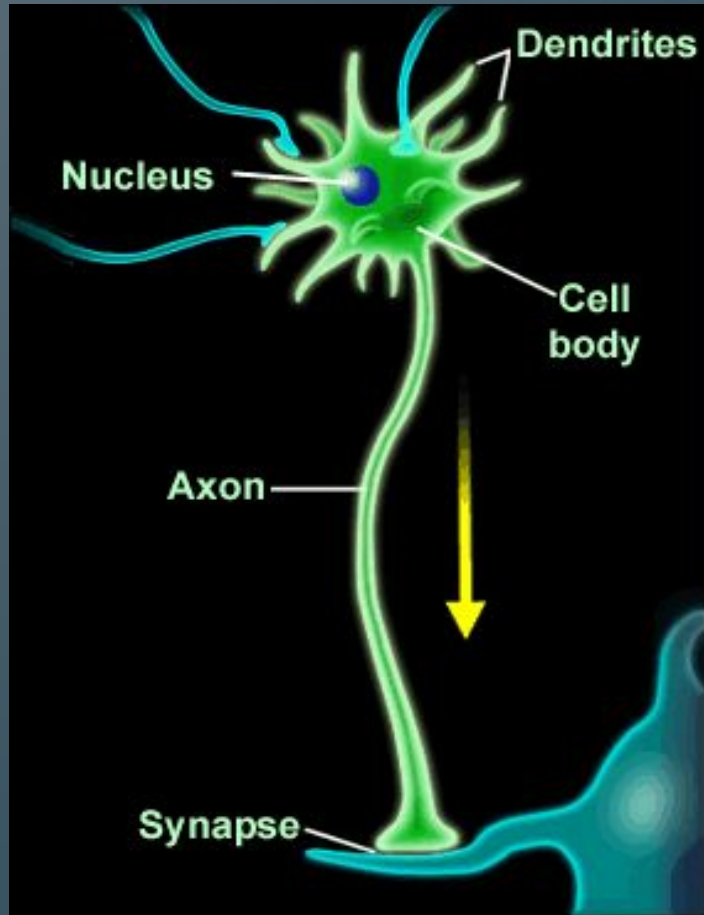


# Neurotransmitter :types &life cycle

*By  
Dr. Faten Allyan*

نقل الرسائل من خلايا NT

# Neurons

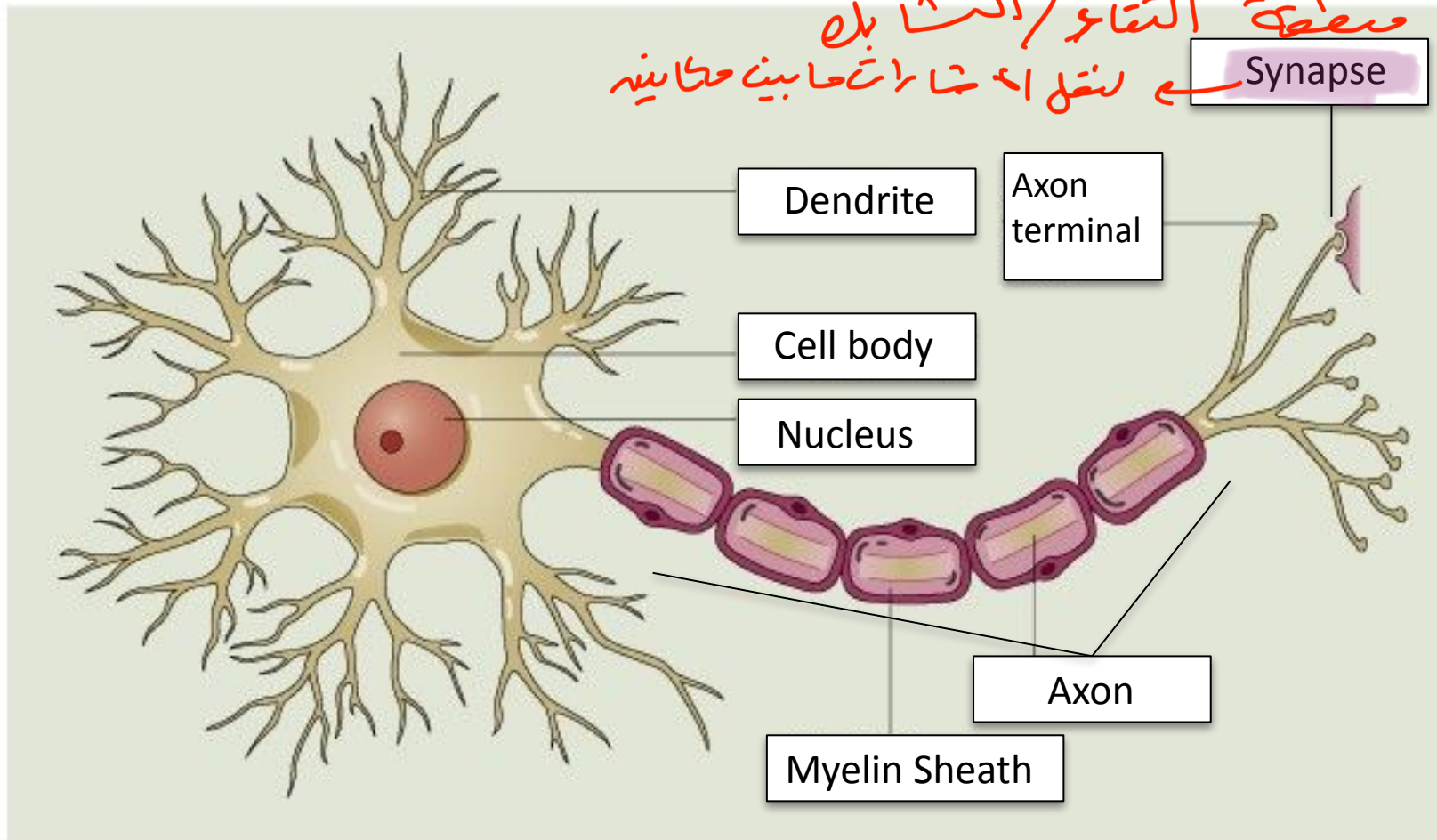


Cells in the brain  
that carry  
messages through  
signals to other  
parts of the brain.

by the  
neurotransmitter  
↓  
depend on the  
message, signal

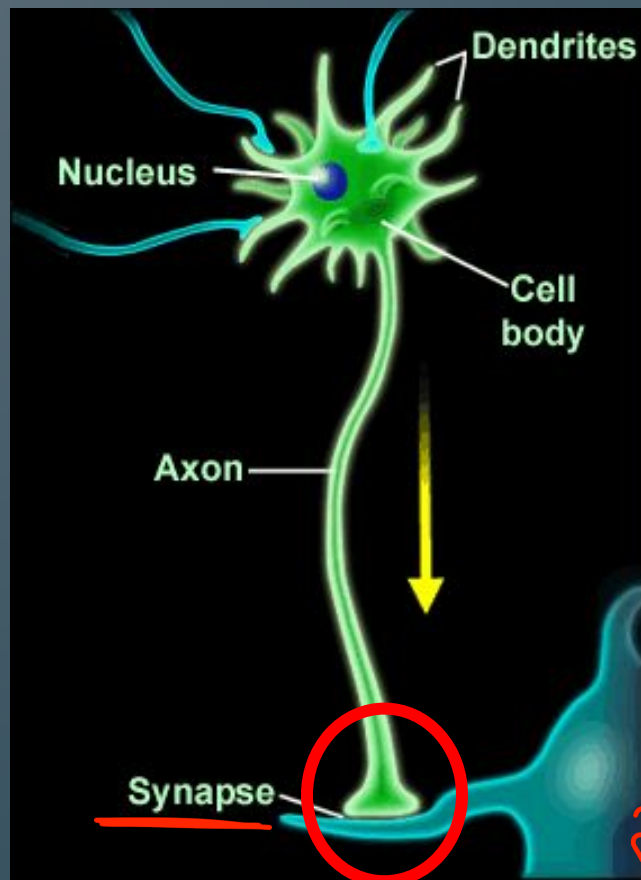
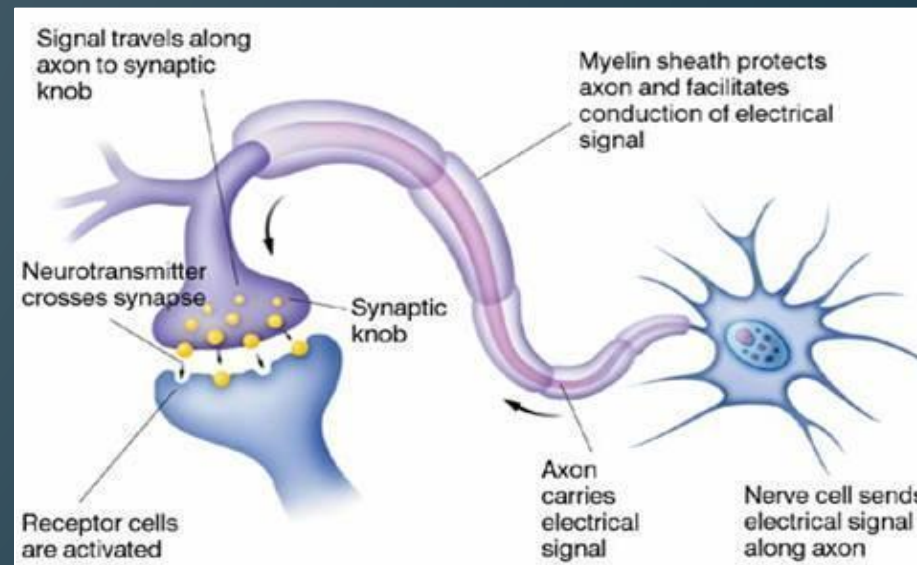
# NEURON ACTIVITY

1. Label the parts of the neuron.



# How does the brain work?

## Synapses!



## Connections between neurons

Dendrites = Take in information ✓  
Axon = Send out information ✓  
↳ to the synapse.

المخبرية في  
التأليف

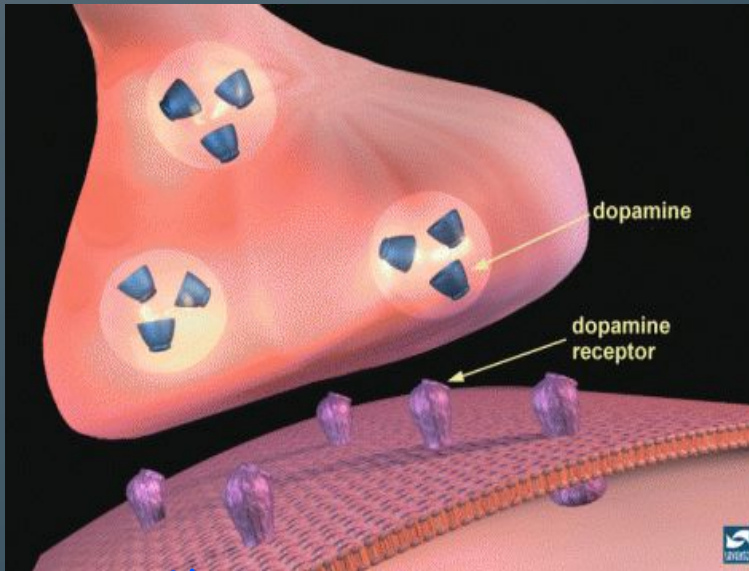


# Let's go deeper...

كوسرات الجيم جارة ن

synaps. ← رسالة و communication

## What's happening at a synapse?



- Chemical release from one <sup>first</sup> neuron to another

- Packages of chemicals (vesicles of neurotransmitters) are released from one neuron

so the vesicle release the NT and reach to the synaps cleft

- Another neuron receives the chemicals (receptors)

↓  
to reach the post synaps

\* pre synaptic has vesicle inside it there is NT  
depolarization → release the NT to synaptic cleft → post synaptic

## Neurotransmission

کسی یقین لازم تعلیم سے مناسب  
حسب ار N.T [signal]

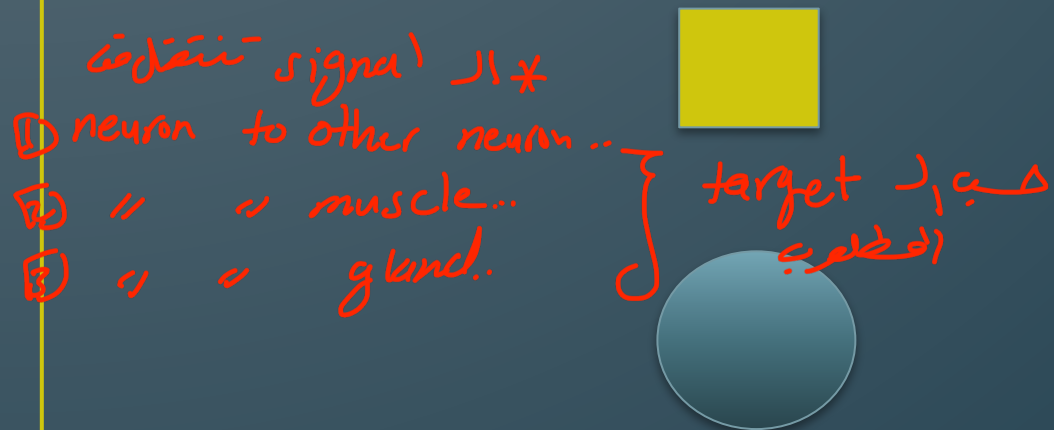
# Neurotransmission

## Neuron 1 NEUROTRANSMITTERS

- N.T
- Chemicals in vesicles that get released
  - Examples: dopamine, serotonin

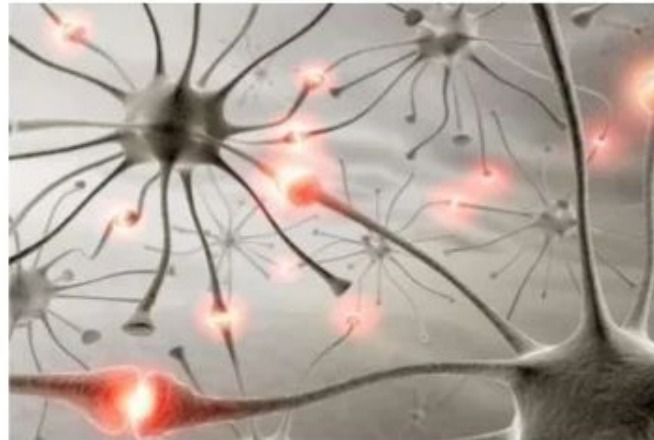
## Neuron 2 RECEPTORS

- Receivers for specific chemicals
- Examples: dopamine receptor, serotonin receptor



# INTRODUCTION

- Neurotransmitters <sup>in presynaptic</sup> are chemical messengers that transmit signals from a neuron to a target cell across a synapse. <sup>rapid, in the synaptic vesicle in presynaptic</sup>
- Target cell may be a neuron or some other kind of cell like a muscle or gland cell.
- Necessary for rapid communication in synapse.
- Neurotransmitters are packaged into **synaptic vesicles** - presynaptic side of a synapse.





# What is a neurotransmitter?

↳ produced by enzymatic process forming the chemicals. EN.TJ

- A chemical substance that:

- Is synthesized and stored in a presynaptic neuron (the enzymes needed for its synthesis must be present in the neuron),
- Is released at a synapse following **depolarization** of the nerve terminal (usually ~~dependent~~ on influx of calcium ions), "Na ions to the neurons" entry of positive charge of ions
- binds to receptors on the postsynaptic cell and/or presynaptic terminal,
- elicits rapid-onset and rapidly reversible responses in the target cell,
- Is removed or inactivated from the synaptic cleft.

synapse, used here → ↑ Na<sup>+</sup>, Ca<sup>2+</sup>

\* hyper polarization → -ve ↓ Cl<sup>-</sup>, +ve ↓ K<sup>+</sup> happen in the synaptic cleft.  
depolarization → +ve ↑ Na<sup>+</sup>, Ca<sup>2+</sup>

معلومات

heart + beat  
lung to breath  
stomach to digest

- They are chemicals that communicate information throughout our brain and body.
- The brain uses neurotransmitters to tell your heart to beat, your lungs to breathe, and your stomach to digest.
- They can also affect mood, sleep, concentration, weight, and can cause adverse symptoms when they are out of balance. stress, appetite ...etc

\* پریشان حال سے ہم فلان زلزلہ serotonin بیا نکلا کثیر و بکثرت بیزید و زلزلہ  
due to the depression !!

لے بیاروں خفیفہ جبرامہ کر



we should change our life style...

نستغزها جبراً - bad life style

- Neurotransmitter levels can be depleted many ways.
- Stress, <sup>nutrition</sup> poor diet, neurotoxins, genetic predisposition, <sup>تلاعبة</sup> drug (prescription and recreational), alcohol and caffeine usage can cause these levels to be out of optimal range.

\* trace element  
معدن خفيفة  
الكمية

|                   |             |
|-------------------|-------------|
| → fluid           | electrolyte |
| → magnesium       |             |
| → potassium       |             |
| → Na <sup>+</sup> |             |
| → zinc            |             |

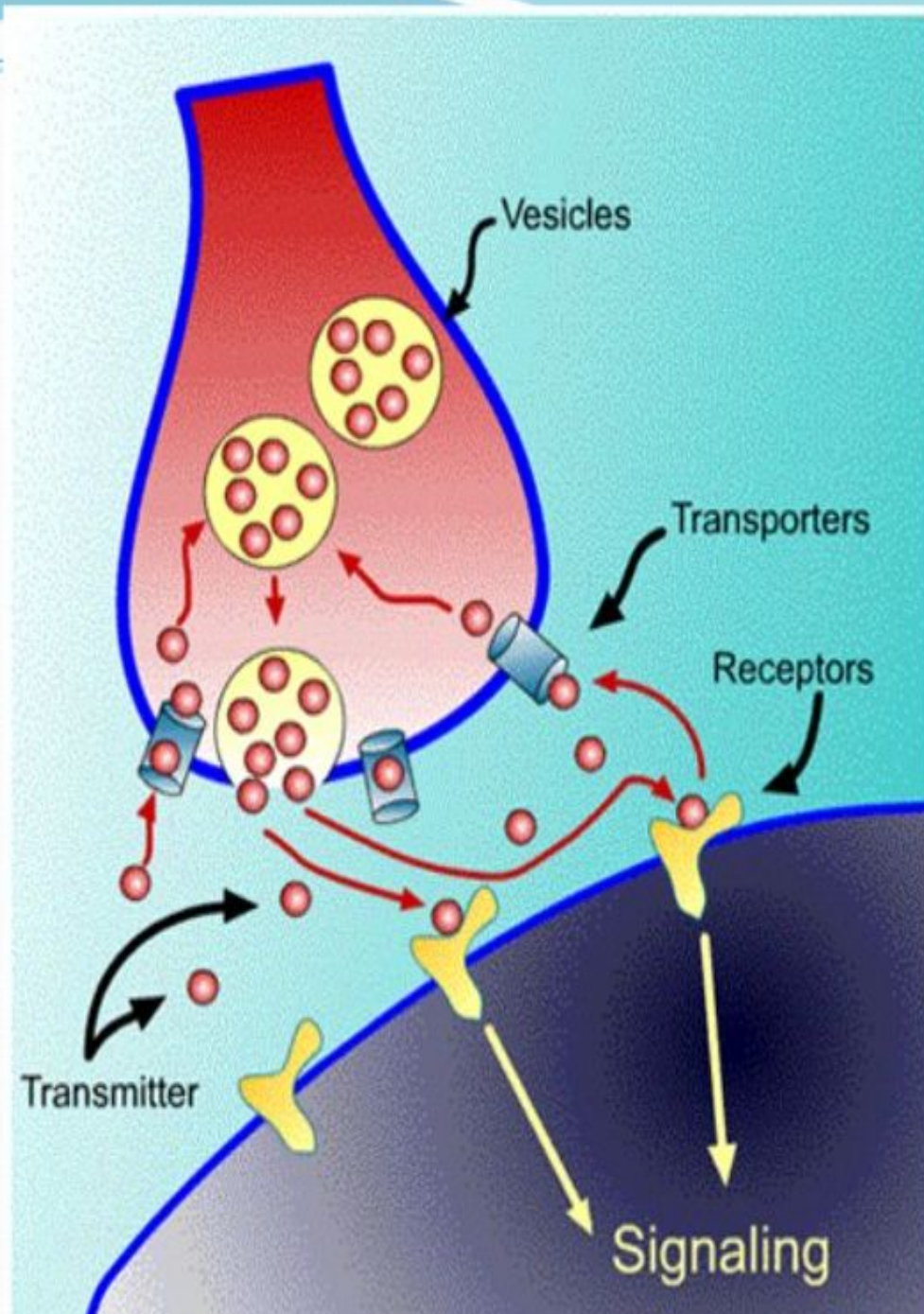
to the N.T

dark chocolate ←  
تزيد سيريونين  
mood.  
يضع متنازها



- The neurotransmitters are stored in tiny sac-like structures called vesicles at the end of axons. When an impulse, or nerve signal, reaches the end of the axon, the vesicles release a neurotransmitter into the small space between the adjoining cells (synaptic gap<sup>cleft</sup>).

\* يجب توازن العناصر لكي ن.ت حتى يتم القيام بالوظيفة..



\* لا ضيق الإحراز (إستوميل) للعصب شفاك ← lead to over reaction of the N.T and may lead to adverse reaction.

to degrade the N.T

- Enzymes concerned with the synthesis of neurotransmitters are present both in the cell body and in the nerve ending.
- A portion of neurotransmitter is produced in the cell body and transported to the nerve ending.



# Synapses 2 type

- Junction between two presynaptic and postsynaptic neurons
- There are two types of Synapse:

there is no vesicles

- 1. **Electrical Synapses** : Two neurons connected by gap junctions

\* يتم الاتصال بين الخلايا بواسطة [AP] cells  
↪ 2 way . [pre → post / post → pre]

- 2. **Chemical Synapses** : Chemical messenger is transmitted across the junction separating the two neurons

وفقا لاختصاصه  
in ACh 2 way...

\* يتم الاتصال بين الخلايا بواسطة NT (neurotransmitter) vesicle.  
↪ in one side from presynaptic to post synaptic..  
↪ more sensitive to the drug..



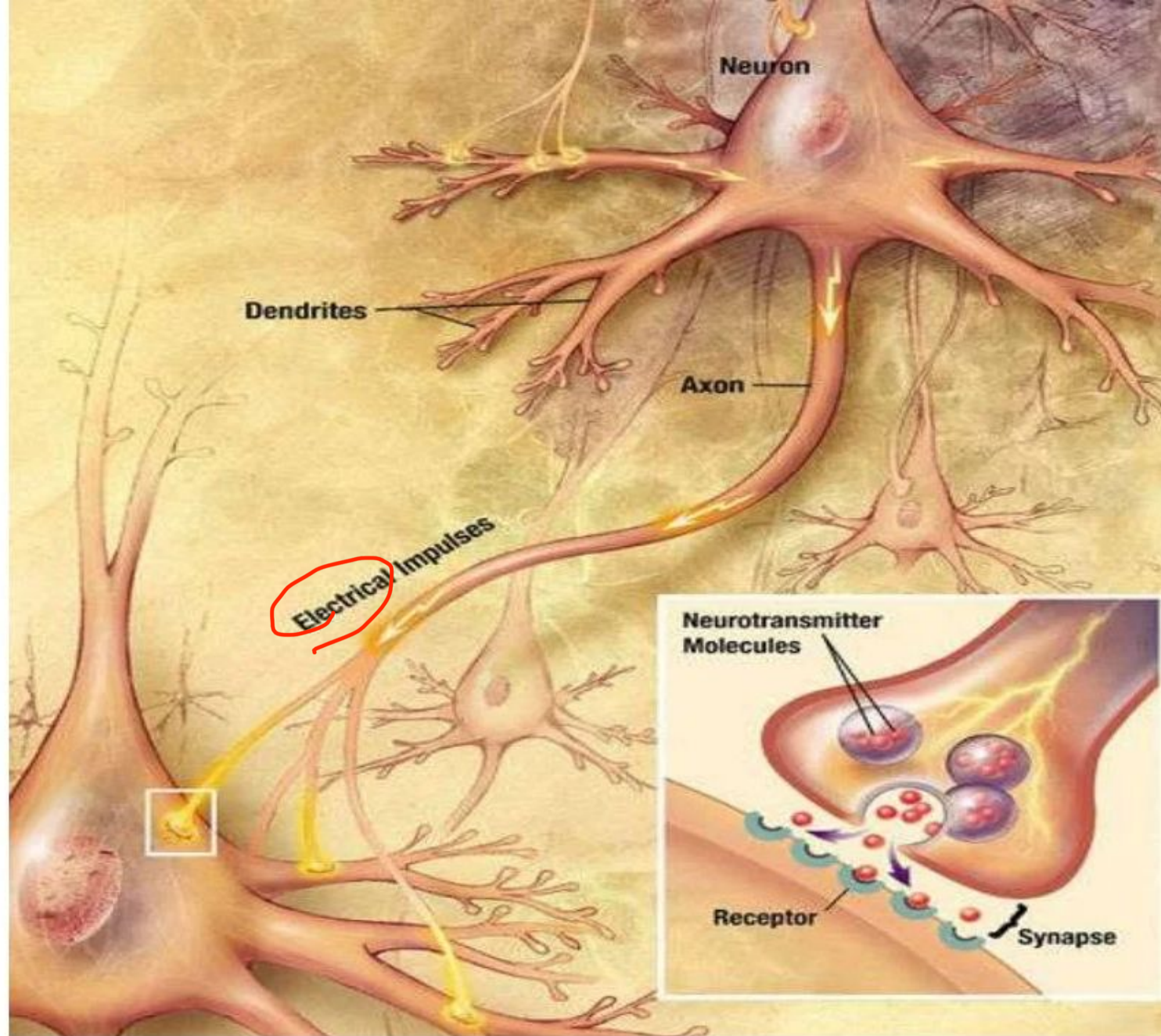


Illustration of the major elements in chemical synaptic transmission.

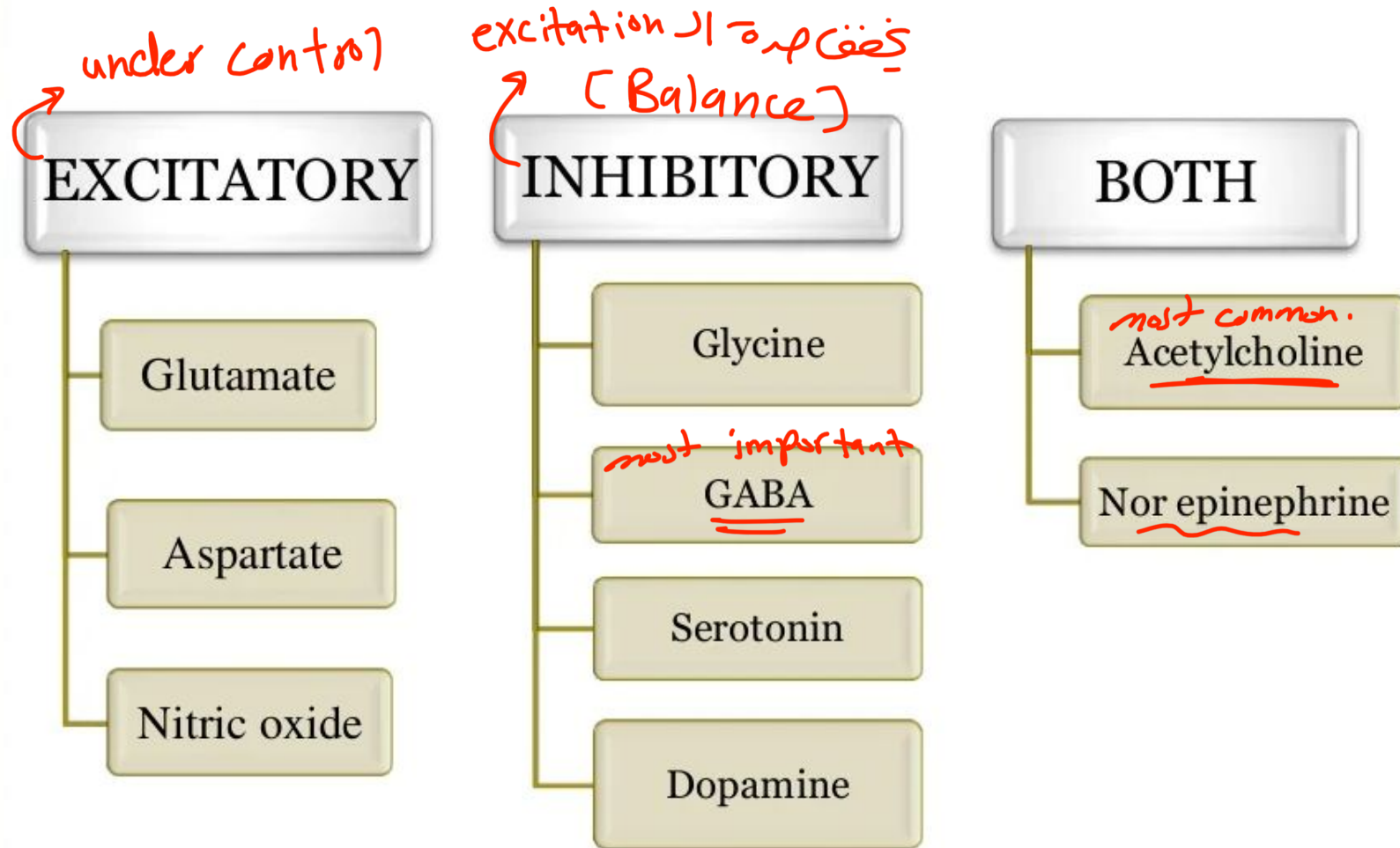
# PROPERTIES OF NEUROTRANSMITTERS

excitatory  
← inhibitory  
both  
↳ Ach

- 1) Synthesized in the presynaptic neuron
- 2) Localized to vesicles in the presynaptic neuron
- 3) Released from the presynaptic neuron under physiological condition
- 4) Rapidly removed from the synaptic cleft by uptake or degradation
- 5) Presence of receptor on the post-synaptic neuron.
- 6) Binding to the receptor elicits a biological response



# TYPES OF NEUROTRANSMITTERS

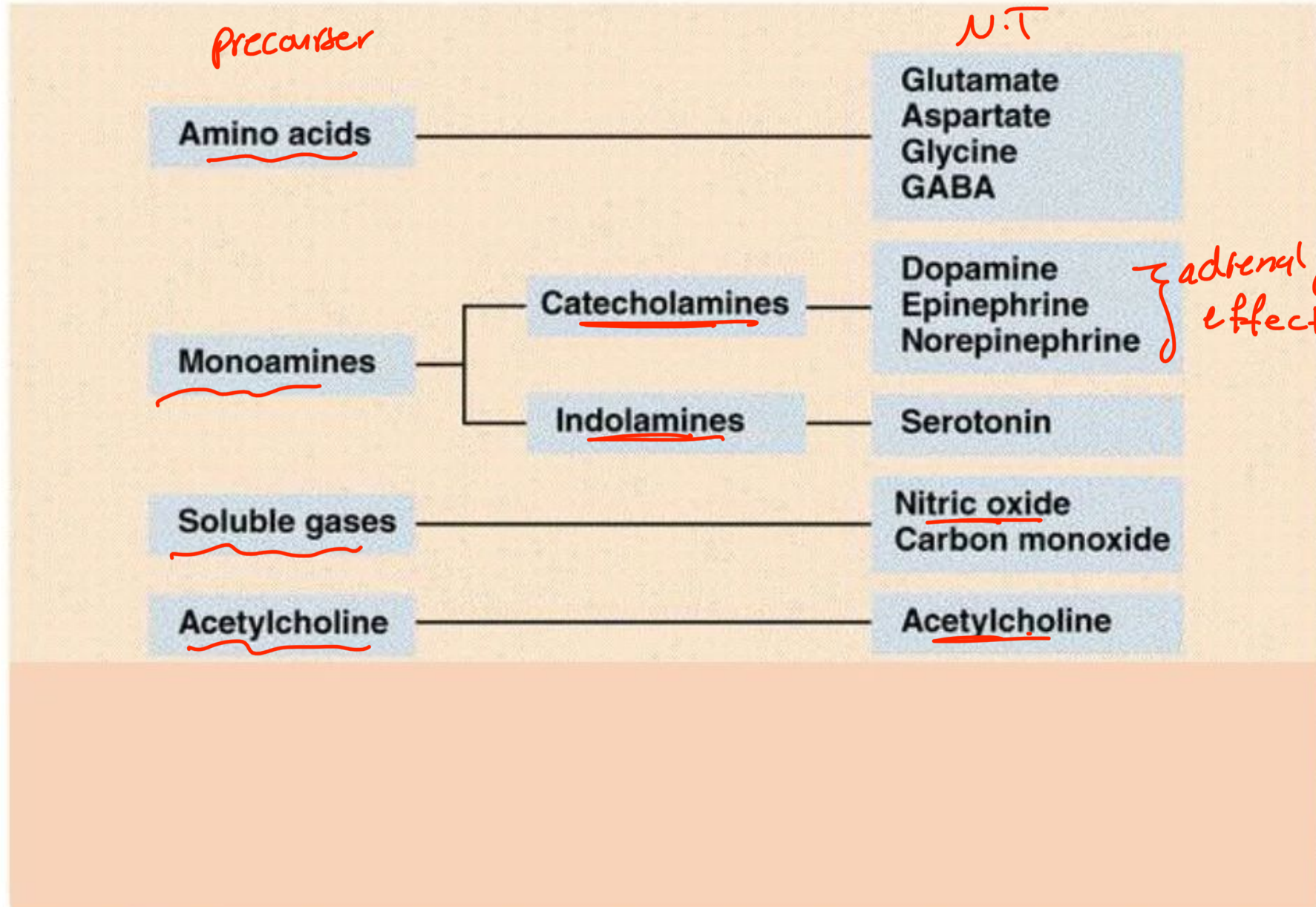




# Types of Neurotransmitters

- There are two kinds of neurotransmitters – **INHIBITORY** and **EXCITATORY**.
- **Excitatory** neurotransmitters are not necessarily exciting – they are what stimulate the brain.
- Those that calm the brain and help create balance are called **inhibitory**. Inhibitory neurotransmitters balance mood and are easily depleted when the excitatory neurotransmitters are overactive.

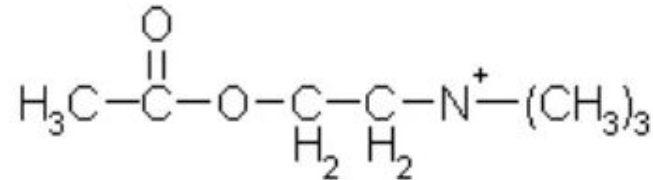
## ► Classes of Neurotransmitters



# ACETYLCHOLINE (ACh)

*cholinergic*

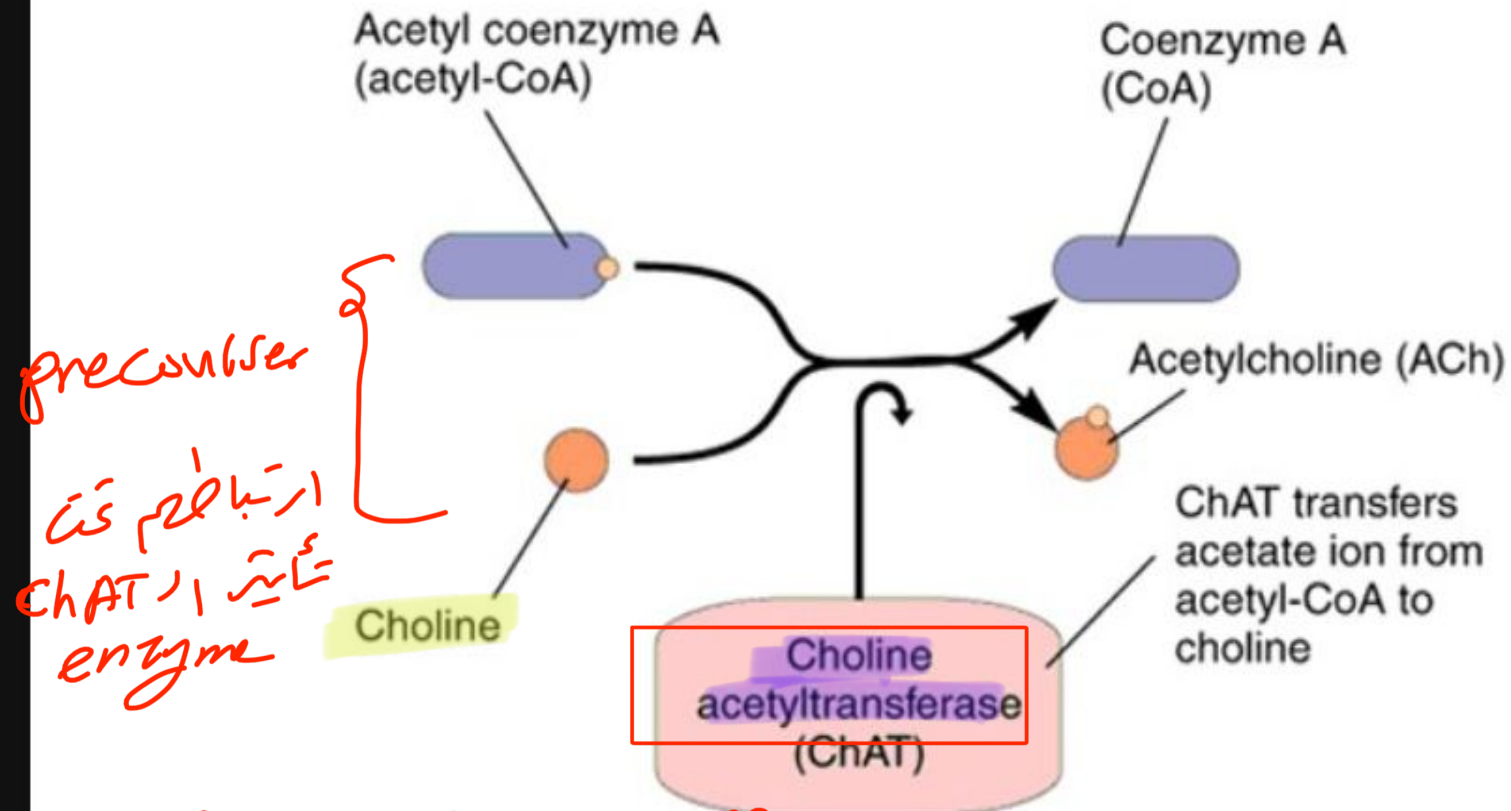
- **Acetylcholine** was the first neurotransmitter to be discovered.
- Isolated in 1921 by a German biologist named **Otto Loewi**.



- Uses choline as a precursor **cholinergic** neurotransmitter.
- Used by the Autonomic Nervous System, such as smooth muscles of the heart, as an inhibitory neurotransmitter.  
*mainly .* *unvoluntary M.*
- Responsible for stimulation of muscles, including the muscles of the gastro-intestinal system.
- Used everywhere in the brain.
- Related to **Alzheimer's Disease**.



## ► Biosynthesis of Acetylcholine



1. effect of enzyme  
 2. ACh use in [muscle] ChAT  
 3. ACh synthesis

حرفة  
خبرته، memory  
function [cognition]   
so present in many region of Brain →

خداي ضد خا ALH  
اني صاير !!

• Acetylcholine is transmitted within cholinergic pathways that are concentrated mainly in specific regions of the brainstem and are thought to be involved in cognitive functions, especially memory. Severe damage to these pathways is the probable cause of Alzheimer's disease.

3) It is also found in sensory neurons and in the autonomic nervous system, and has a part in scheduling REM (dream) sleep. Rapid Eye movement

- Outside the brain, acetylcholine is the main neurotransmitter in the parasympathetic nervous system – the system that controls functions such as heart rate, digestion, secretion of saliva and bladder function.

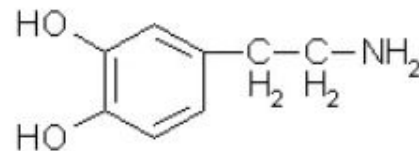


\* *Clostridium* <sup>Bacteria</sup> botulism :- release toxin act in the AChR and block it so lead to paralysis...

- The plant poisons curare cause paralysis by blocking the acetylcholine receptor sites of muscle cells.
- The well-known poison botulin works by preventing the vesicles in the axon ending from releasing acetylcholine, causing paralysis.

# DOPAMINE

- Is synthesized in three steps from the amino acid <sup>precursor</sup> **tyrosine**.
- Associated with reward mechanisms in brain.  
*اعتزاز بالنفس / Satisfaction / عكا فائدة*
- Generally involved in regulatory motor activity, in mood, motivation and attention.
- **Schizophrenics** have too much dopamine.
- Patients with **Parkinson's Disease** have too little dopamine.



Dopamine

**Schizophrenia:** These simply mean experiences that someone with schizophrenia has, such as hallucinations, unusual physical movements, and illogical thoughts.

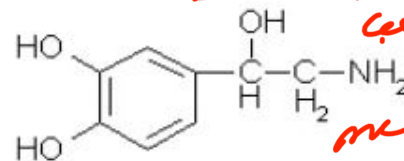
درزجی بوجھتہ (نہیہ من الیگزاتے)

**Parkinson's disease:** is a brain disorder that causes uncontrollable movements, such as shaking, stiffness, and difficulty with balance and coordination. Symptoms usually begin gradually and worsen over time.



# NOREPINEPHRINE (*nor adrenaline*)

- Synthesized directly from **dopamine**. *precursor*
- Direct precursor to epinephrine.
- It is synthesized in four steps from tyrosine.
- Synthesized within vesicles.
- Norepinephrine is strongly associated with bringing our nervous systems into "high alert." *stress*
- It increases our heart rate and our blood pressure.
- It is also important for forming memories.



Norepinephrine

*دستگاه قلب و عروق  
صنایع ACh  
دوره ۱۱  
memory*

# GLUTAMATE

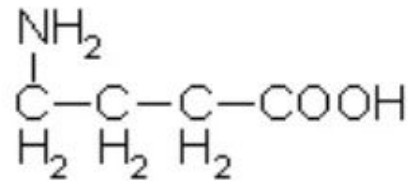
↳ excitatory



- It is an amino acid
- It is the most commonly found excitatory neurotransmitter in the brain.
- It is involved in most aspects of normal brain function including cognition, memory and learning.  
Autism → problem in glutamate
- Glutamate is formed from  $\alpha$  - ketoglutarate, an intermediate of Kreb's cycle.

# $\gamma$ -AMINO BUTYRIC ACID (GABA)

- Synthesized directly from **glutamate**. *inhibitory.*
- GABA is the most important **inhibitory** neurotransmitter *over excitatory - يوازن الإفراط في إطلاق النار by Balancing the over firing..*
- Present in high concentrations in the CNS, preventing the brain from becoming overexcited.
- If GABA is lacking in certain parts of the brain, **epilepsy** results.



GABA



GABA ۱۱۳۰۵ drug

- **Gamma amino butyric acid** (GABA) is the major inhibitory neurotransmitter that is often referred to as “nature’s VALIUM-like substance”. When GABA is out of range (high or low excretion values), it is likely that an excitatory neurotransmitter is firing too often in the brain. GABA will be sent out to attempt to balance this stimulating over-firing.

stimulation ۱۱۹۲

- People with too little GABA <sup>epilepsy</sup> tend to suffer from anxiety disorders, and drugs like Valium work by enhancing the effects of GABA. Lots of other drugs influence GABA receptors, including alcohol and barbiturates. If GABA is lacking in certain parts of the brain, epilepsy results.

→ drug for the epilepsy patient.

glucose → glutamate → GABA

- GABA is derived from glucose, which is transaminated in the Krebs's cycle to glutamine and then converted to GABA by the enzyme, glutamic acid decarboxylase.
- Glucose → Glutamine → GABA.

any defect in this enzyme affect in the GABA level..



# SEROTONIN

- **SEROTONIN** is an inhibitory neurotransmitter – which means that it does not stimulate the brain. *Balance of the over excitation (stress)*
- Adequate amounts of serotonin are necessary for a stable mood and to balance any excessive excitatory (stimulating) neurotransmitter firing in the brain.
- If you use stimulant medications or caffeine in your daily regimen – it can cause a depletion of serotonin over time.

✱ یی یتبعوا صیفة حامیه راع یصیر مشاکخ ۱ serotonin  
صیت حد قله اهلکد راع یصیر محتم depression ..

- Low serotonin levels leads to an increased appetite for carbohydrates (starchy foods) and trouble sleeping, which are also associated with depression and other emotional disorders. It has also been tied to migraines, irritable bowel syndrome, and fibromyalgia.

واکم خیر صبر  
[یعنی میں دل بیکار رہتا ہوں جو کہ سیرٹونین کا نقصان ہے]

- Low serotonin levels are also associated with decreased immune system function.

- In addition to mood control, serotonin <sup>in GIT also</sup> has been linked with a wide variety of functions, including the regulation of sleep, pain perception, body temperature, blood pressure and hormonal activity

\* 2% of serotonin in Brain  
Just



- 
- Within the brain, serotonin is localized mainly in nerve pathways emerging from the raphe nuclei, a group of nuclei at the centre of the reticular formation in the Midbrain, pons and medulla.
  - These serotonergic pathways spread extensively throughout the brainstem, the cerebral cortex and the spinal cord.

- Largest amount of serotonin is found in the intestinal mucosa. GIT

- Although the CNS contains less than 2% of the total serotonin in the body, serotonin plays a very important role in a range of brain functions. It is synthesized from the amino acid tryptophan.  
precursor

## Steps in neurotransmitter processing are:

**Synthesis:** Neurotransmitters are synthesized by the enzymatic transformation of precursors.

**Storage:** They are packaged inside synaptic vesicles.

**Release:** They are released from presynaptic terminal by exocytosis when calcium enters axon terminal during an action potential  
Diffuse across the synaptic cleft to the postsynaptic membrane.

**Binding:** They bind to receptor proteins.

**Inactivation:** The neurotransmitter is degraded either by being broken down enzymatically, or reused by active reuptake.



# ALCOHOL & NEUROTRANSMITTERS

- It **binds directly to receptors** for ACh, serotonin, GABA and glutamate.
- It **enhances the effects of the GABA**, which is an inhibitory neurotransmitter.
  - Enhancing an inhibitor make things **sluggish**.
  - The neuron activity is diminished- **sedative effects** of alcohol.
- Alcohol **inhibits glutamate receptor function**.
  - This causes discoordination, **slurred speech**, staggering, **memory disruption**, and **blackout**.
- Alcohol **raises dopamine levels**.
  - This leads to **excitement, pleasure and later addiction**.



# NICOTINE & NEUROTRANSMITTERS



- Nicotine imitates the action of ACh & binds to ACh receptor.
- Like acetylcholine, nicotine leads to a burst of receptor activity.
- Nicotine activates cholinergic neurons in many different regions throughout your brain simultaneously.
- This stimulation leads to:
  - Increased release of glutamate.
  - Stimulation of cholinergic neurons promotes the release of dopamine. The production of dopamine causes feelings of reward and pleasure.

والسبب انه ال nicotine شغل برون ١١ serotonin



# DISEASES ASSOCIATED WITH NEUROTRANSMITTERS

## NEUROTRANSMITTER

- Acetylcholine
- Dopamine
- GABA
- Serotonin
- Glutamate

## DISEASE

- Alzheimer's
- Parkinson's disease
- Schizophrenia
- Epilepsy
- Migraines
- ADD A tension defect disorder
- Depression
- Autism
- Migraine
- stroke





\*the N.T has relation with the cancer !! , parkinson

## RECENT DEVELOPMENTS

- A team of scientists from **University of Barcelona** in 2011, has discovered that **D-aspartic acid** (*D-Asp*) is a novel neurotransmitter that could potentially be used in the **fight against** neurological diseases such as Parkinson's and schizophrenia.
- According to a new study led by researchers at the **Ohio State University Comprehensive Cancer Center in 2011**, doses of a neurotransmitter **dopamine** might offer a way to boost the effectiveness of anticancer drugs and radiation therapy.

# CONCLUSION

- The ability of nervous system to orchestrate complex behaviors, learn and remember depends on communication between vast no: of neurons.
- Mediated by neurotransmitters.
- They play an important role in control and coordination of body.
- Many neurological diseases and mental disorders are due to improper functioning of neurotransmitters.

Done ☒