2. **Spontaneous rhythm** (**Electroencephalogram EEG**): It is a record of the spontaneous electrical activity of the brain

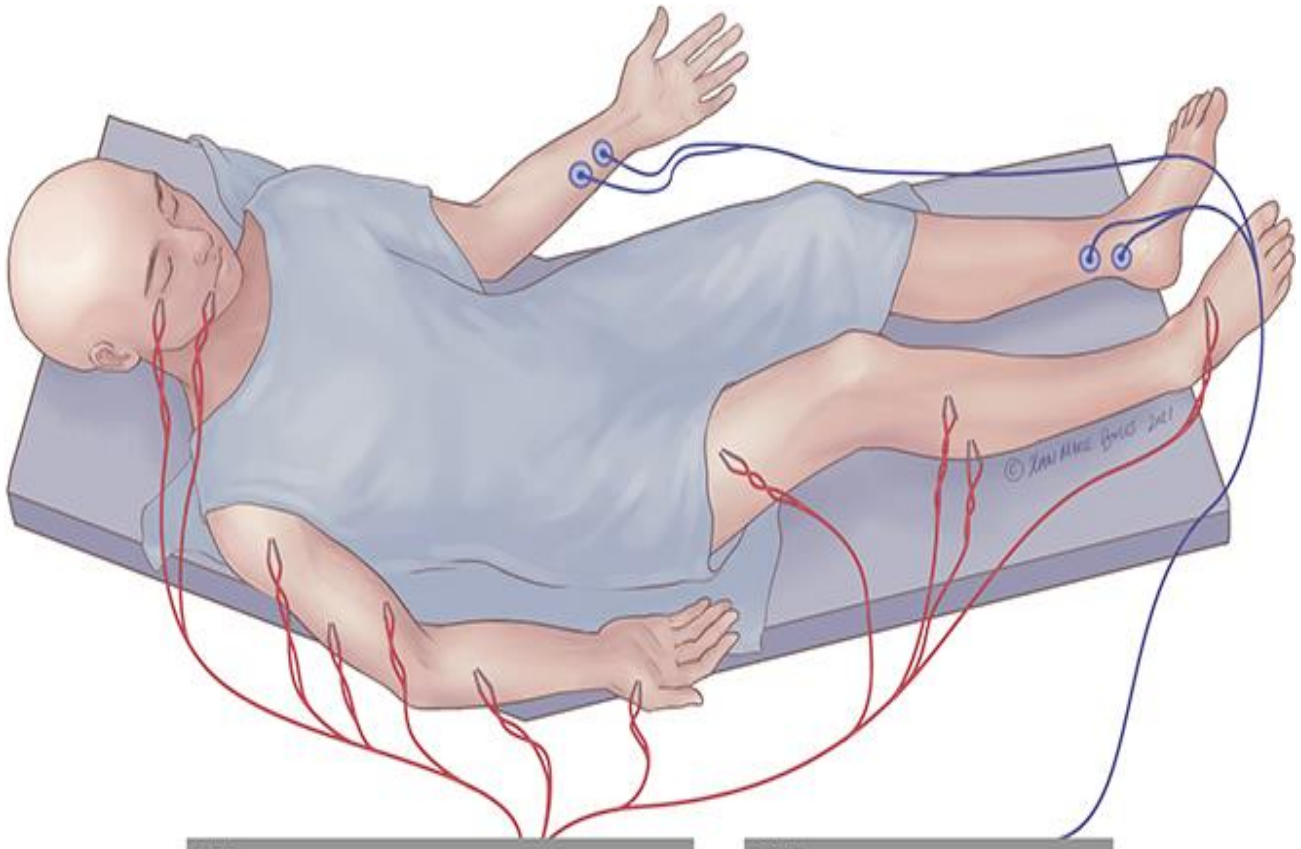


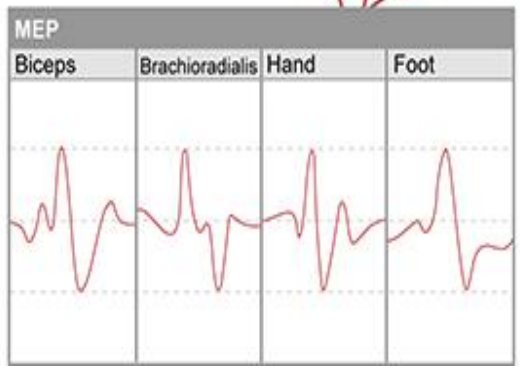
Evoked Cortical potential

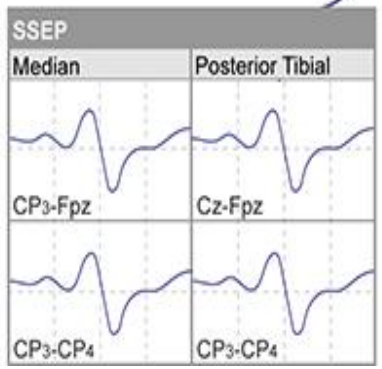
They are cortical potential changes that are produced in the cortex after stimulation of a receptor (sensory stimulation).

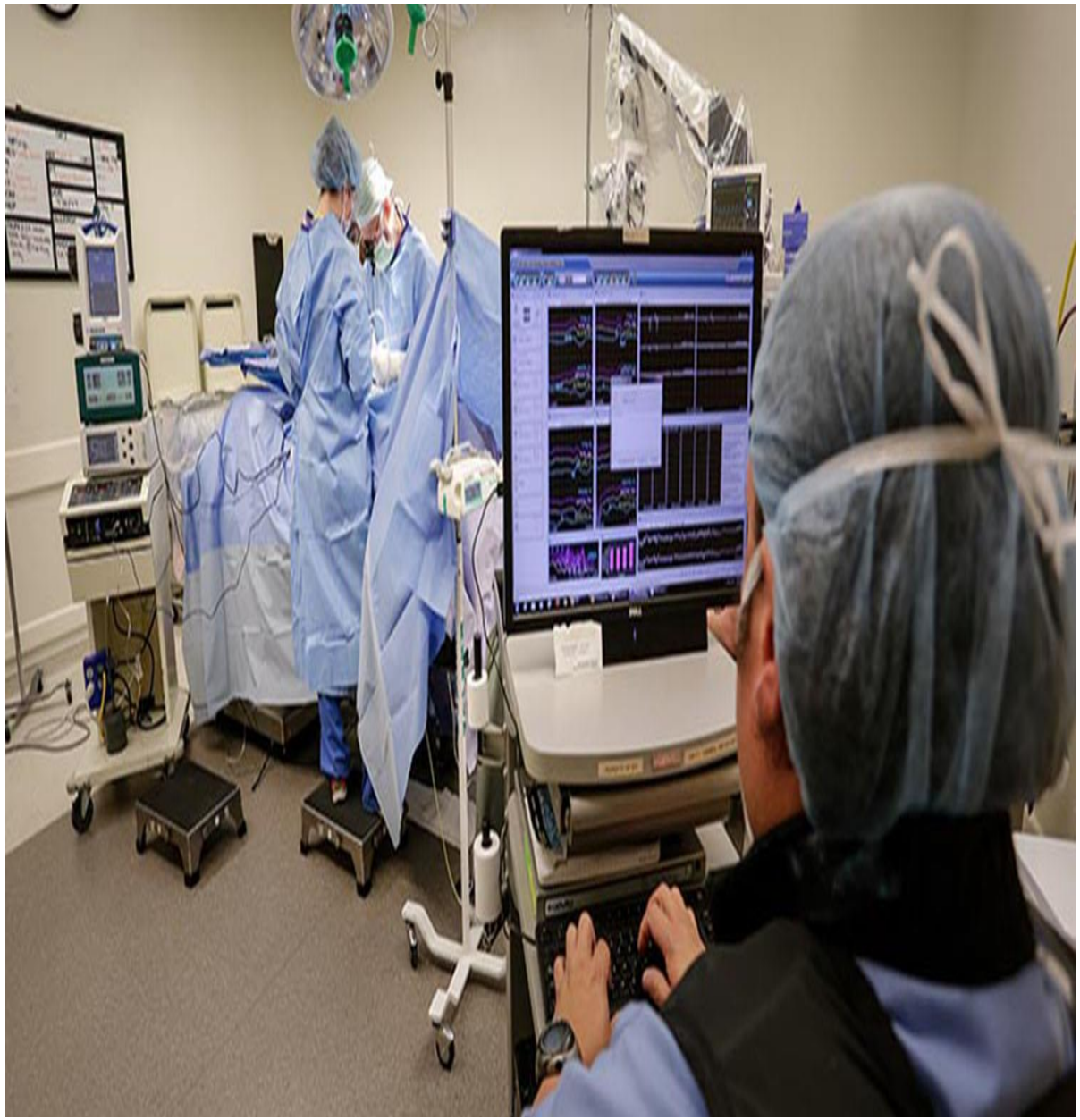


Neuromonitoring









Electroencephalogram (EEG)

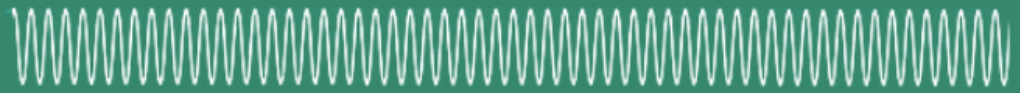
EEG is a record of the spontaneous electrical activity of the brain

An EEG can **find changes in brain activity (functional changes) ????** that aid in diagnosing brain conditions **Such as** :

1. **Epilepsy or another seizure condition**
2. Brain tumors.
3. Brain damage from a head injury.
4. Inflammation of the brain, such as herpes encephalitis.
5. Stroke.
6. **Sleep conditions.**

EEG Waves

Gamma Waves
(30-100 Hz)



Insight
Learning
Problem Solving

Beta Waves
(12-30 Hz)

Active thinking
Alertness
Scrolling

Alpha Waves
(8-12 Hz)

Relaxation
Meditation
Lucid awareness

Theta Waves
(4-8 Hz)

Daydreaming
Intuition
Creative thinking

Delta Waves
(0.5-4 Hz)

Deep sleep
Recovery
Unconsciousness

Sleep

- **Def:** It is a state of **unconsciousness** from which the person **can be aroused**.
- **Duration of sleep:** inversely related to age:

- **Adults:** about 7-8 hours.
- **Infants:**18 hours.
- **Old:** about 5-6 hours.

- **Types of sleep:**

There are **two types** of sleep that alternate with each other and are characterized by **different EEG patterns**.

1) Non rapid eye movement sleep (NREM) = Slow-wave sleep (SW-sleep) in which the brain waves are strong and of **low frequency**.

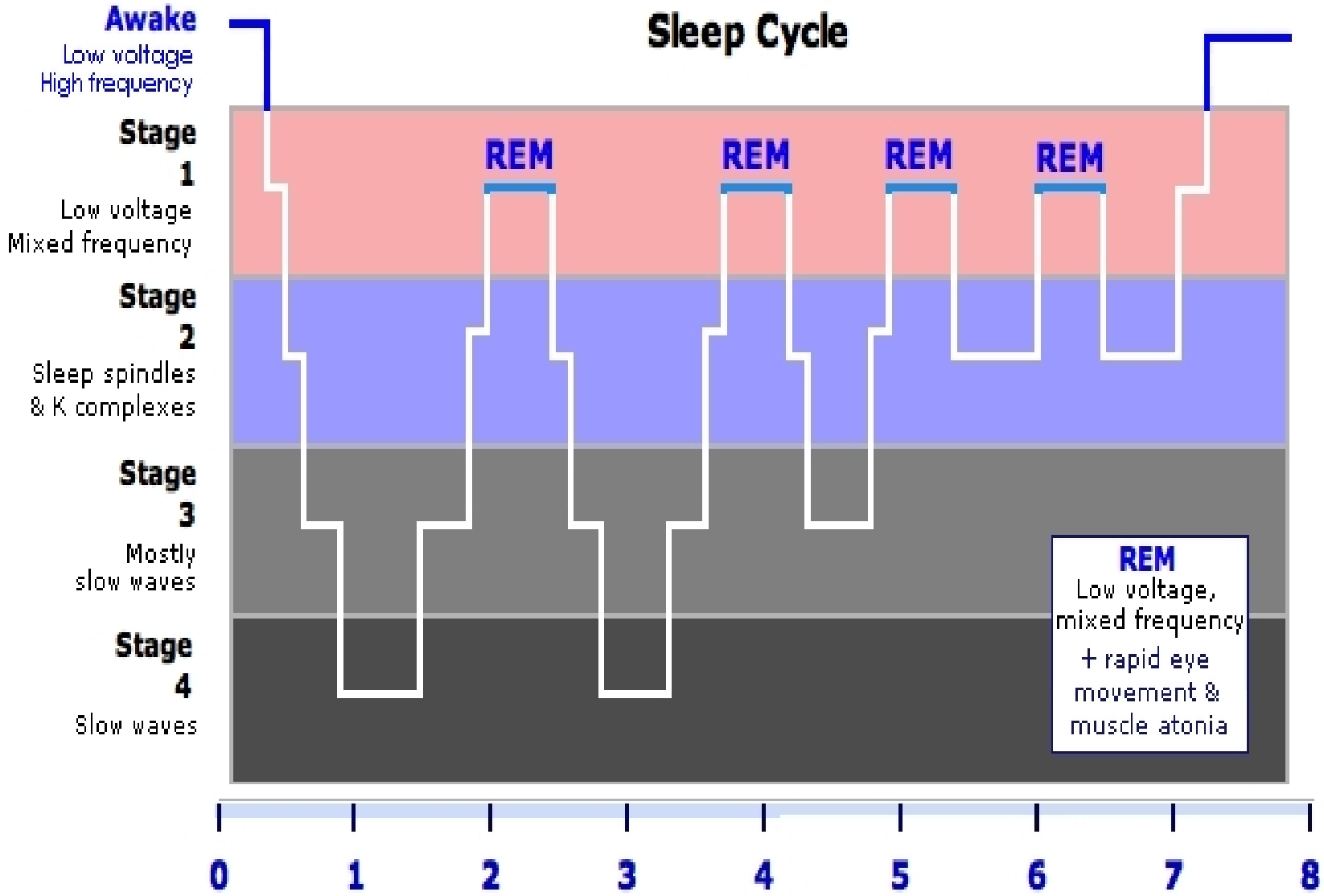
2) Rapid eye movement sleep (REM sleep) in which the **eyes** undergo **movements**

Sleep

	Slow wave sleep (SW sleep)	Rapid eye movement sleep (REM sleep)
Duration	**90** minutes	**5-20** minutes
Represent	**75 %** of total sleep time	**25 %** of total sleep time
Dreams	**May be** associated with **dreams** but **not remembered**	Usually associated with **dreams** (vivid dreams) & nightmares
Muscle tone	**Mild reduction**	**Marked reduction**
Heart rate, ABP & resp rate	**Mild reduction**	**Increase & irregular**
Rest	**Restful** sleep	**Restless** sleep
EEG waves	**Slow** & high voltage	**Rapid** & low voltage
	As the **stages of SWS proceed**, **it become deeper & restful**	The brain is highly active in this stage. **EEG** shows a pattern similar to alert state (**β rhythm**).

Sleep cycles

- When an individual falls asleep, he **first enters** a period of **slow wave sleep (stages 1, 2, 3, and 4) 90 minutes.**
- This is **followed by** a phase of **REM sleep** for **5-20 minutes**.
- This completes a **sleep cycle**, which, therefore, **consists of a period of NREM sleep & the following period of REM sleep**.
- Usually, **normal adult** have **4-5 sleep cycles/ night**



Basic theories of sleep

- Sleep is caused by **an active inhibitory process** and not simply **(Beside)** due to **fatigue of the reticular activating system (passive theory)**

I- Initiation of NREM sleep:

Stimulation of many areas of the brain ➔ sleep, **these areas include:**

1) Raphi nuclei in the lower half of the pons and in the medulla:

– Nerve fibers from these nuclei spread locally in the **brain stem reticular formation** and upward into the **thalamus**, **hypothalamus**, **limbic system** and even **cortex**.

– The endings of these nuclei fibers **release serotonin** which is the transmitter producing sleep.

2) Nucleus of the tractus solitarius in the medulla.

Basic theories of sleep

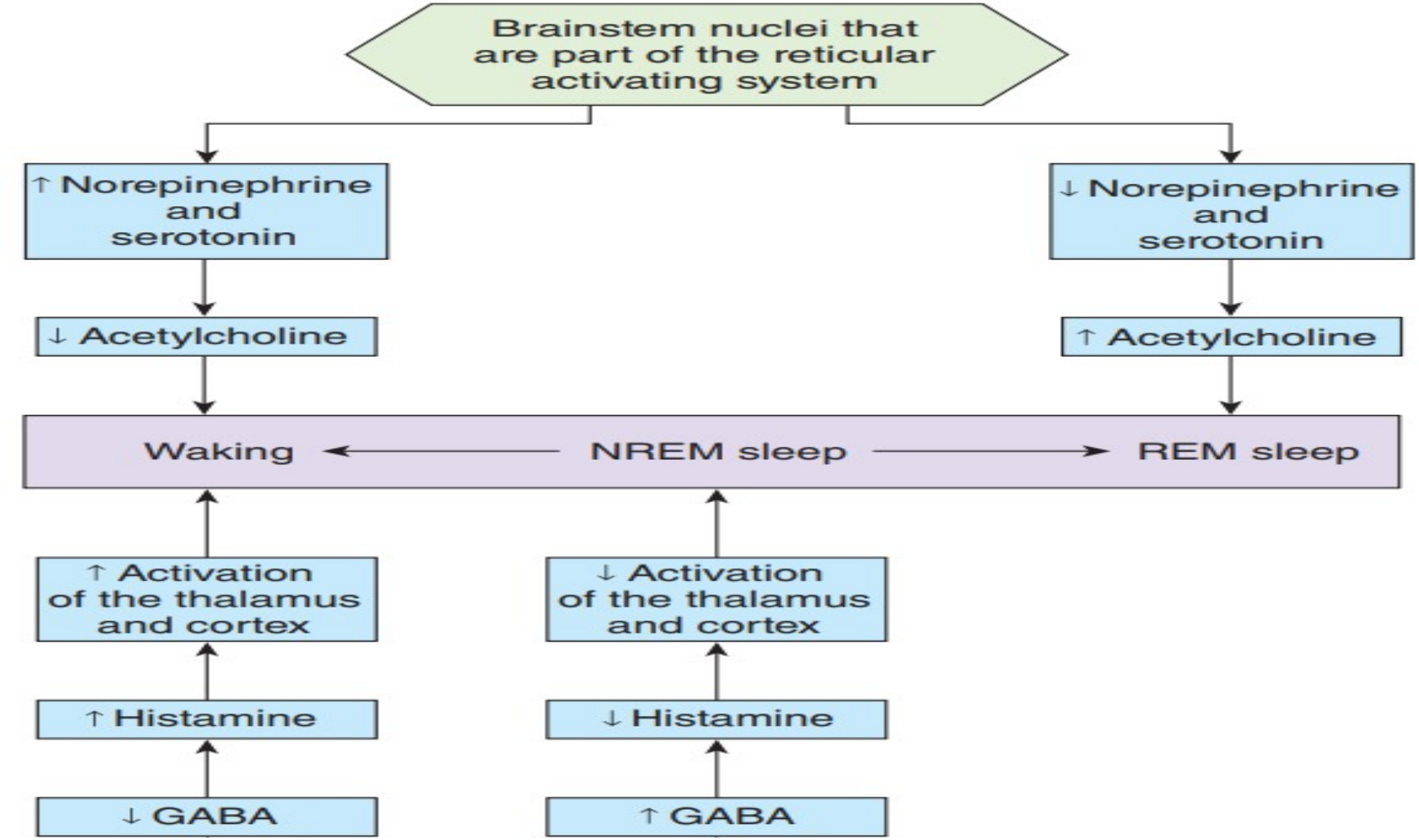
II- Initiation of REM sleep:

- REM sleep is **initiated** by ↑ activity of **cholinergic neurons** located in the **upper brain stem reticular formation**.
- These neurons **(REM-On neurons)** send **excitatory** signals **to RAS, thalamus as well as cerebral cortex**.

III- Termination of REM sleep:

- The **termination of the REM sleep** results from ↑ activity of the **serotoninergic neurons in the raphi nuclei** which **send inhibitory** projections to **the cholinergic neurons in the RAS**.

Basic theories of sleep



Physiological significance of sleep

- Adequate periods of sleep are essential for **restoration of normal brain activity & different functions of the CNS**.

➢ **Stage 4 NREM** sleep is the **most effective** for the recovery of the brain. During this stage, the **cerebral metabolic rate and cerebral blow flow decreases markedly** → **↓ free radicals production** and prevention of their damaging effects

❖ **REM sleep** may facilitate the changes that enhance brain development. This is particularly **important in infants and young children**, who spent more time in REM sleep compared with the adults. It enhances the chemical and structural changes that are involved in **learning and memory**.

- Prolonged periods of wakefulness or deprivation of sleep ➔ **deterioration of the higher brain functions**.

Memory

Def: Storage of acquired knowledge or skills in brain for later recall when needed. Classified according to :

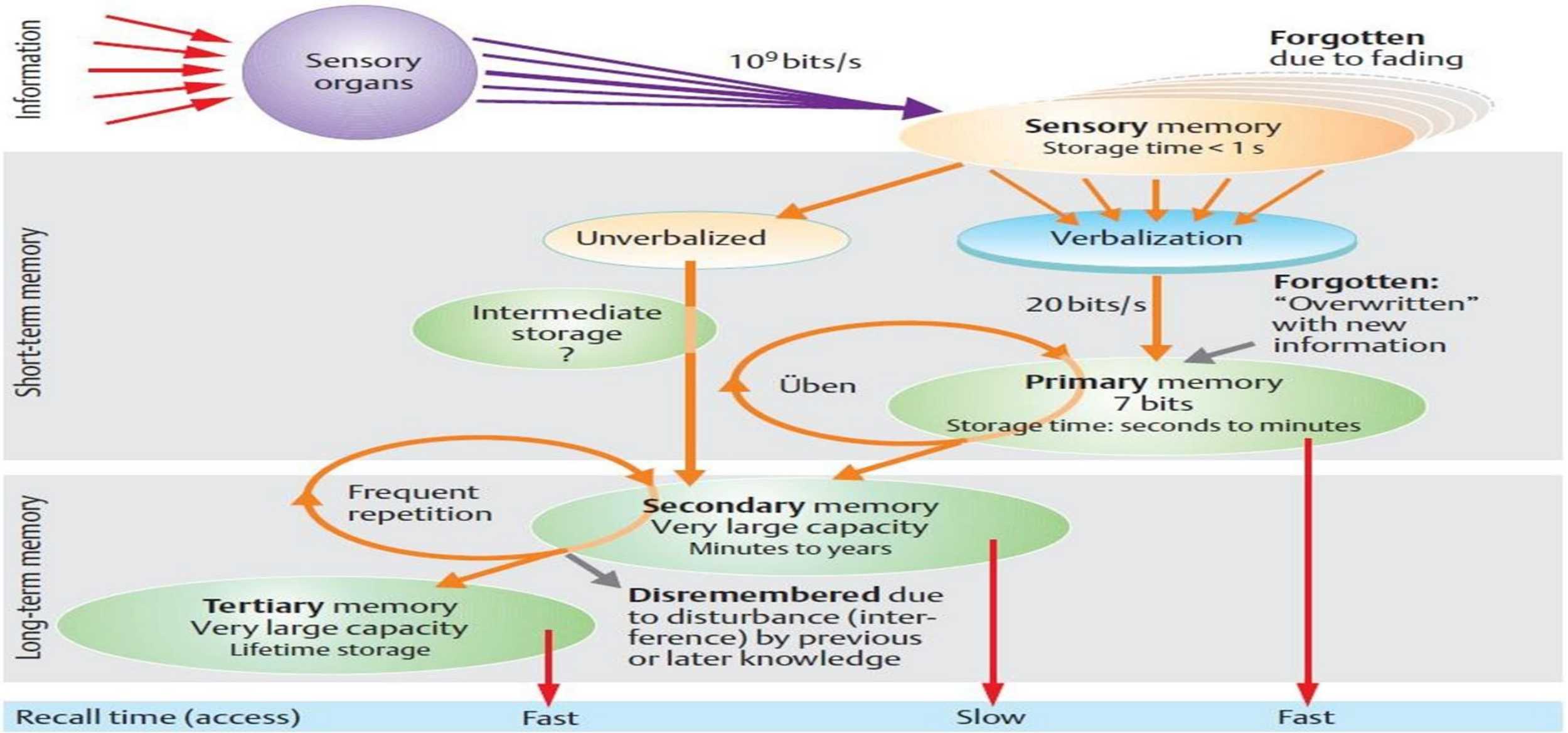
A. The nature of information stored

1. **Explicit (Declarative memory):** about facts and events (this is a conscious recall of information).
2. **Implicit (Non-declarative) memory:** about skills & habits (memory writing, driving a car or playing a piano).

B. The time course of storage

1. **Short term memory (STM)**: lasts for seconds or minutes then either fades or changed into intermediate or long-term memory.
2. **Intermediate term memory:** lasts for hours, days or even weeks.
3. **Long term memory (LTM):** can be recalled up to several years, **may become Permanent**.

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
Üben
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

Mechanisms of Memory

Memories are stored in the brain through **facilitation of synaptic transmission**. The new or facilitated pathways are called **memory traces**. Once the traces are established, they can be selectively activated by the thinking mind to reproduce the memories.

I) In case of short-term memory; this is achieved by either;

a) Activation of reverberating circuits

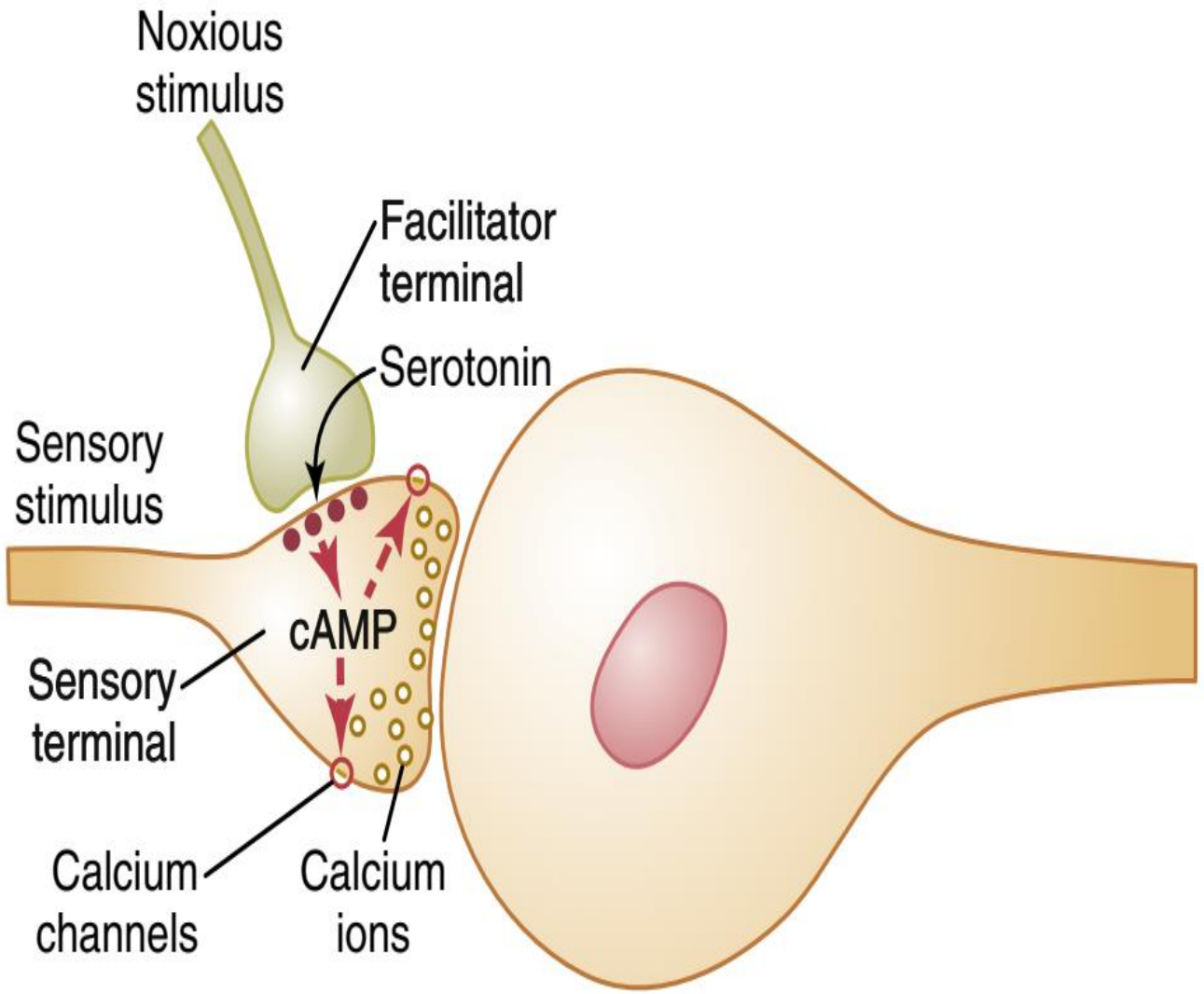
b) Post-tetanic potentiation

c) Facilitation of the presynaptic terminals

Mechanisms of Memory

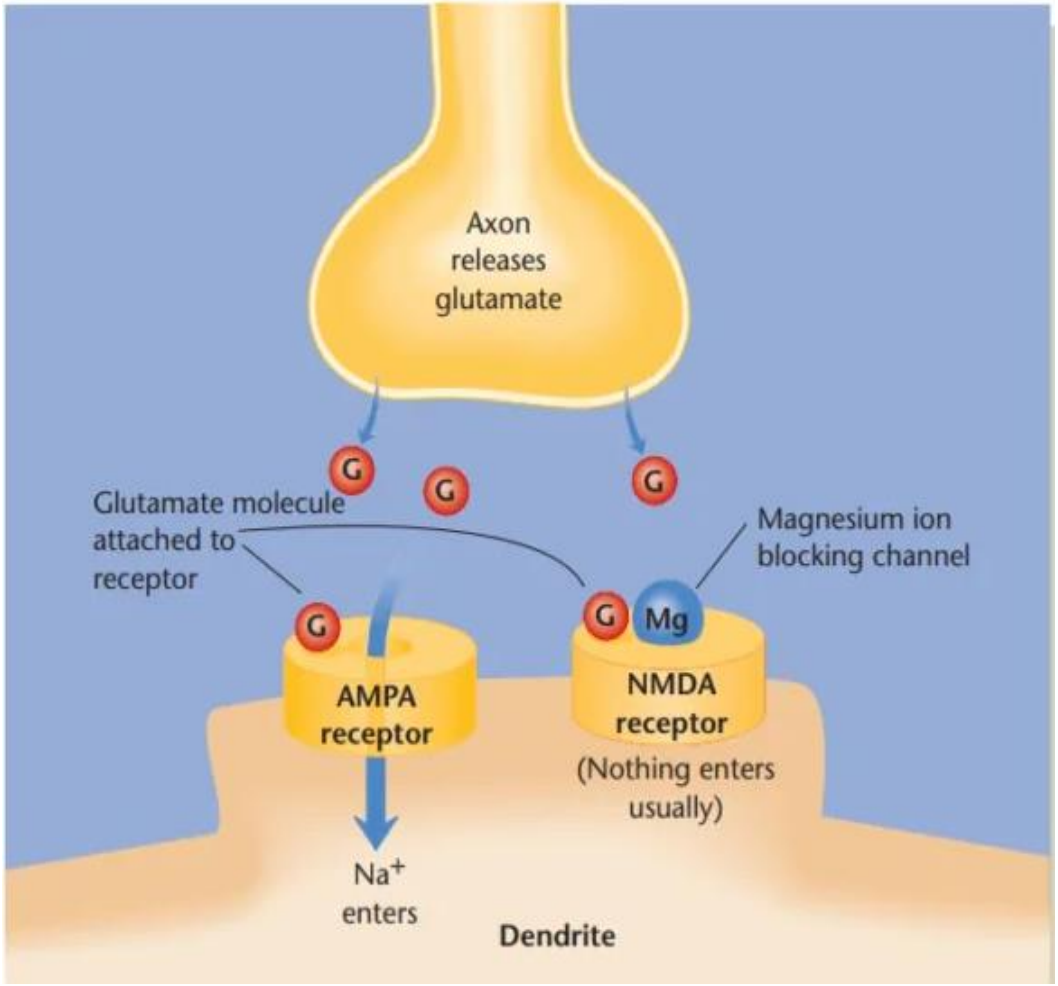
Facilitation of the presynaptic terminals (synaptic sensitization):

This occurs **through a facilitatory neuron** which terminates on the presynaptic ending. **The facilitatory neuron releases serotonin** which **through cAMP causes closure of K+ channels in the presynaptic ending** → **prolongation of action potential** in the presynaptic ending → **prolonged activation of Ca2+ channels** → **↑Ca2+ entry** into the presynaptic terminal → **more release of the transmitter** → **augmented PSP**.

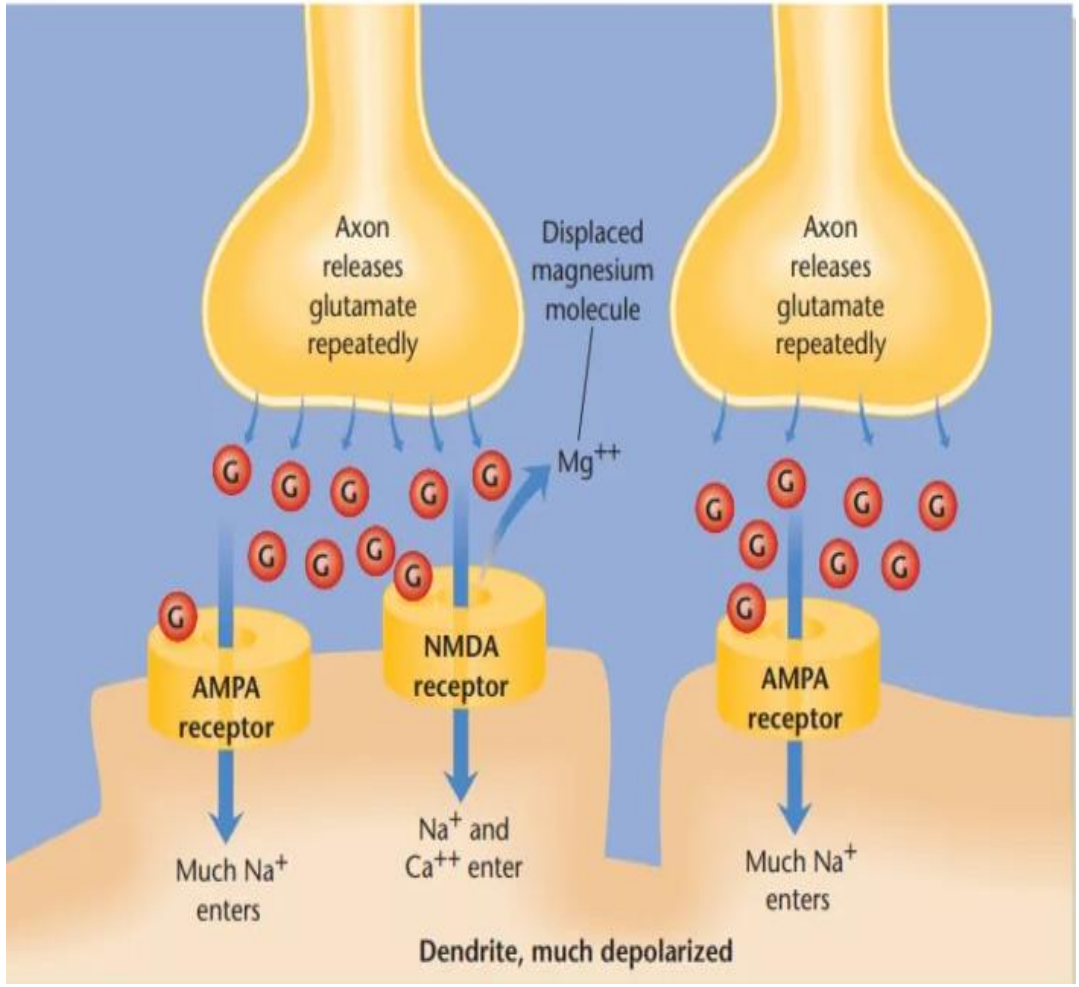


Mechanisms of Memory

II) In case of intermediate-term memory; is based on **chemical changes** in the presynaptic terminal or post-synaptic neuronal membrane **that increase the synaptic sensitivity**.



Repeated Stimulation



Mechanisms of Memory

III) In cases of long-term memory; is generally believed to result from actual **structural changes**, instead of only chemical changes, at the synapses, and these enhance or suppress signal conduction.

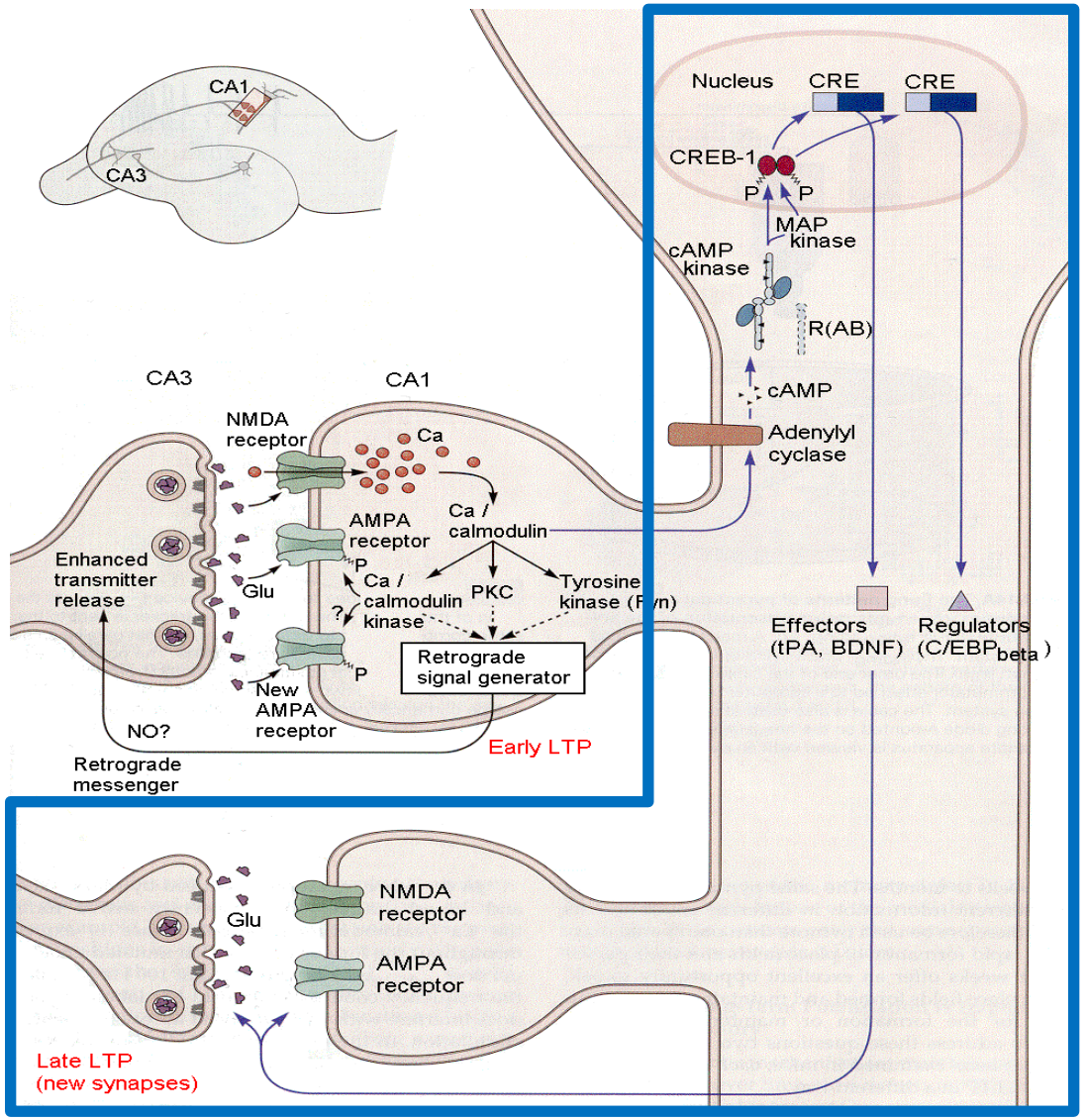
These **structural changes** include:

a) increase in vesicles release sites for secretion of transmitter substance.

b) increase in number of transmitter vesicles released.

c) increase in number of presynaptic terminals.

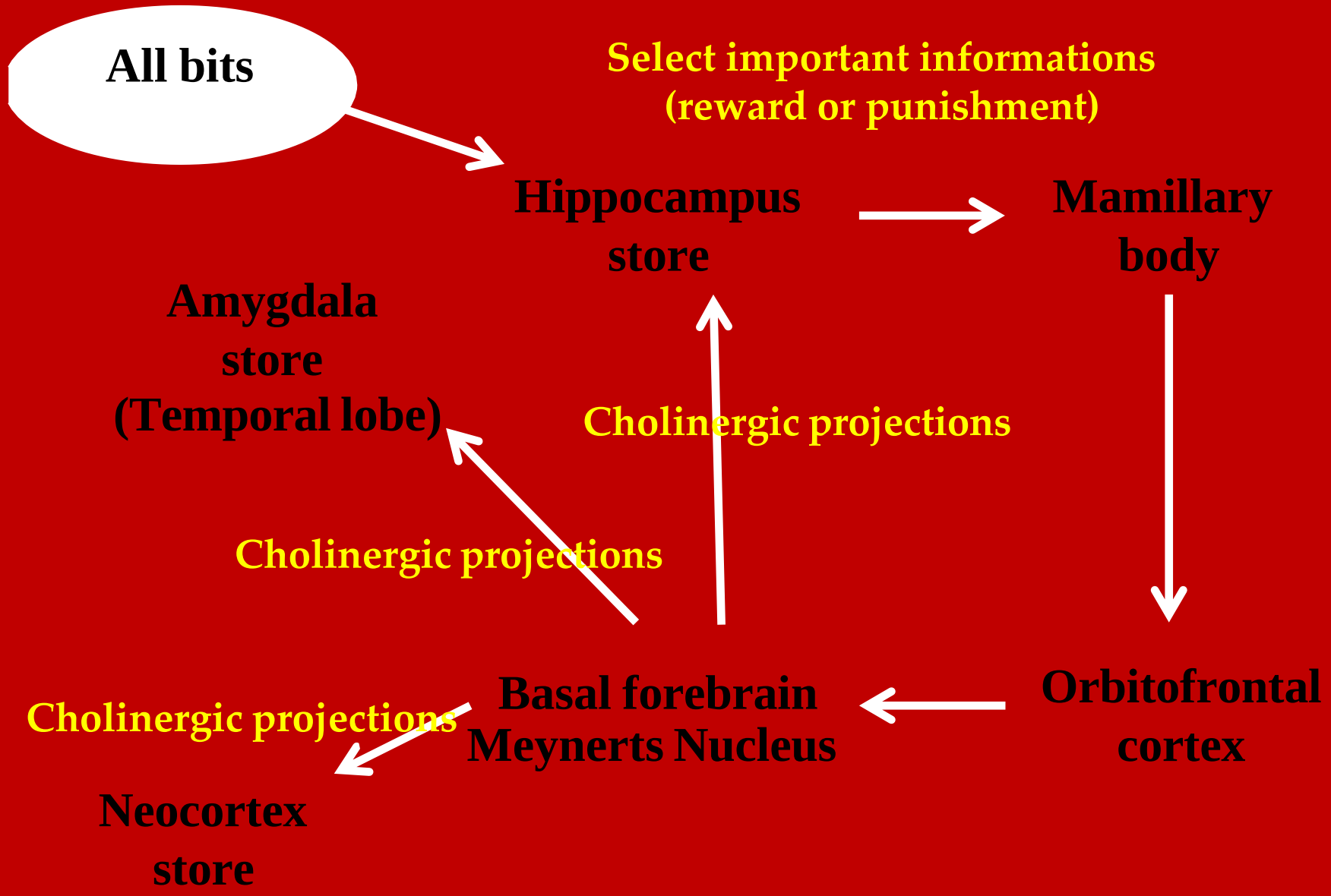
d) changes in structures of the dendritic spines that permit transmission of stronger signals.



Consolidation of Memory

- For **STM to be converted into LTM** which can be remembered months or years later, it must be **consolidated**.
- Efficient consolidation takes 1 hour or more. This time is used for **rehearsal (recycling)** the same information again & again.
- **Hippocampus and amygdala** is essential for **consolidation of memory**. It provides the principal **(decision-making)** which determines importance and significance of the incoming sensory information **(associated with reward or punishment)** .
- Hippocampus provides the drive which makes mind recycles over and over the new information until permanent storage takes place.
- The different kinds of **sensory memories** are stored in appropriate sensory cortical association areas **e.g.** visual memories in visual association areas, memories of voice and spoken words are stored in auditory association area, while memories of faces are stored in face recognition area.

Encoding of Memory



Amnesia

- Impairment of memory due to lesion in certain areas of brain

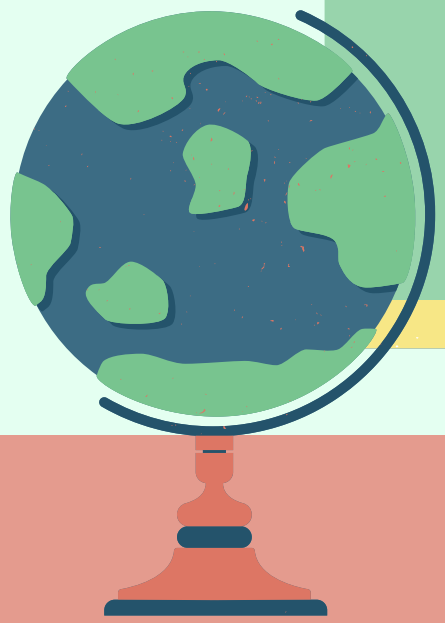
Retrograde amnesia	Anterograde amnesia
* **Inability to recall** memories **from the past** i.e. from LTM**.**	* **Inability to store new i**nformation in LTM for later recall.
* It follows brain trauma which interferes with brain activities	* Lesion in medial portions of temporal lobe, **hippocampus ???**(essential areas for storage & consolidation).
* Patient has good recall for present	* Patient has recall for past

➢ **Senile dementia and Alzheimer disease**

- ❑ It occurs in **old age (senile dementia)** and **middle age (Alzheimer)**, but it can occur at any age
- ❑ It is characterized by impairment of memory, lack of concentration, inattentiveness . It is due to **Loss of cholinergic terminals that diffuse from nucleus basalis to neocortex, amygdala and hippocampus**

Any Questions

??




Thank
You