



Brain Neurotransmitters



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- Important
- Further Explanation

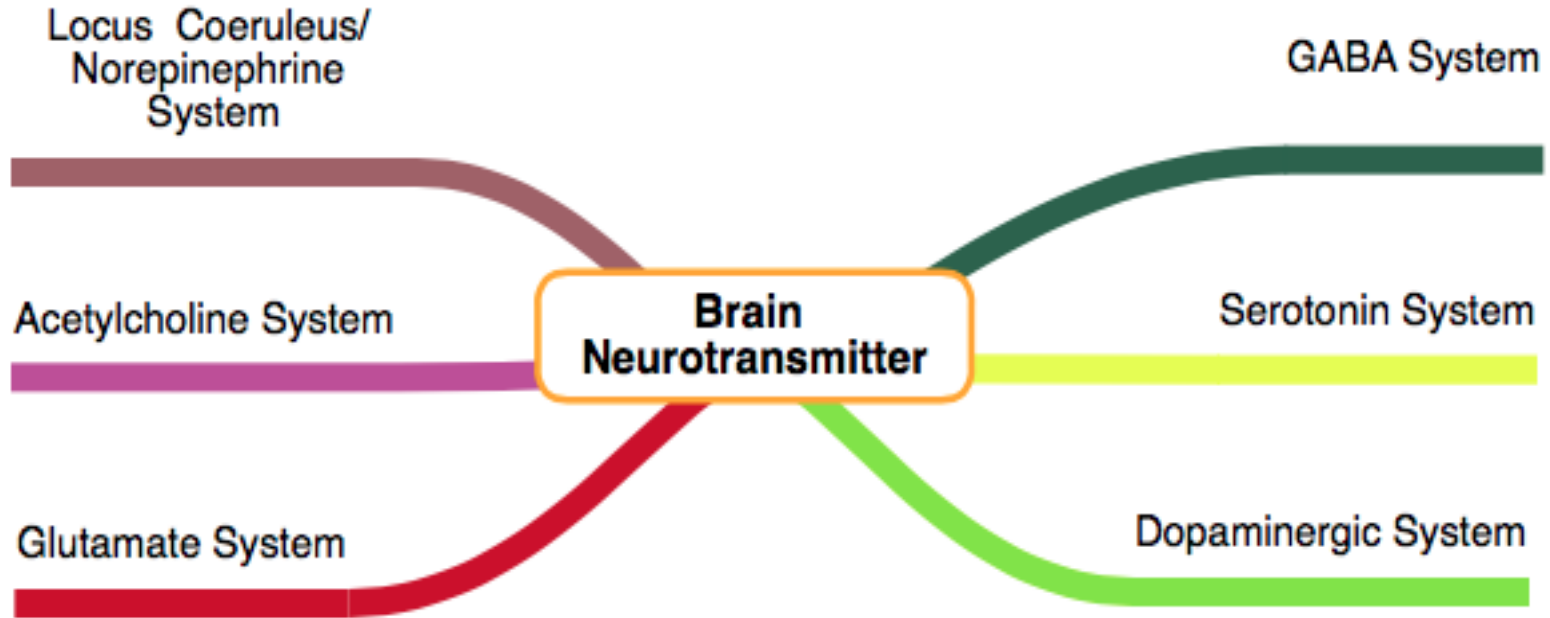
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Recommended Video!

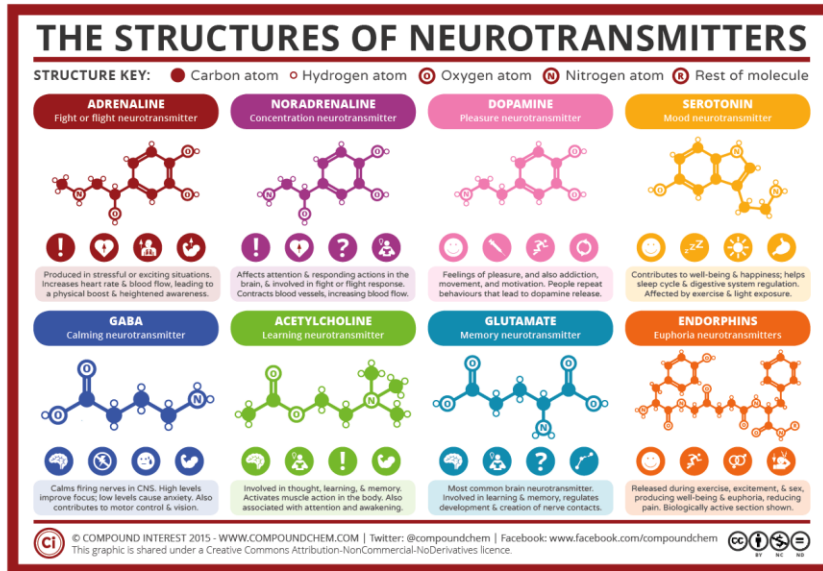


Please check out this link before viewing the file to know if there are any additions/changes or corrections. The same link will be used for all of our work [Physiology Edit](#)



Brain Neurotransmitters

- ❖ They are chemical substances that are released/excreted by electrical impulses into the synaptic cleft from synaptic vesicles of the presynaptic membrane.
- ❖ They then diffuse into the postsynaptic membrane where they bind to and activate the receptors present.
- ❖ This will either lead to an initiation of electrical signals or inhibition of the postsynaptic neuron.



Important Amines NT

Dopamine

Serotonin(5-HT)

Histamine

Epinephrine

ACh

Norepinephrine
(NE)

Important Amino acids NT

Glutamate

Glycine
"inhibitory"

GABA "inhibitory"

Aspartate

Important Soluble gases NT

Nitric oxide(NO)

Carbon monoxide
(CO)

Brain Neurotransmitters

The most important neurotransmitter's discussed and emphasized on are:

1. Adrenaline/NE;
2. ACh;
3. Glutamate;
4. GABA;
5. Serotonin;
6. Dopamine.

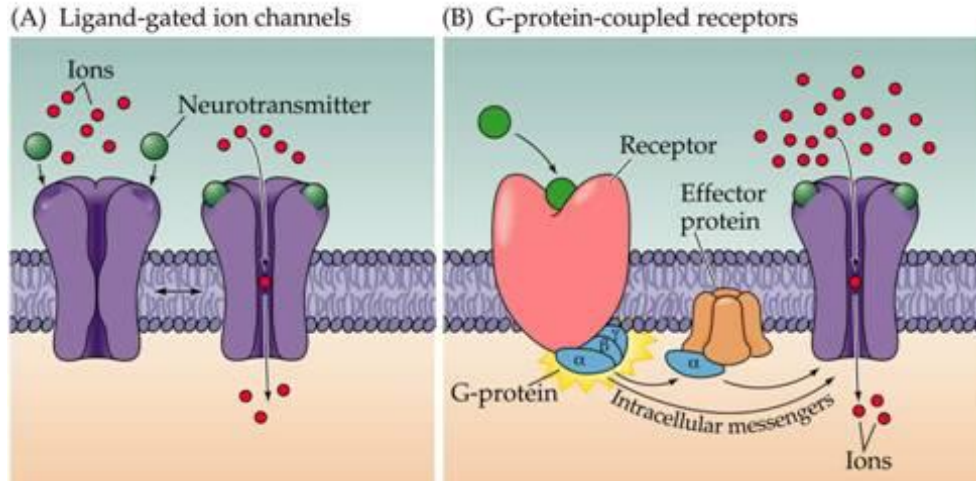
Types/classes of receptors:

❖ **Metabotropic receptors** (G-protein-coupled receptor):

trans membrane receptor that act through a secondary messenger.

❖ **Ionotropic receptors** (Ligand gated ion channels) :

ligand gated ion channel.



The Locus Coeruleus/Norepinephrine System

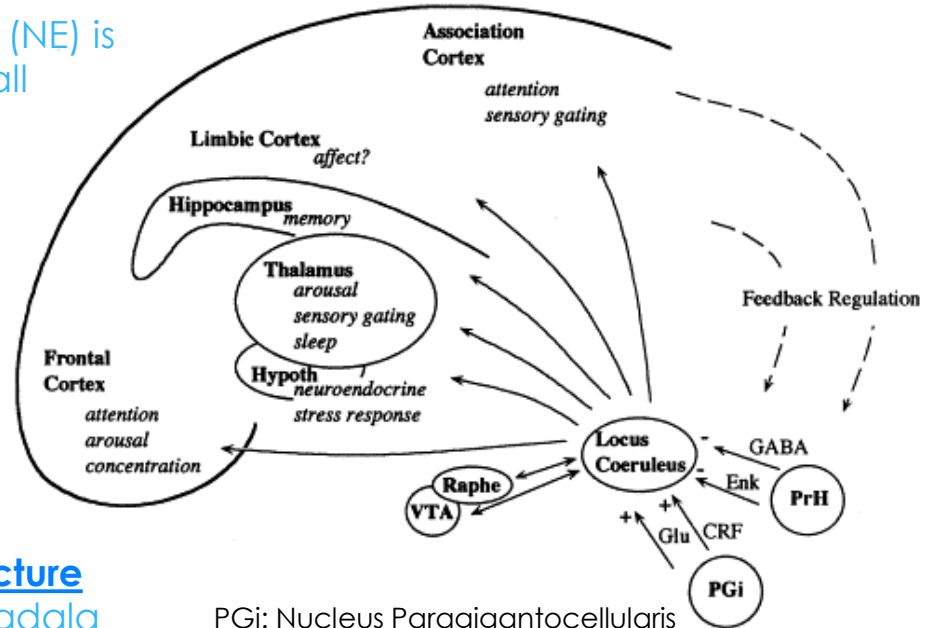
✧ **Locus coeruleus (LC):**
is the site at which norepinephrine (NE) is formed and distributed to almost all brain structures.

✧ **Activated during :**
✧ Vigilance, arousal and stress.

✧ **Unactivated during : (SEE the electrical discharge)**
✧ Decrease in Non-REM sleep (SWS)
✧ Absence in REM sleep

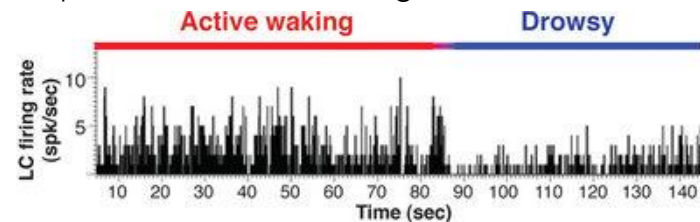
✧ **Projection to: (SEE the picture) [Another picture](#)**
✧ Thalamus , Cortex , hippocampus , Amygdala
Hypothalamus , autonomic brainstem centers ,
Spinal cord

✧ **Implicated in (Stress-related disorder)**
✧ Depression
✧ Withdrawal from some drugs of abuse
✧ panic disorder



PGi: Nucleus Paragigantocellularis
PrH: Perirhinal Cortex

Graph 1 – Electrical discharge of Locus Coeruleus



Acetylcholine System

- ✧ Major neurotransmitter in the **peripheral nervous system**.
- ✧ Produced and excreted by the neurons in the **parietal lobes** (basal forebrain and **ponto-mesencephalic cholinergic complex**) of the brain.
- ✧ **Association with:**
 - ✧ Thought.
 - ✧ Memory
 - ✧ Muscular coordination.
 - ✧ Speed of information processing in the brain.
 - ✧ Production of the myelin sheath.
- ✧ **Disorder of the ACH System include:**
 - ✧ Alzheimer's Disease is the most common form of dementia associated with ACH.
 - ✧ Mood swings.
 - ✧ Bipolar disorders.
 - ✧ Depression.

Glutamate System

✦ **Most commonly found** neurotransmitter in the brain.

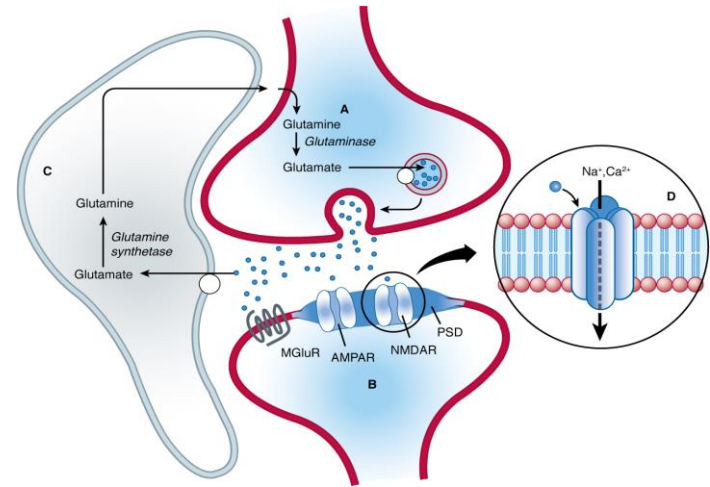
✦ Always excitatory.

✦ Its Formation:

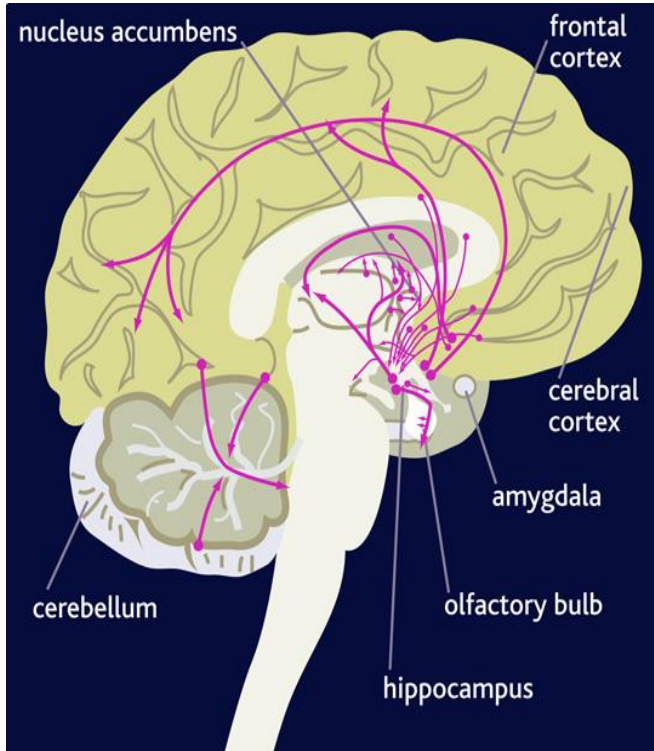
- ✦ It is formed by the Krebs's Cycle (alpha ketoregulation).
- ✦ Then Carried into astrocytes, converted to glutamine.
- ✦ Then passed onto glutaminergic neurons.

✦ Its Function:

- ✦ **In Learning and memory**



GABA (Gamma Aminobutyric Acid) System



- ✧ Considered the main **inhibitory neurotransmitter of the CNS** and is found in the **retina**.
- ✧ 50% of inhibitory synapses in the brain being GABA mediated (abundant).
- ✧ **Formed by decarboxylation of glutamate.**
- ✧ **Three types of GABA receptors:**
 - ✧ **GABA (A&B) receptors widely distributed in the CNS.**
 - ✧ GABA B receptor --> Metabotropic
 - ✧ **GABA (C) receptors.**
 - ✧ Are only found in the retina.

Serotonin System

✧ Its Location:

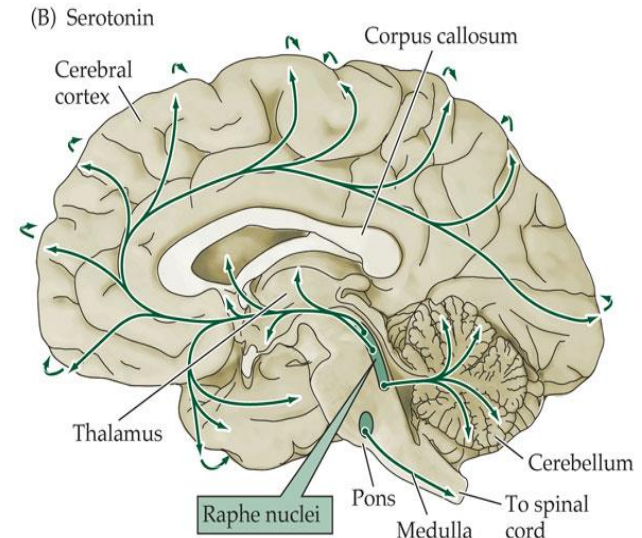
Serotonergic neurons are primarily centered in the rostral and caudal raphe nuclei.

✧ Its projection:

- ✧ Ascending to the cerebral cortex and limbic and basal ganglia.
- ✧ Descending axons and terminate in the medulla and spinal cord.

✧ Serotonin (5-HT) Disorders:

- ✧ Depression
- ✧ Anxiety



Dopaminergic System

✧ Transmitted via three major pathways:

✧ **FROM :**

Extends from the substantia nigra.

✧ **TO :**

the caudate nucleus-putamen (neostriatum)

✧ **Concerned with**

sensory stimuli and movement.

✧ **FROM :**

ventral tegmental area of the midbrain

TO :

the Mesolimbic forebrain (nucleus accumbens.)

✧ **Concerned with**

Cognitive and emotional behavior

✧ **FROM :**

Hypothalamus

TO :

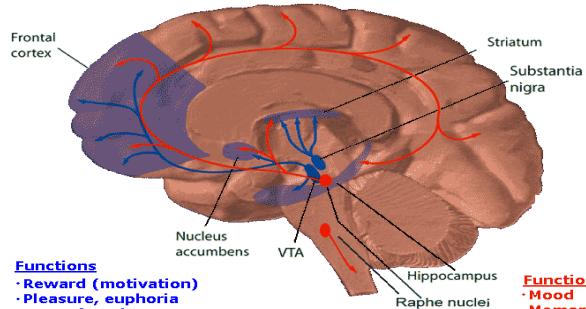
Pituitary gland

✧ **Concerned with**

influences the secretion of certain hormones, including prolactin

Dopamine Pathways

Serotonin Pathways



Functions

- Reward (motivation)
- Pleasure, euphoria
- Motor function (fine tuning)
- Compulsion
- Perseveration

Functions

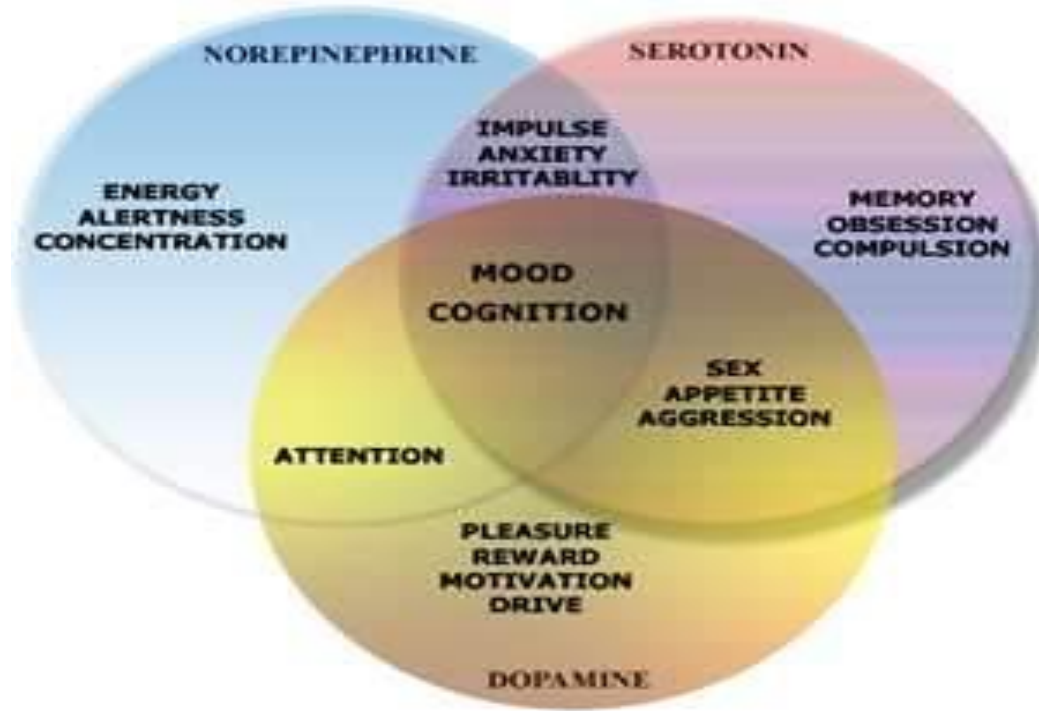
- Mood
- Memory processing
- Sleep
- Cognition

✧ Dopaminergic neurons disorders:

1. Schizophrenia
2. Parkinson's Disease

Brain Neurotransmitters

Different Neurotransmitters With Individual and Interconnected Sensations



Neurotransmitter	Postsynaptic effect	Derived from	Site of synthesis	Postsynaptic receptor	Fate	Functions
1. Acetylcholine (ACh)	Excitatory	Acetyl co-A + Choline	Cholinergic nerve endings	1. Nicotinic 2. Muscarinic	Broken by acetylcholinesterase	Cognitive functions e.g. memory Peripheral action e.g. cardiovascular system
2. Catecholamines i. Epinephrine (adrenaline)	Excitatory in some but inhibitory in other	Tyrosine from phenylalanine	Adrenal medulla and some CNS cells	Excites both α & β receptors	1. Catabolized to inactive product through COMT & MAO in liver 2. Reuptake into adrenergic nerve endings	ANS. e.g. fight or flight, on heart, BP, gastrointestinal activity etc.
ii. Norepinephrine	Excitatory	Tyrosine, found in pons. Reticular formation, locus coeruleus, thalamus, and mid-brain	Begins inside axoplasm of adrenergic nerve ending	α_1 α_2 β_1 β_2	3. Diffusion away from nerve endings to body fluid	Norepinephrine controls attention and arousal and sleep/wake cycle.

Neurotransmitter	Postsynaptic effect	Derived from	Site of synthesis	Postsynaptic receptor	Fate	Functions
iii. Dopamine	Excitatory	Tyrosine	CNS, concentrated in basal ganglia and dopamine pathways	D ₁ to D ₅ receptor	Same as above	<p>Decreased dopamine in Parkinson's disease.</p> <p>Increased dopamine concentration causes Schizophrenia</p>
3. Serotonin (5HT)	Excitatory	Tryptophan	<ol style="list-style-type: none"> 1. CNS, 2. Gut (chromaffin cells) 3. Platelets 4. retina 	5-HT ₁ to 5-HT ₇ 5-HT _{2A} receptor mediate platelet aggregation and smooth muscle contraction	Inactivated by MAO to form 5-hydroxyindoleacetic acid (5-HIAA) in pineal body it is converted to melatonin	<ol style="list-style-type: none"> 1. Mood control 2. sleep 3. pain sensation 4. temperature, 5. BP, and hormonal activity

Neurotransmitter	Postsynaptic effect	Derived from	Site of synthesis	Postsynaptic receptor	Fate	Functions
4. Glutamate	Excitatory 75% of excitatory transmission in the brain	By reductive amination of Krebs's cycle intermediate α -ketoglutarate	Brain and spinal cord	e.g. NMDA, AMPA and kainate receptors	It is cleared from the brain ECF by Na^+ dependent uptake system in neurons and neuroglia	Long term potentiation involved in memory and learning by causing Ca^{++} influx.
5. Gamma amino butyric acid (GABA)	Major inhibitory mediator	Decarboxylation of glutamate by glutamate decarboxylase (GAD) in GABAergic neuron	CNS	<ul style="list-style-type: none"> ✧ GABA A increase Cl^- conductance. ✧ GABA - B is metabotropic works with G - protein GABA transaminase catalyzes ✧ GABA - C found exclusively in the retina 	Metabolized by transamination to succinate in the citric acid cycle	GABA - A causes hyperpolarization (inhibition) Anxiolytic drugs like benzodiazepine cause increase in Cl^- entry into the cell & cause soothing effects. GABA - B cause increase conductance of K^+ into the cell

1- LC is activated during:

- A. Stress
- B. Sleep
- C. Attention/vigilance
- D. All the above

2- Irregular firing of LC neurons occurs during :

- A. Vigilance and arousal
- B. Stress
- C. Sleep
- D. Quite wakefulness

3- Which is the most commonly found NT:

- A. Glutamate
- B. Serotonin
- C. Dopamine
- D. Acetylcholine

4- Which disorder is associated with acetylcholine:

- A. Schizophrenia
- B. Anxiety
- C. Alzheimer's disease
- D. Parkinson's disease

5- Which type of GABA receptors is only found in the retina?

- A. GABA A
- B. GABA B
- C. GABA C
- D. All the above

6-Which NT is responsible for schizophrenia?

- A. Dopamine
- B. Serotonin
- C. Acetylcholine
- D. Norepinephrine

- 1. A
- 2. D
- 3. A
- 4. C
- 5. C
- 6. A

1- Why is the electrical discharge of locus coeruleus different during awakening and drowsiness?

Because the electrical discharge of LC is proportional to the amount of effort/attention exerted.

2- List two dopaminergic disorders:
Schizophrenia and Parkinson's Disease

3-List three dopaminergic functions:
Reward, motor function and pleasure/euphoria.

4- List three acetylcholine disorders:
Alzheimer's disease, bipolar disorder and mood swings.

THANK YOU FOR CHECKING OUR WORK!

BEST OF LUCK

Done By:

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- ✧ Moath aleisa

