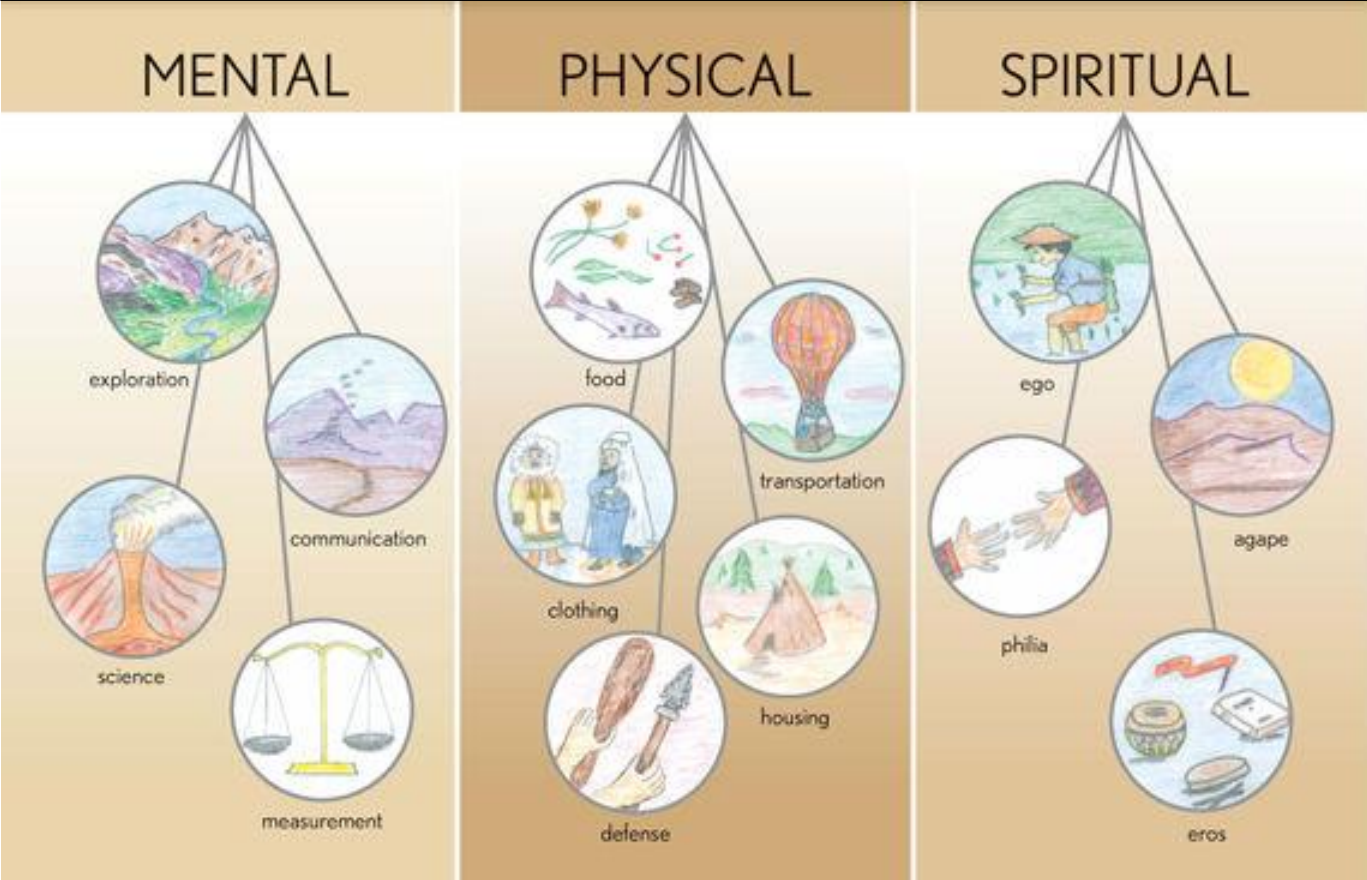


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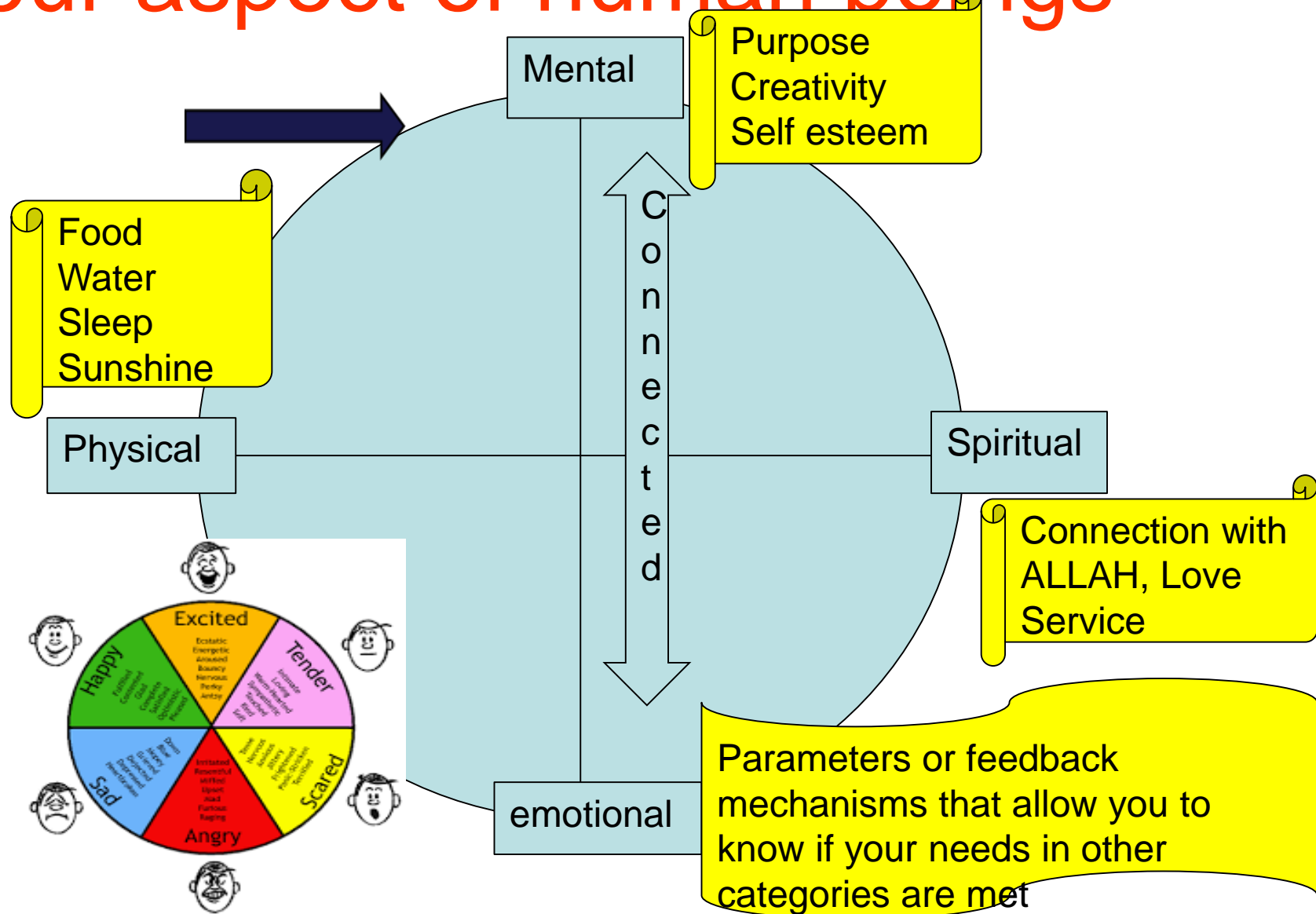
# Intellectual functions of Brain

Learning and Memory

# Give heading to this figure

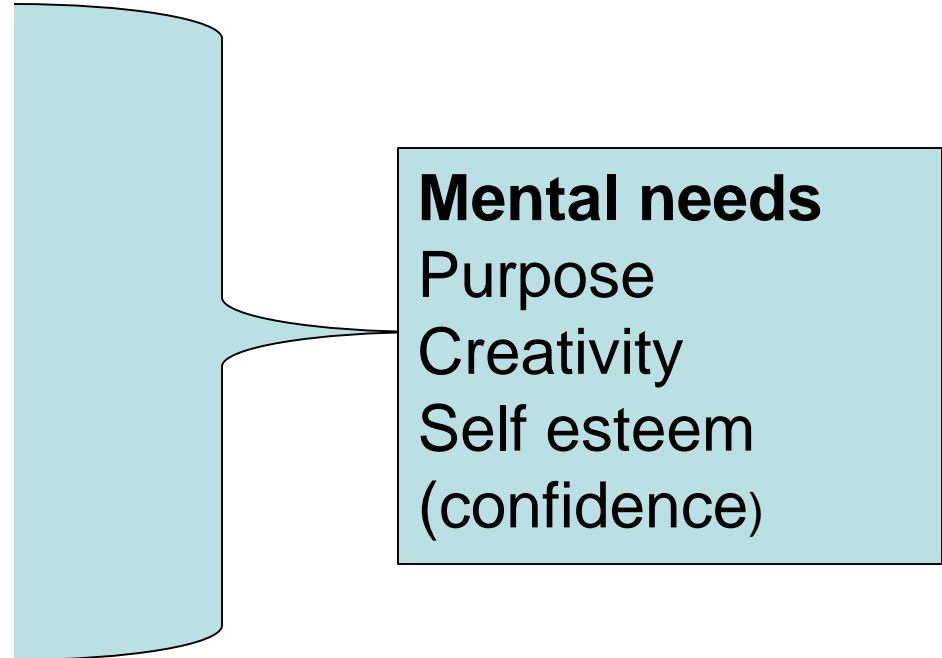


# Four aspect of human beings



# Mental needs( how do you get purpose )

- Intelligence
- Learning
- Memory
- Consciousness



## **Mental needs**

Purpose

Creativity

Self esteem

(confidence)

# Intelligence

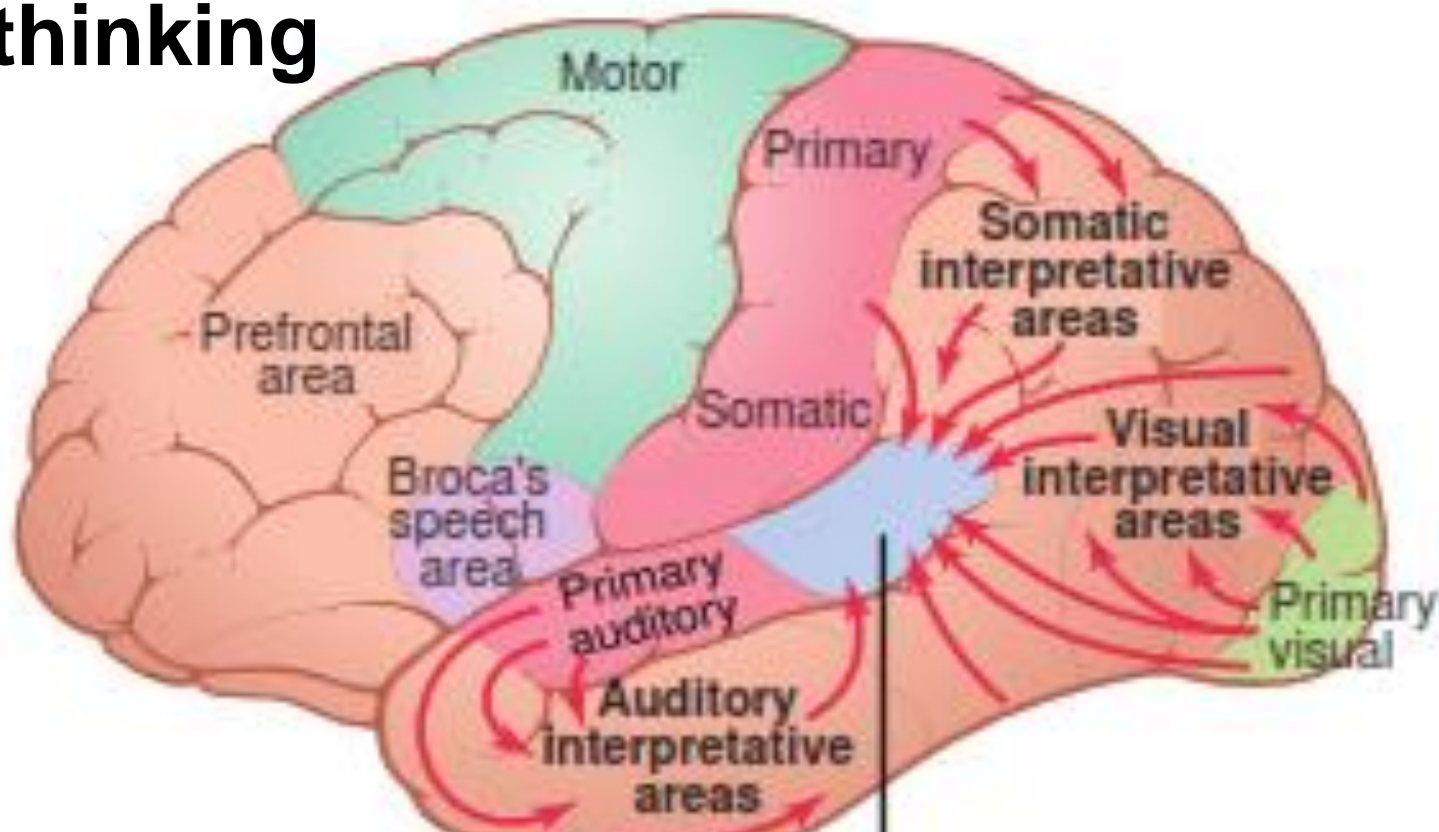
**The global capacity of a person**

**to think rationally,**

**to act purposefully, and**

**to deal effectively with his environment.**

Name area of the brain that does the important function of **rational thinking**



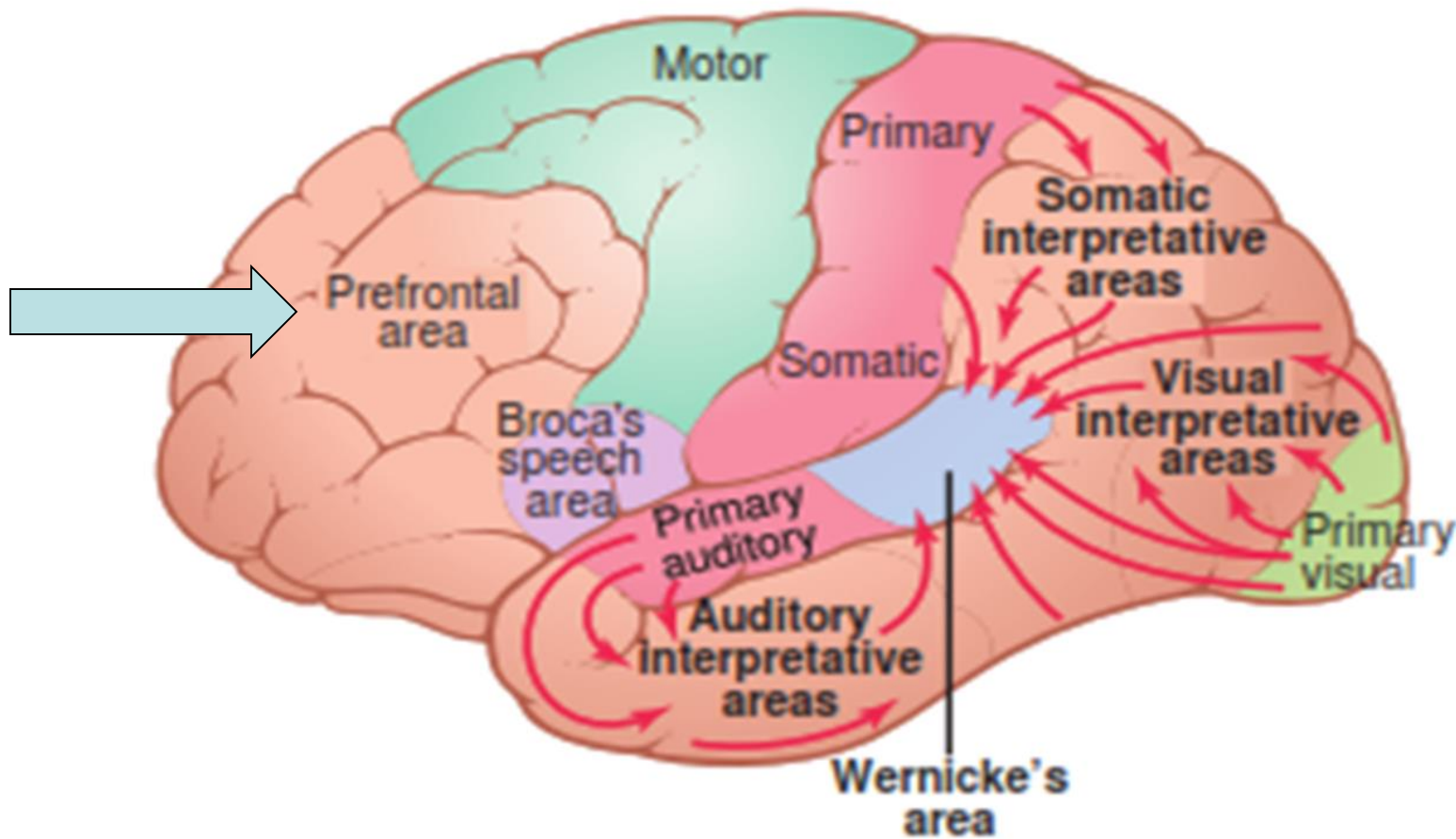
**Name this area ?**

# Function of Wernicke's area

After severe damage in Wernicke's area, a person might hear perfectly well and even recognize different words but still be unable to arrange these words into a **Coherent thought**. Likewise, the person may be able to read words from the printed page but be unable to recognize the thought that is conveyed



Name area of brain that helps in making **Purpose/observing moral and social values**(another high level thinking )



# Write down the purpose of attending this lecture ?

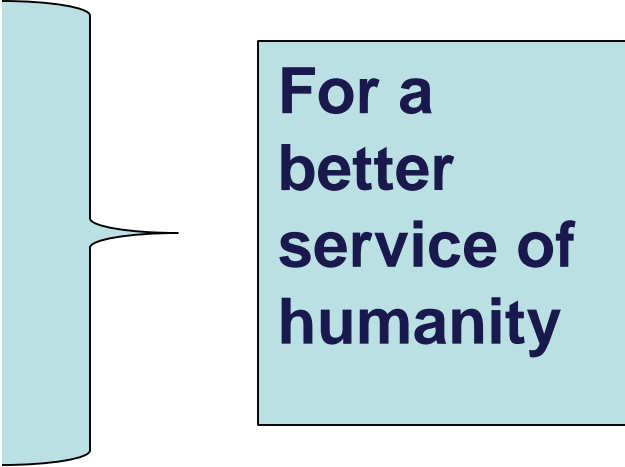
*Purpose is a stable and generalized intention to accomplish something that is at once **personally meaningful** and at the same time leads to productive **engagement with some aspect of the world beyond the self.***

***purpose is value based e.g. honesty , truth, timeliness , service to humanity etc.***

# Purpose( broad , long term goals)

To explain and implement the basic knowledge of my mental processes to

- learn effectively
- be conscious
- improve my Memory



**For a  
better  
service of  
humanity**

# To achieve our purpose we need to develop Learning Objectives

- Explain learning theories
- Define and classify memory.
- Explain mechanisms of memory
- Describe how we recall the memory.
- Describe the way we can improve our memory

# Learning ( theories )

1. Behaviorism ( learning is change in behavior)
  - Depend on external world /stimulus e.g.  
Classical conditioning, operant conditioning

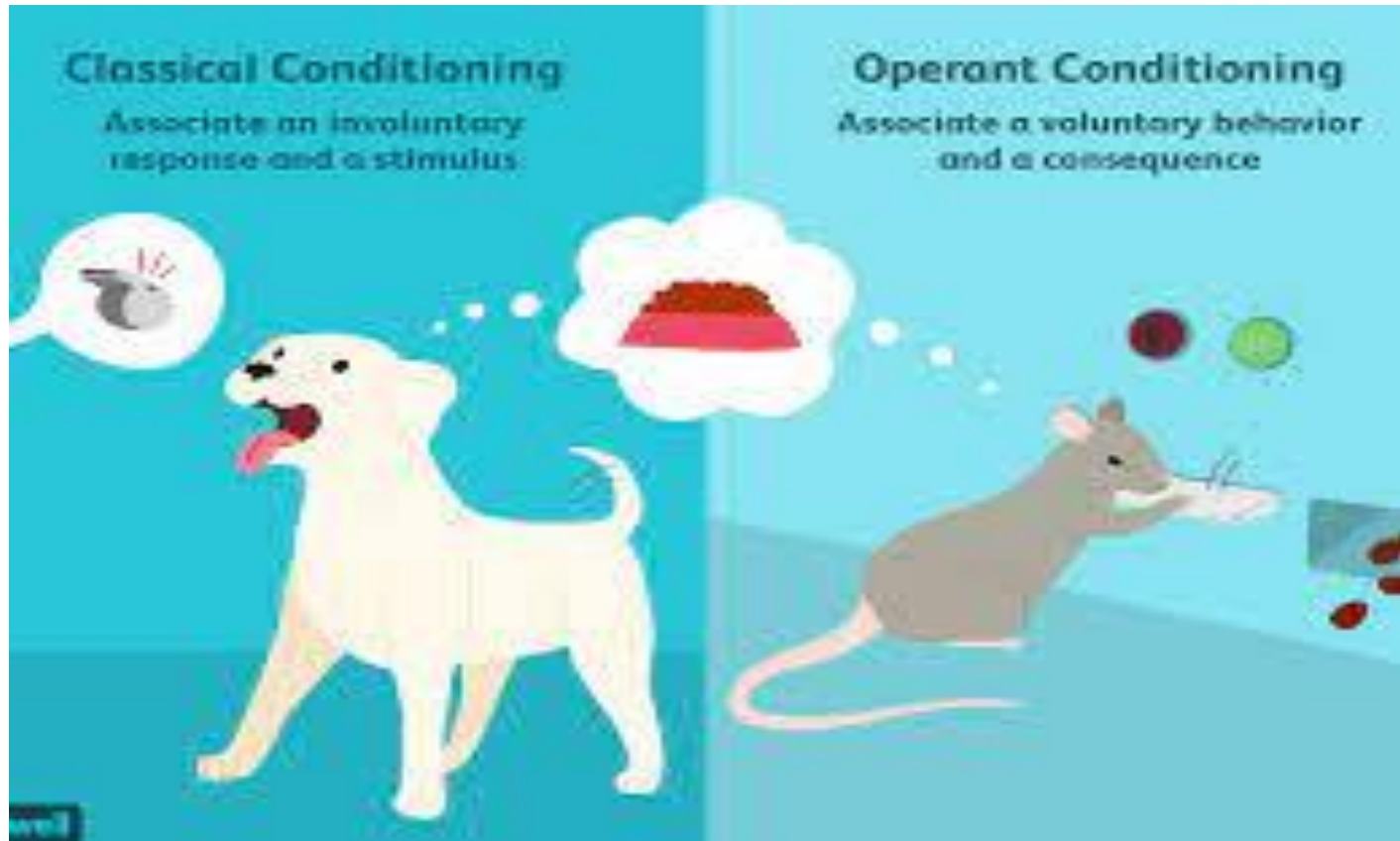
Two processes are needed for acquiring of associative memory → change in behavior

## Classical conditioning

- **involves associating an involuntary response and a stimulus,**
- reflexive process on the part of learner

## Operant conditioning (shaping behavior through reward

- voluntary response associated with the stimulus.
- learner is also given an incentive/reward
- Active process in which the learner must show an action that can be punished or rewarded

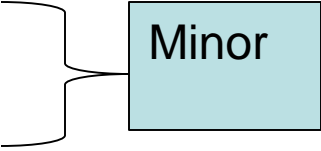


# Real life implications ( remember your purpose )

- Minds can be shaped through careful planning e.g.
- Emergency sounds / bells in emergency ward should elicit reflexly in you the action of doing CPR ( cardiopulmonary resuscitation ) you should just respond ( Classical conditioning)
- Reward yourself for good thing that you do
- punish yourself for bad things that you do



## Reward center ( pleasant feeling)

- **Medial fore brain bundle**
  - **Lateral nucleus of hypothalamus**
  - **Ventromedial nucleus in hypothalamus**
  - **Amygdala**
  - **Thalamus**
  - **Basal ganglia**
- 
- Minor

## Punishment centers ( unpleasant/fear/pain /sick feelings )

- Area around cerebral aqueduct in mid brain
- Periventricular zone of hypothalamus
- Amygdala
- Thalamus
- Hippocampus

# Role of reward and punishment in changing behavior

## Habituation/ ignoring

- Cerebral cortex does not respond if there is no sense of reward or punishment due to inhibition of synaptic pathways for this information called **habituation** → a type of **negative memory**

## Reinforcement

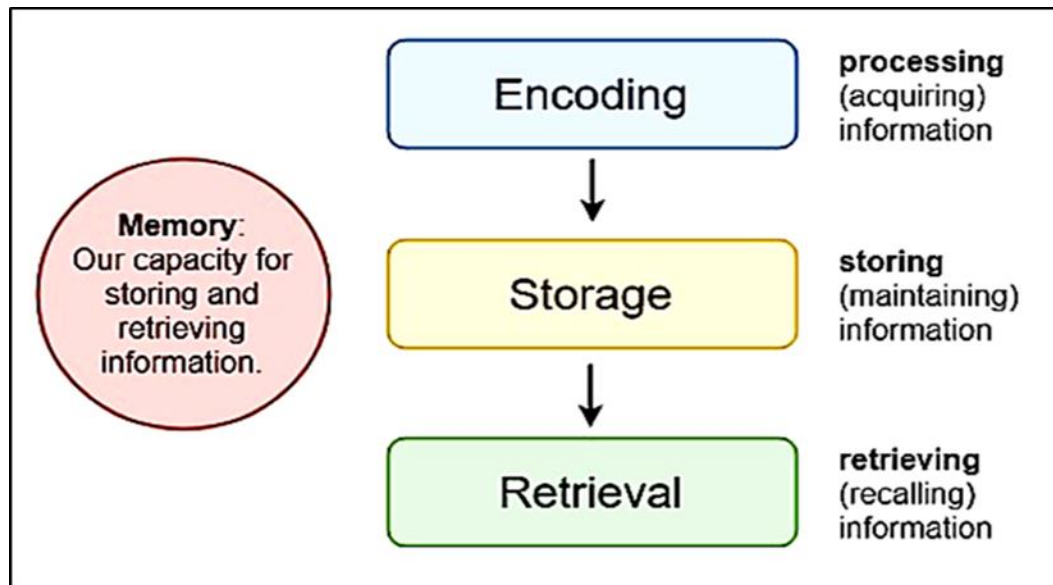
- Information that causes pain or pleasure → storing memory traces due to facilitation of synaptic pathways called **memory sensitization / reinforcement** → **positive memory**

**Consciousness** : continuing stream of awareness of either our surroundings or our sequential thoughts

## 2. Cognitivist theory of learning

- Learning is a developmental process and depends on function of internal brain processes (memory )

- How is it different from behaviorism theory of learning ?



# Classification

- On the basis of
  - 1. Duration for which memory lasts**
    - i) Short Term / working memory
    - ii) Intermediate
    - iii) Long Term
  - 2. Type of information that is stored**
    - i) Declarative
    - ii) Skill Memory

Task read page 745 – 748  
construct a table like below and  
fill it

<b>Characteristics</b>	<b>Short term / working</b>	<b>Intermediate term</b>	<b>Long term</b>
Duration			
Capacity limit			
Physiologic mechanisms responsible			

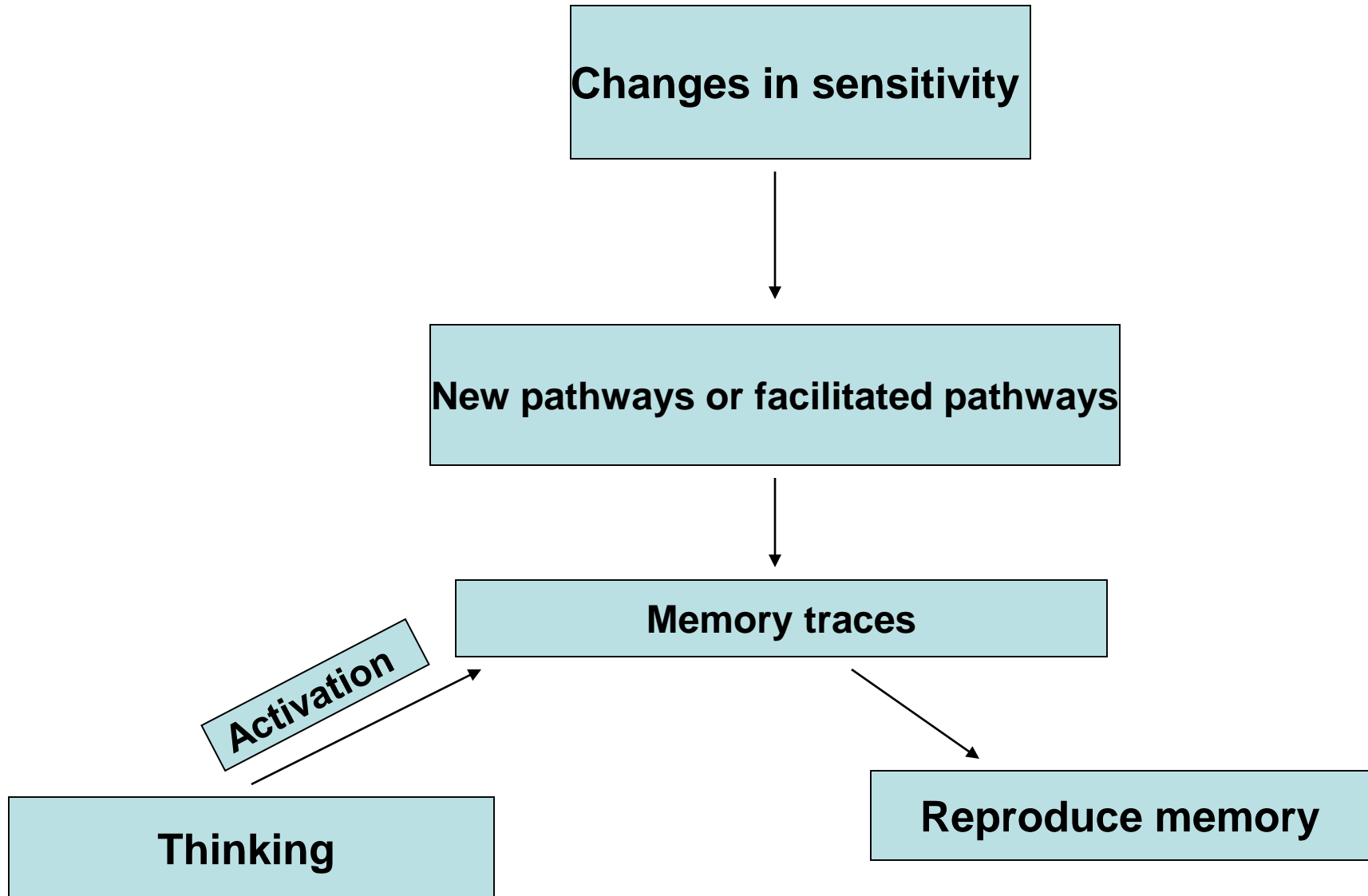
# Basic mechanism

- Changes in sensitivity ( $\downarrow$  or  $\uparrow$ ) of synaptic transmission between neurons as a result of previous neural activity

Contd.....



# Basic mechanism



# Sites of CNS involved in memory

- All levels of CNS
  - Mainly cerebral cortex
  - Lower brain centers
  - Spinal cord

**Duration**

**Short Term**

seconds to  
minutes

**Intermediate**

minutes to weeks

**Long Term**

Permanent

**MEMORY**

**Information**

**Declarative**

Episodic/ Semantic

**Non Declarative/  
Skill**

Skills/habits/Reflexive

# Classification on the Type of information that is stored

## 1. Declarative memory

(Recognition memory, Explicit memory)

Various details of an integrated thought

## 2. Implicit memory

(Skill memory, reflexive memory, non-declarative memory)

associated with motor activities of a person's  
body (hitting a tennis ball)

# Declarative Memory

- Involves consciousness/ awareness
- Memory of Surroundings, time relationship, causes of experiences, meaning of experience and deductions
- Memory of thoughts and important experiences
  - Episodic
    - ❖ Events
  - Semantic (facts)
    - ❖ Words
    - ❖ Rules
    - ❖ Languages
- Dependent on **Hippocampus** and medial temporal parts of brain

# Skill Memory

- Does not involve consciousness/ awareness
- Skills, habits, conditioned reflexes (automatic)
- 4 Types; Associative, Non Associative memory, Skills & habits, Priming
  - Motor activities of body
    - e.g. tennis ball
      - ❖ Speed
      - ❖ Direction etc
- **Does not involve Hippocampus**

Long-term memory

Declarative memory

Non-declarative memory

Episodic memory

Semantic memory

*Medial temporal lobe, diencephalon*

*Medial temporal lobe, diencephalon*

Procedural memory

*Striatum*

Priming

*Neocortex*

Classical conditioning

Emotional responses

*Amygdala*

Skeletal responses

*Cerebellum*

Non-associative learning

*Reflex pathways*

# Declarative

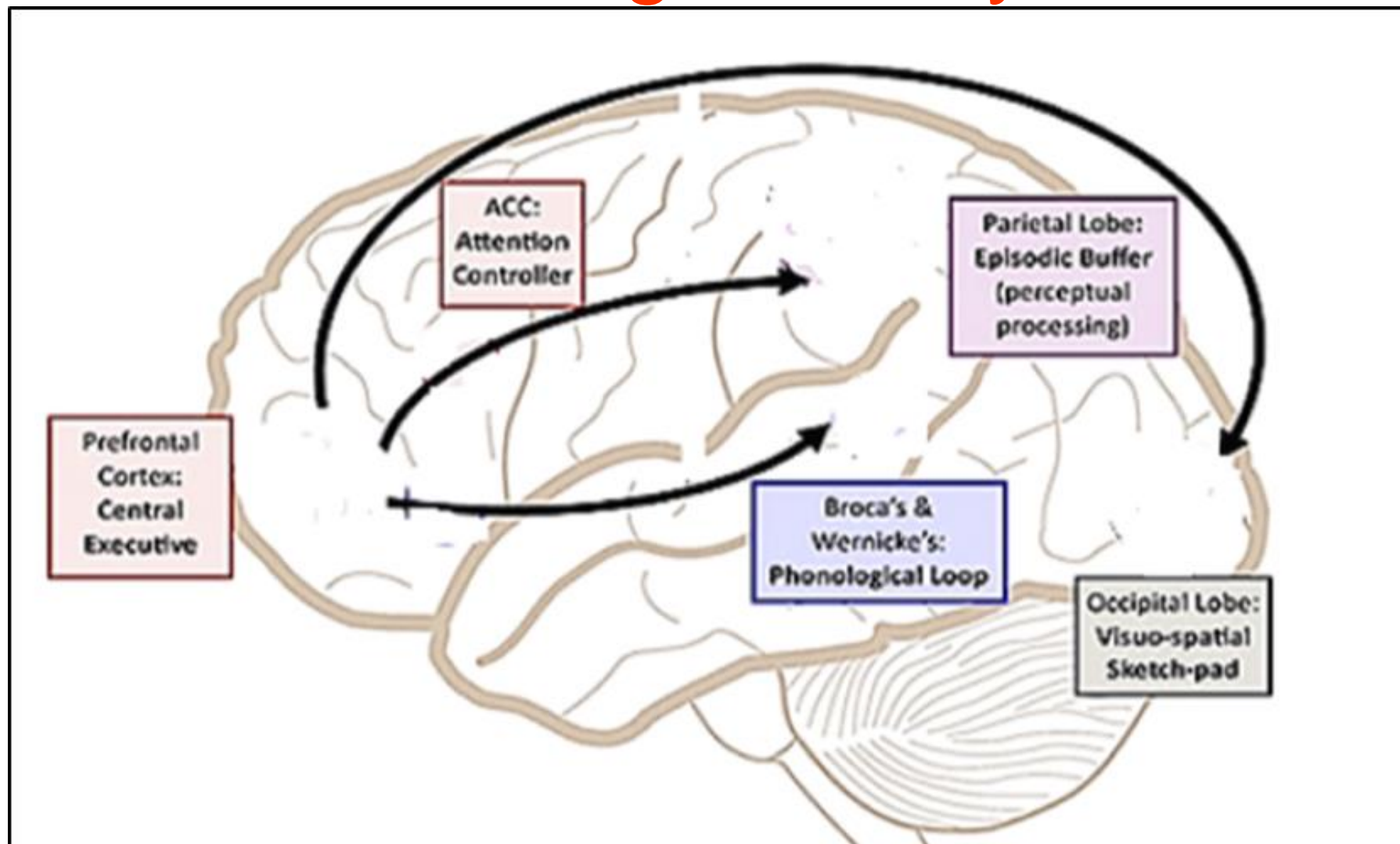
- memories of facts and events
- **Fact** like Islamabad is the capital of Pakistan or an **event** like a prior vacation
- **knowing what**

# Non declarative

- **skills** and **habits** (e.g., riding a bicycle, driving a car, playing golf or tennis or a piano)
- Priming - blue → Sky, few words of song and say the rest
- classical conditioning (Pavlovian conditioning)
- nonassociative learning such as habituation and sensitization
- **knowing how**



# Working memory



# Short-term memory

**Seconds to minutes unless → long term memories**

Remembering a phone no. and lasts as long as the person thinks about it - **Working memory**  
e.g. 7 – 10 numerals in a telephone No.

## MECHANISM

- Transient biochemical changes
- how long the various substrate proteins (e.g., membrane channels) are phosphorylated
- cyclic AMP will be degraded

# Short Term Memory..

## i. **Continuous Neural Activity**

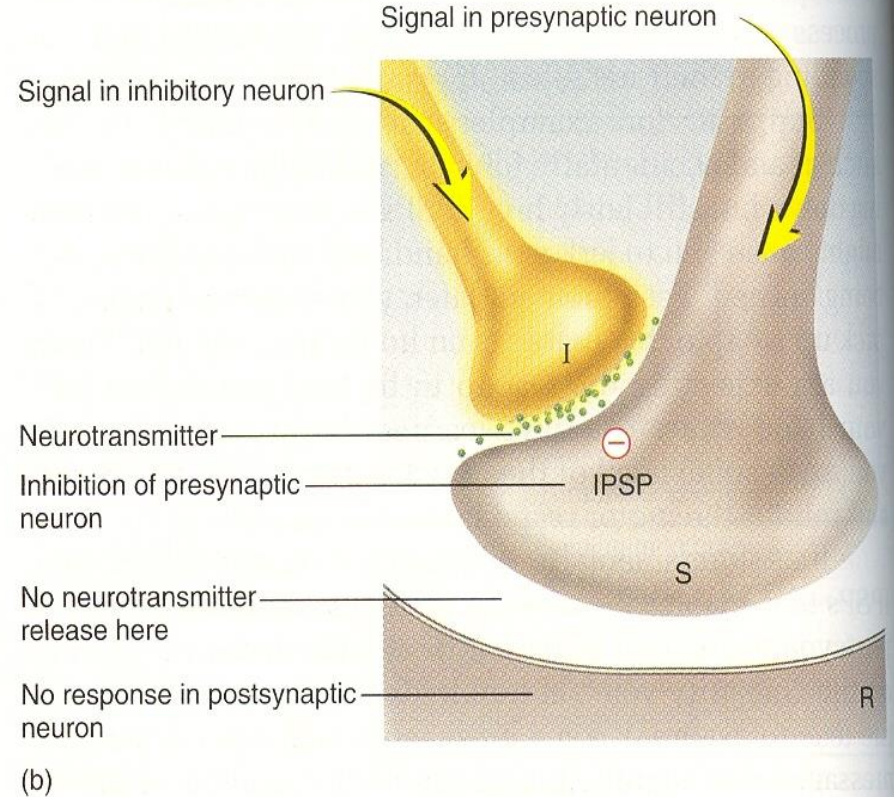
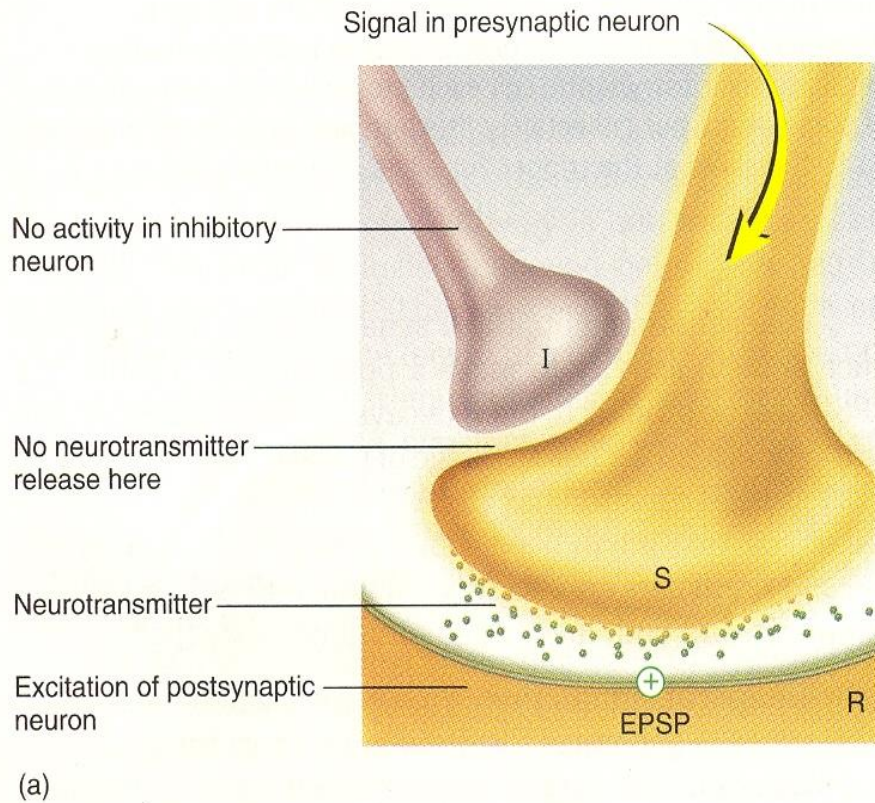
Temporary memory trace

Circuit of reverberating neurons

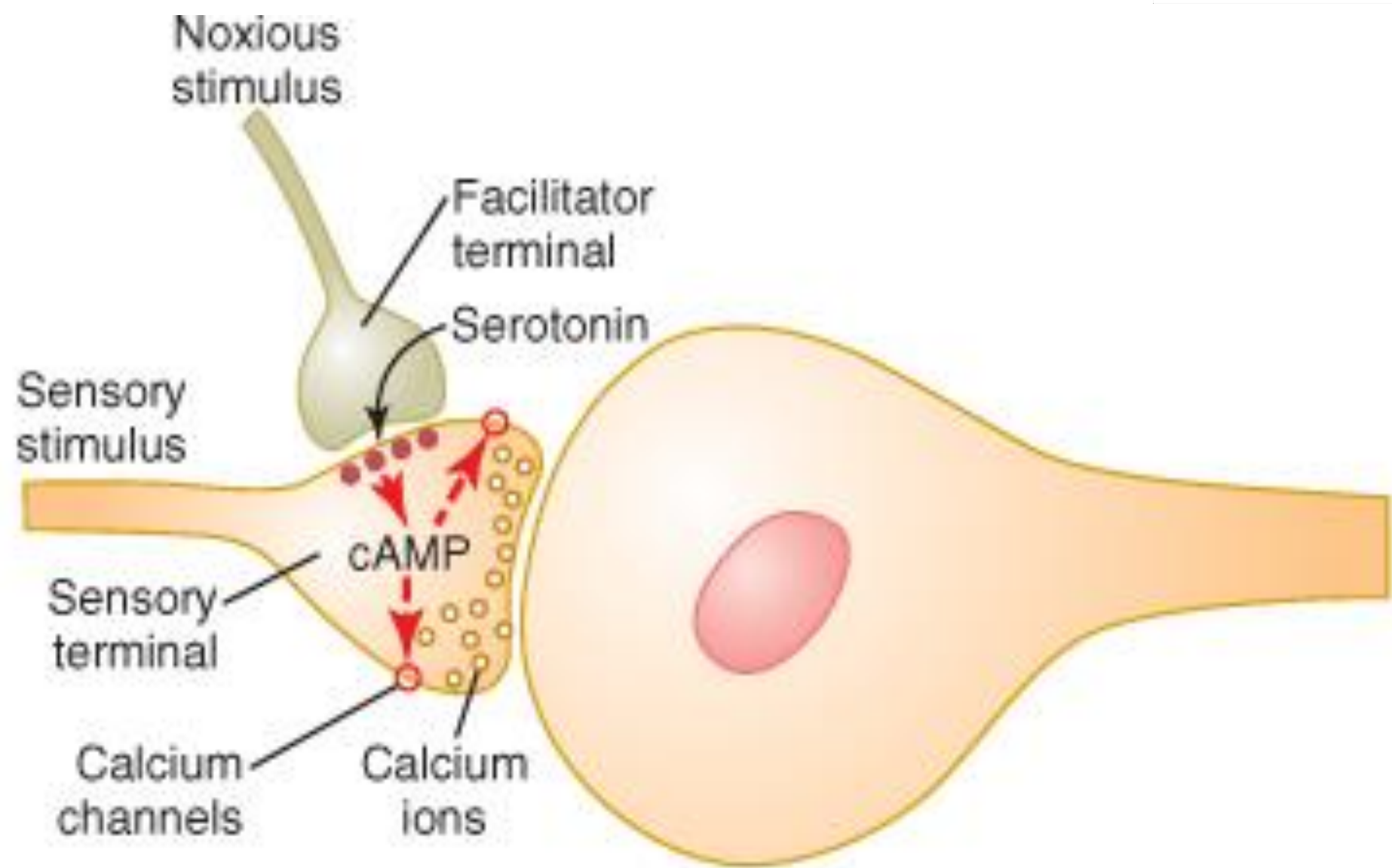
## ii. **Presynaptic Facilitation or Inhibition** →

Prolonged Facilitation or Inhibition

# Presynaptic inhibition



**Figure 13.24 Presynaptic Inhibition.** (a) In the absence of inhibition, neuron S releases neurotransmitter and stimulates neuron R. (b) In presynaptic inhibition, neuron I suppresses the release of neurotransmitter by S, and S cannot stimulate R.



# Intermediate Long Term Memory

Many Minutes → Weeks

Lost or

Permanent → long term

## Mechanism

Temporary chemical or Physical changes in either presynaptic terminal/ postsynaptic membrane (presynaptic facilitation ) if persist for few minutes to several weeks leads to intermediate long term memory ( if given attention)

Contd.....

# Molecular Mechanism of Intermediate Memory

**It enables us to ignore repetitive, irrelevant stimuli so that we can remain responsive to stimuli greater significance.**

**How inhibition improves memory ?**

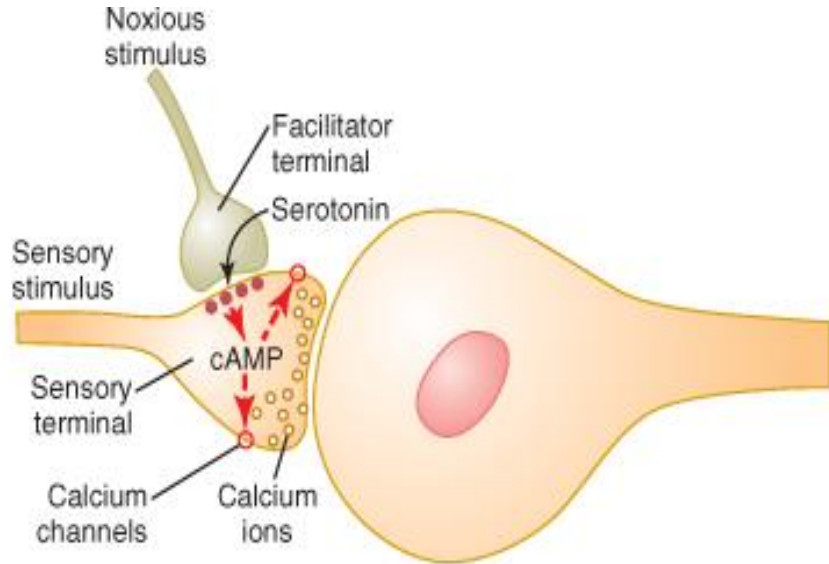
# Molecular Mechanism...

## Mechanism for Facilitation

If facilitated terminal is stimulated along with sensory terminal, signal transmission in postsynaptic neuron becomes stronger and stronger for minutes, hours, days or weeks



# Facilitation



Serotonin



Serotonin Receptors



Adenyl Cyclase

→ Formation of

cAMP



Activation of a protein kinase



Blockage of  $K^+$  channels



Prolonged action potential



Prolonged activation of  $Ca^{++}$  channels



Prolonged release of neurotransmitter

# Long-Term Memory

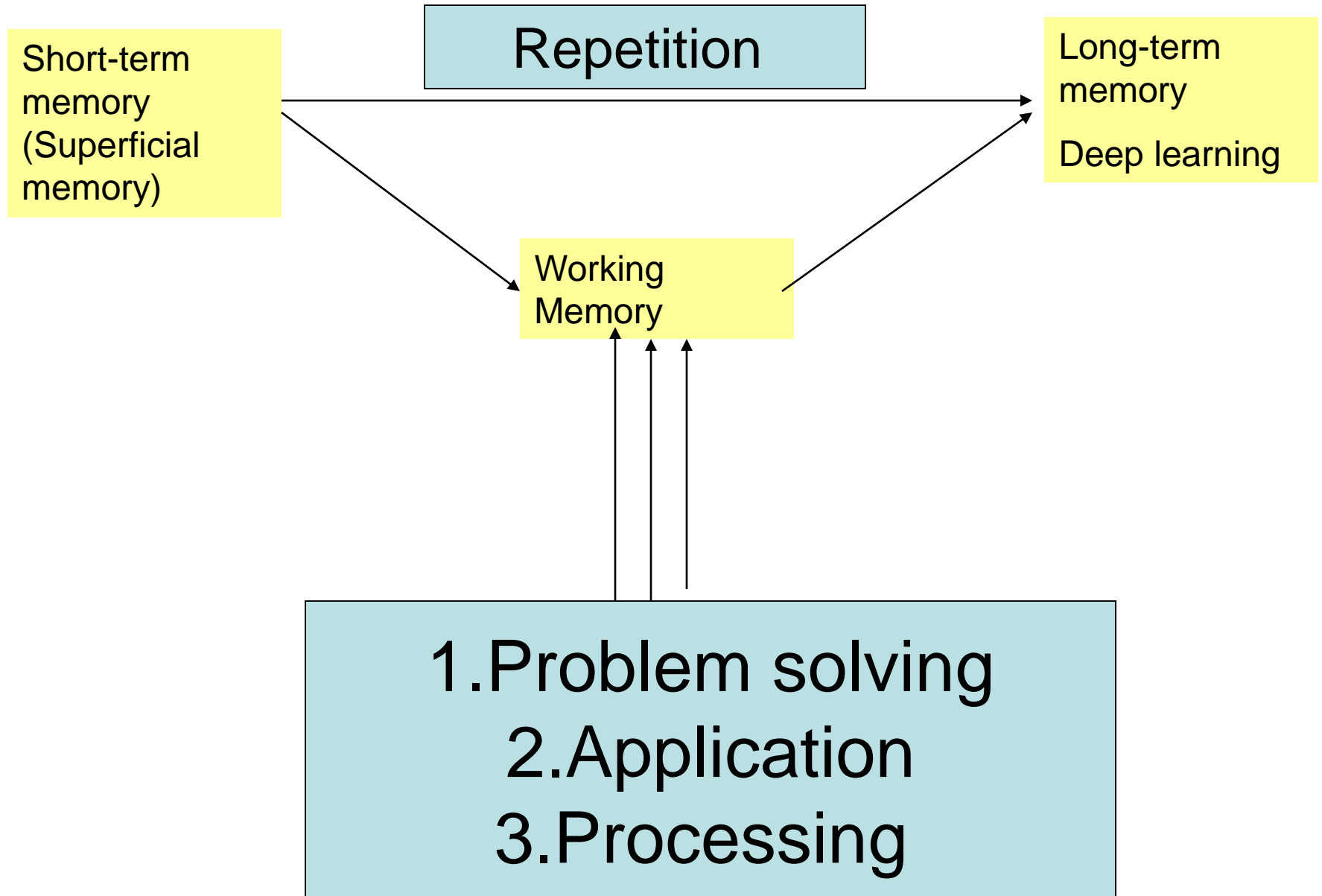
## Structural changes

1. ↑ no. of vesicle release sites for transmitter
2. ↑ no. of transmitter vesicles released
3. ↑ no. of pre-synaptic terminals
4. Changes in structure of dendrites for stronger signal transmission
5. ↑ no. of neurons (nerve growth factor)
6. Change in connections of neurons

# Mechanism of Memory And NMDA Receptors

- Current Hypothesis suggests that Memory Neurons have **NMDA (N methyl D-Aspartate)** receptors that act as Calcium Channels → **long term potentiation**- calcium accumulation in post synaptic neurons
- LTP causes enhancement in synaptic transmission of brain synapses especially hippocampus

# Short-term → Long-term Memory



# Memory

## Short/Intermediate term memory

- No change in protein synthesis and gene regulation
- Do not involve structural modifications

## Long term memory

- changes in protein synthesis and gene regulation
- involve structural modifications

# Inter-Cortical Transfer of Memory

Transferred and stored to opposite side

Anterior portion of corpus callosum

(via commissures)

# Consolidation of Memory

Short Term → Long Term

Chemical, Physical and Anatomical Changes in Synapses

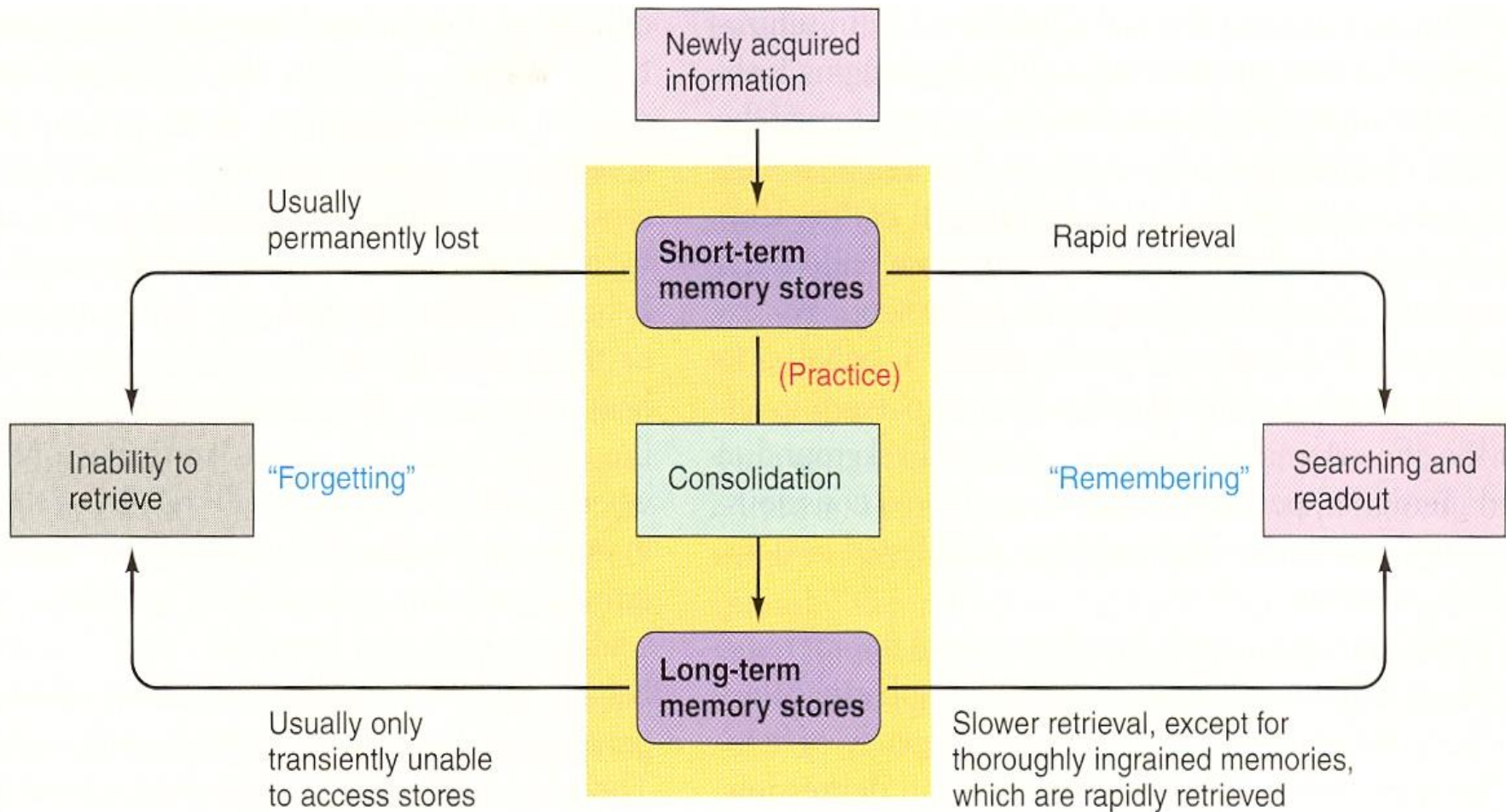
Minimal consolidation in → 5-10 minutes

Strong Consolidation in an hour or more

**A convulsion or anaesthesia can block consolidation**

Rehearsal Enhances transference of Short Term memory → Long Term Memory

# Memory storage and consolidation





# Codifying of New Memories

- Similarities and differences
- Stored with similar memories
- Easy to “Search”



**Repeat**  
what you  
**hear**  
out loud

**Divide**  
**information**  
**into**  
**chunks**

**Make**  
**associations**

**Make a**  
**note**

# Roles of Specific Parts of Brain

**Declarative memory:** Hippocampus

**Non-Declarative memory:** Hippocampus not involved; little or no role of consciousness or awareness

**Hippocampus:** Storage

**Thalamus:** Recall/ search memory stores

**Thalamus / limbic system** → Punishment and reward → output through hippocampus

# Disorders related to memory

1. Anterograde Amnesia
2. Retrograde Amnesia

# Anterograde Amnesia

**Unable to establish new long-term memories** of those types of information that are the basis of intelligence

i.e. verbal and symbolic memories are affected and not the reflexive memory & Skills

- **Hippocampal lesion**
- **Little effect on** stored memory and short term memory

# Retrograde Amnesia

## Inability to Recall Memories from recent Past

degree of amnesia for recent events is greater than for distant past

## Lesions of Thalamus (specific)

Hippocampal lesion → retro and anterograde amnesia

Progressive loss of short term memory

- ❖ starting at the age of 50-55
- ❖ degenerative disease
- ❖ premature aging of brain  
(Death in middle age, if occurs early)

# Skill learning or Reflexive learning

- People with Hippocampal lesions do not have problem learning physical skills ; hand and physical skills involved in sports
- Depends on physically repeating the task again and again

# New Brain Cells

Latest studies show that New Neurons form from stem cells in two areas

- Olfactory Bulb
- Hippocampus

This process is called **Neurogenesis**



# Improve Memory Improve health

- Give your brain a workout
- Don't skip the physical exercise
- Get proper sleep
- Make time for friends
- Keep stress in check
- Have a laugh
- Maintain a brain-boosting diet
- Identify and treat health problems

# Purpose of life



# MCQ 1

Declarative memory is also called

- A. Associative Memory
- B. Non-associative memory
- C. Recognition memory
- D. Reflexive memory
- E. Skill memory

# MCQ 2

Episodic memory is the memory of

- A. Events
- B. Habits
- C. Languages
- D. Rules
- E. Words

# MCQ 4

Classical conditioning is an example of:

- A. Semantic memory
- B. Episodic memory
- C. Implicit memory
- D. Declarative memory
- E. Non associative memory

# MCQ 3

A 50-year old patient with recent damage to the hippocampus from a stroke would likely have all of the following deficits EXCEPT:

- A. Difficulty remembering old facts
- B. Difficulty describing a recent event
- C. Difficulty learning a new vocabulary word
- D. Difficulty recalling a childhood memory
- E. Difficulty remembering a face

# References

- Guyton and Hall
- Sherwood Physiology
- <https://www.britannica.com/science/memory>

Thank You