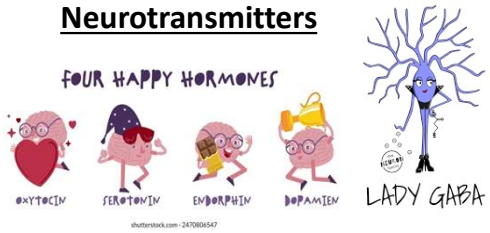
1

Special Senses Module

2nd Year MBBS(SGD)

Neurotransmitters



Presenter: Sana Latif
(Senior Demonstrator)

Updated Date: 26-02-25

2

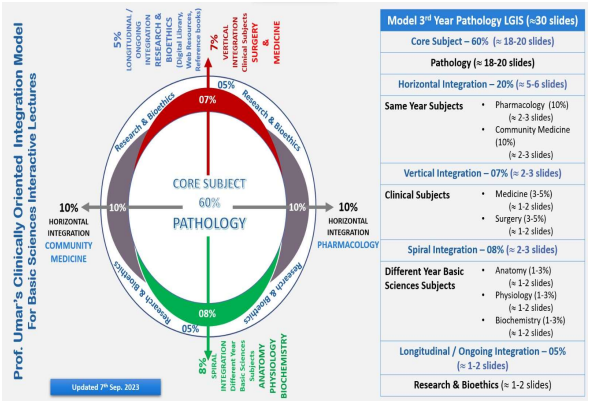
Motto, Vision, Dream

- To impart evidence based research oriented medical education
- To provide best possible patient care
- To inculcate the values of mutual respect and ethical practice of medicine

3

3

Professor Umar Model of Integrated Lecture



4

4

Learning Objectives

At the end of the SGD, students will be able to

1. Define & Classify Neurotransmitters
2. Discuss the Synthesis and Metabolism of Neurotransmitters
3. Explain diseases related to common neurotransmitters

5

5

SGD-MCQ Assessment

1. **The primary excitatory neurotransmitter in the CNS is:**
   A. GABA
   B. Serotonin
   C. Dopamine
   D. Acetylcholine
   E. Glutamate
2. **GABA is synthesized from which of the following amino acids?**
   A. Tyrosine
   B. Glycine
   C. Aspartate
   D. Glutamate
   E. Serine
3. **Dopamine is derived from:**
   A. Methionine
   B. Tryptophan
   C. Arginine
   D. Tyrosine
   E. Leucine
4. **The enzyme responsible for degradation of acetylcholine in the synaptic cleft is:**
   A. Monoamine oxidase
   B. Choline acetyltransferase
   C. Acetylcholinesterase
   D. Catechol-O-methyltransferase
   E. Glutaminase

6

6

SGD-MCQ Assessment

5. **Serotonin is synthesized from:**
   A. Phenylalanine
   B. Tyrosine
   C. Tryptophan
   D. Histidine
   E. Proline
6. **Which of the following neurotransmitters is mainly inhibitory in the spinal cord?**
   A. Glutamate
   B. Glycine
   C. Acetylcholine
   D. Serotonin
   E. Norepinephrine
7. **A deficiency of dopamine is most commonly associated with:**
   A. Huntington disease
   B. Myasthenia gravis
   C. Parkinson's disease
   D. Alzheimer's disease
   E. Multiple sclerosis
8. **Catecholamines include all of the following EXCEPT:**
   A. Epinephrine
   B. Dopamine
   C. Serotonin
   D. Norepinephrine
   E. All derived from tyrosine

7

7

SGD-MCQ Assessment

9. **Which neurotransmitter is found in the neuromuscular junction?**
   A. Acetylcholine
   B. GABA
   C. Dopamine
   D. Histamine
   E. Glutamate

- **In the synthesis of catecholamines, which enzyme converts dopamine to norepinephrine?**
  A. Tyrosine hydroxylase
  B. Catechol-O-methyltransferase
  C. DOPA decarboxylase
  D. Monoamine oxidase
  E. Dopamine β-hydroxylase

8

8

Key

1. E
2. D
3. D
4. C
5. C
6. B
7. C
8. C
9. A
10. E

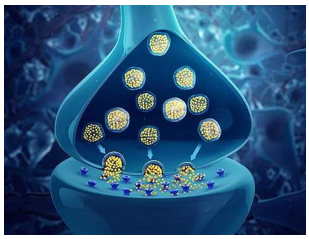
9

9

Core Knowledge

Neurotransmitters

Chemical messengers within the body which transmit cellular signals from neurons to various target cells in muscles, glands, or other nerves.



10

10

Core Knowledge

Classification of Neurotransmitters

Neurotansmitters can be classified on the basis of:

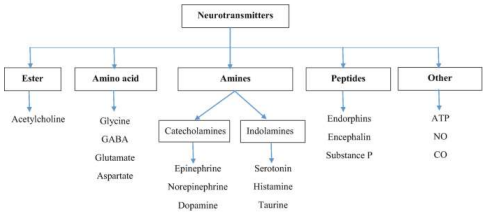
1. Chemical Structure
2. Effect on Post synaptic Cell

11

11

Core Knowledge

Chemical Classification of Neurotransmitters

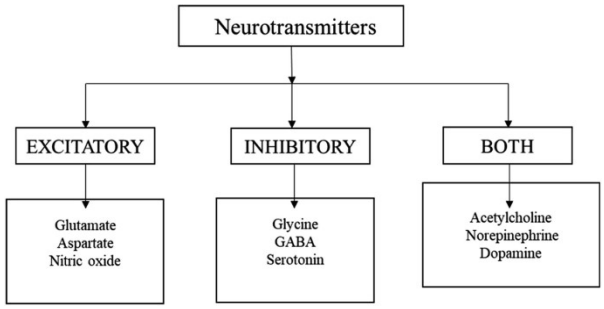


12

12

Core Knowledge

Post Synaptic Effect Classification of Neurotransmitters



13

13

Esters

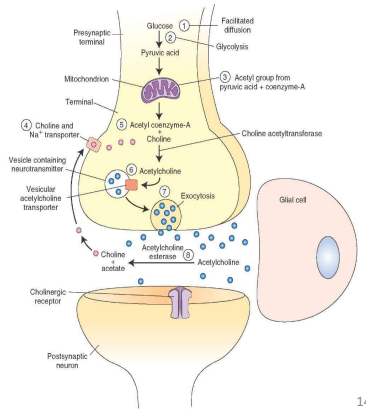
Acetylcholine

Precursor: Choline and Acetyl Co-A

Site: Nerve terminals

Degradation:

In the Synaptic Cleft by Acetyl Cholinesterase.



14

14

Core Knowledge

Monoamines

1. Catecholamines
2. Imidazolamines
3. Indolamines

Metabolised by Monoamine Oxidase Enzyme.

15

15

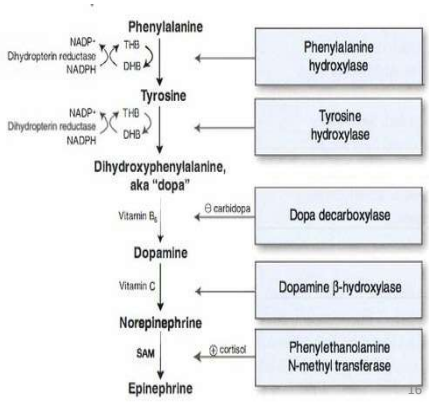
Core Knowledge

Catecholamines

1. **Dopamine**
2. **Nor-epinephrine**

• **Precursor**: Tyrosine

• **Site:** Brain



16

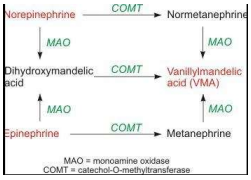
16

Core Knowledge

Catecholamines

Degradation:

- Inactivation: Oxidative deamination by monoamine oxidase (MAO) and,
- O-methylation by catechol-O methyltransferase(COMT) using SAM as the methyl donor.
- The major end product of epinephrine and norepinephrine is Vanillyl Mandelic Acid(VMA).
- Normal level of VMA excretion in urine is 2-4mg/2h hour.
- The major end product of Dopamine is Homo Vanillic Acid (HVA)



17

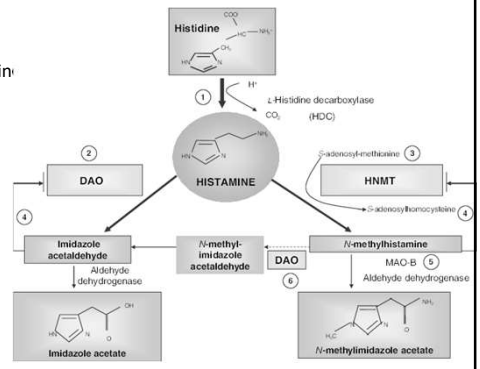
17

Core Knowledge

Imidazolamines

Histamine

- **Precursor**: Histidin
- **Site:**
  Mast Cells



18

18

Core Knowledge

Indolamines

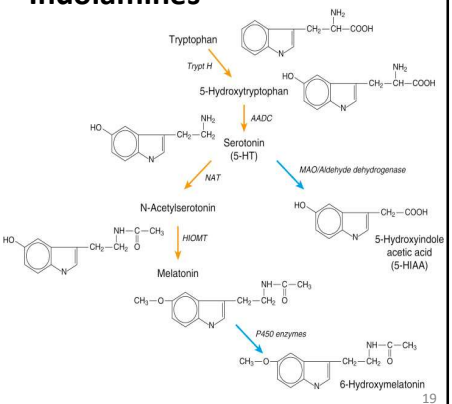
Serotonin

- **Precursor:**
  Tryptophan
- **Site:**

Throughout the body

- **Degradation:**

by MAO to 5-hydroxy-3 indoleacetic acid (5-HIAA)



19

19

Core Knowledge

Amino Acids

1. GABA
2. Glutamate

20

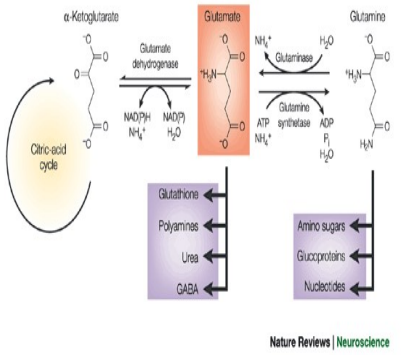
20

Core Knowledge

Amino Acids

Glutamate

- A Non-Essential Amino Acid.
- Biosynthesis can occur throughout the body involving the reactions as shown.



21

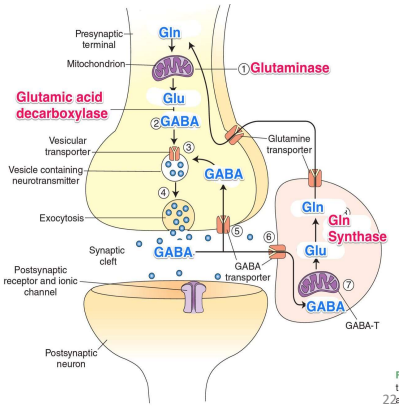
21

Core Knowledge

Amino Acids

GABA

- **Precursor:** Glutamate
- **Site**: GABAergic Neurons



22

22

Core Knowledge

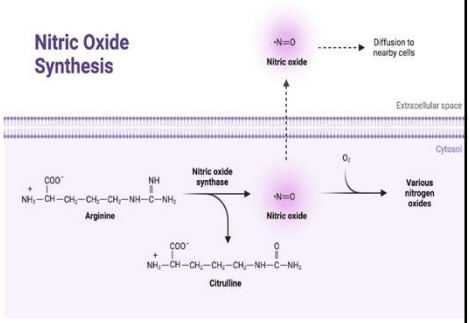
Nitric Oxide

Precursor: Arginine

Site: Cytosol

Function:

Affects other NTs such as on GABA for anti-anxiety and on Nor-Epinephrine release to inhibit pain.

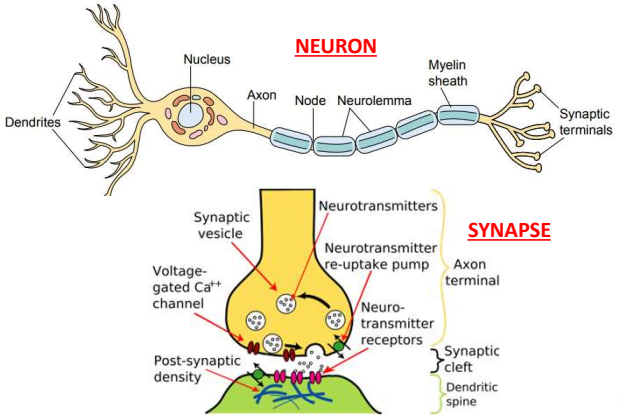


23

23

Horizontal Integration

Anatomy of The Neuron



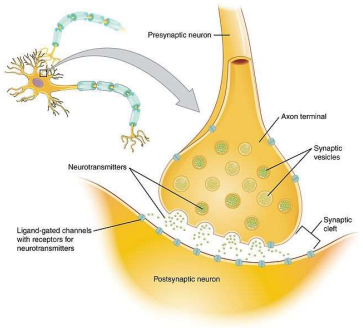
24

24

Horizontal Integration

Histology of the Synaptic Cleft

- A synapse is the site of communication between a neuron and its target cell.
- The term *presynaptic cell/neuron* refers to the neuron sending the signal, while
- The term *postsynaptic cell/neuron* refers to the target cell receiving the signal.
- Presynaptic cells communicate with postsynaptic cells by releasing neurotransmitters across a synapse through a process known as Synaptic Transmission.



25

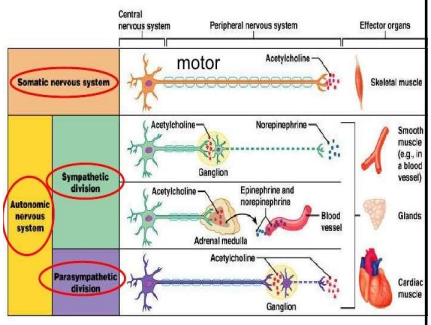
25

Horizontal Integration

Physiology Of The Neurotransmitters

The nervous system uses neurotransmitters to help control a wide range of bodily functions, including:

- Breathing
- Heartbeat and blood pressure
- Muscle movement/coordination
- Hormone regulation
- Digestion
- Sensation/Perception
- Sleep

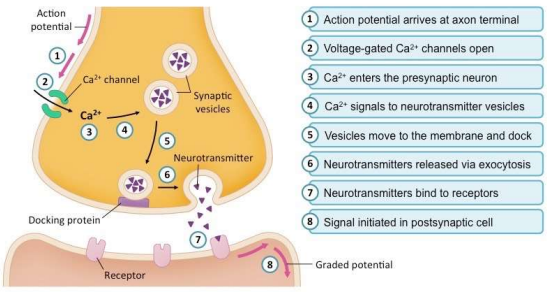


26

26

Horizontal Integration

Physiology Of The Neurotransmitters



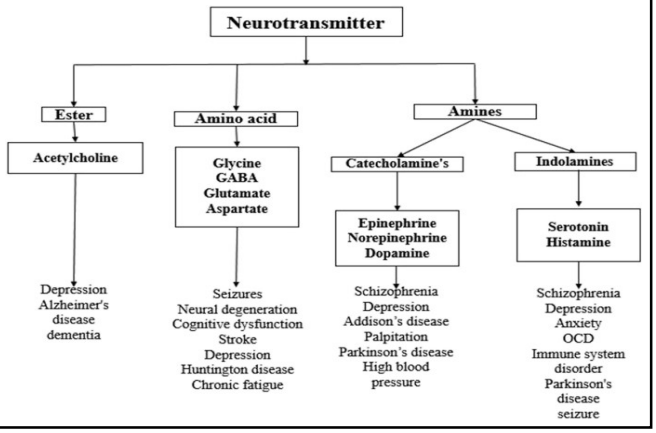
1. Action potential arrives at axon terminal
2. Voltage-gated Ca^{2+} channels open
3. Ca^{2+} enters the presynaptic neuron
4. Ca^{2+} signals to neurotransmitter vesicles
5. Vesicles move to the membrane and dock
6. Neurotransmitters released via exocytosis
7. Neurotransmitters bind to receptors
8. Signal initiated in postsynaptic cell

27

27

Vertical Integration

Clinical Disorders related to NTs



28

Spiral Integration Family Medicine

Management of NT Related Disorders

Family Medicine plays important role in following manner:

- Diagnosis through medical history ,physical examination and laboratory tests
- Education and counselling of patient and family
- Refer to Specialists
- Monitoring and follow-up

29

29

Spiral Integration Family Medicine

Role of AI in Management

Artificial Intelligence plays role in following aspects:

- Personalized Nutrition
- Diagnostic Tools
- Food Recommendations
- Drug Development

30

30

Spiral Integration Research Article

Effects Of Sleep Deprivation On Typical Neurotransmitters

Xuanyi Wang

E3S Web of Conf.
Volume 553, 2024
2024 International Conference on Ecological Protection and Environmental Chemistry (EPEC 2024)

Abstract:

Several evidence suggests that sleep deprivation (SD) leads to significant changes in the function of neurotransmitter receptors in different nerve cell types. So far, research in this area has focused on brain regions that promote wakefulness and sleep and the hippocampus, which is involved in learning and memory. When wakefulness is longer than the natural duration, there are some selective disruptions in the brain's sensory processing and cognitive performance.The author of this article discusses sleep deprivation and brain self-clearance patterns, and then explores the relationship between three typical neurotransmitters and sleep deprivation, as well as the detection and change trends of neurotransmitters and their metabolites.It can then be used to assist in the early diagnosis of certain diseases.Of the three neurotransmitters, two can be defined as pleasure neurotransmitters and one is associated with the degenerative neurological disease AD(Alzheimer's disease). The author also found that there are different response patterns between these neurotransmitters and SD.

https://www.e3s-conferences.org/articles/e3sconf/abs/2024/83/e3sconf_epec2024_05041/e3sconf_epec2024_05041.html

31

31

Spiral Integration Bioethics

Ethical Consideration

- Informed Consent
- Health care must allocate sources fairly, transparently and equitably
- Maintaining patient's confidentiality
- Research ethics

Spiral Integration 32

32

How to use HEC Digital Library

Steps to Access HEC Digital Library

1. Go to the website of HEC National Digital Library
   http://www.digitallibrary.edu.pk
2. On Home Page, click on the INSTITUTES.
3. A page will appear showing the universities from Public and Private Sector and other Institutes which have access to HEC National Digital Library (HNDL).
4. Select your desired Institute.
5. A page will appear showing the resources of the institution
6. Journals and Researches will appear
7. You can find a Journal by clicking on JOURNALS AND DATABASE and enter a keyword to search for your desired journal.

33

Learning Resources

- Text Book of Biochemistry Lippincott 8th Edition chapter 13, 19, 21
- Google images
- Google scholar

34

34

35

35