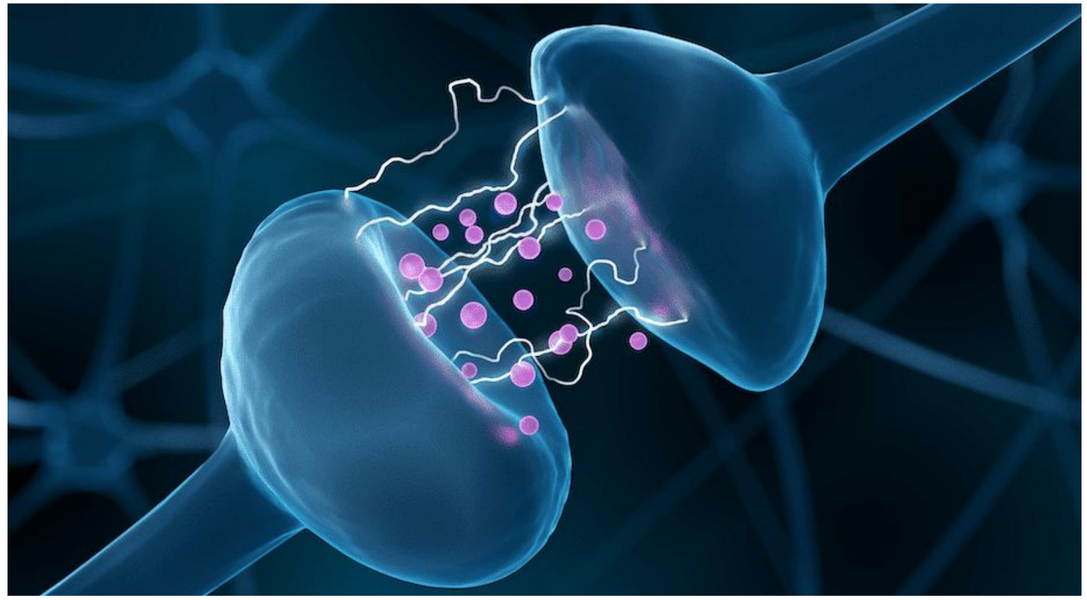
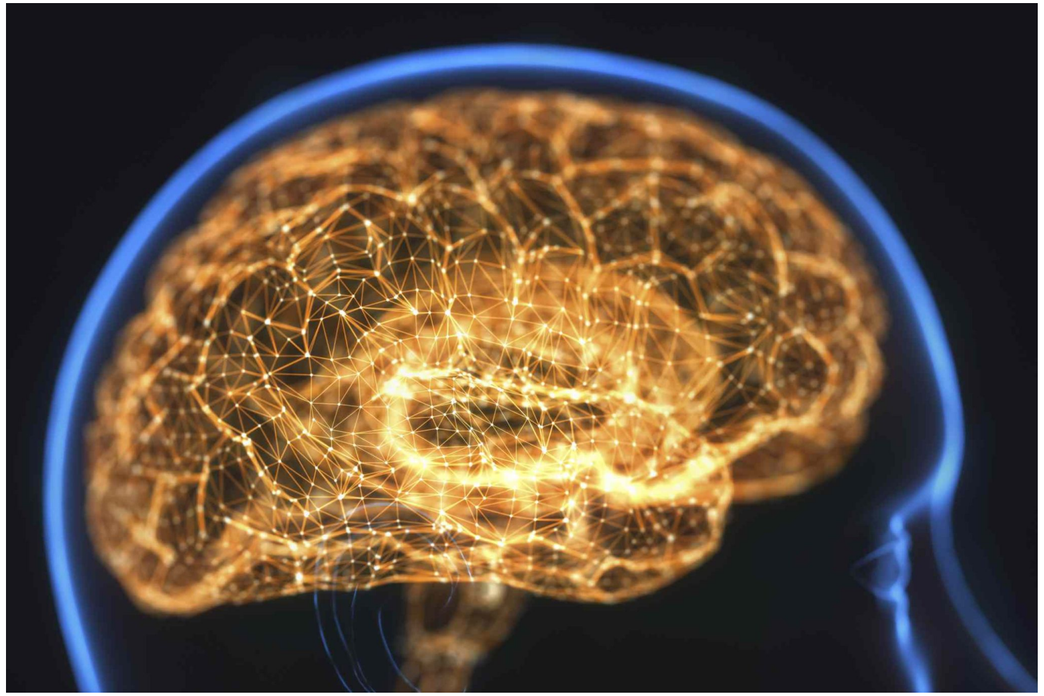
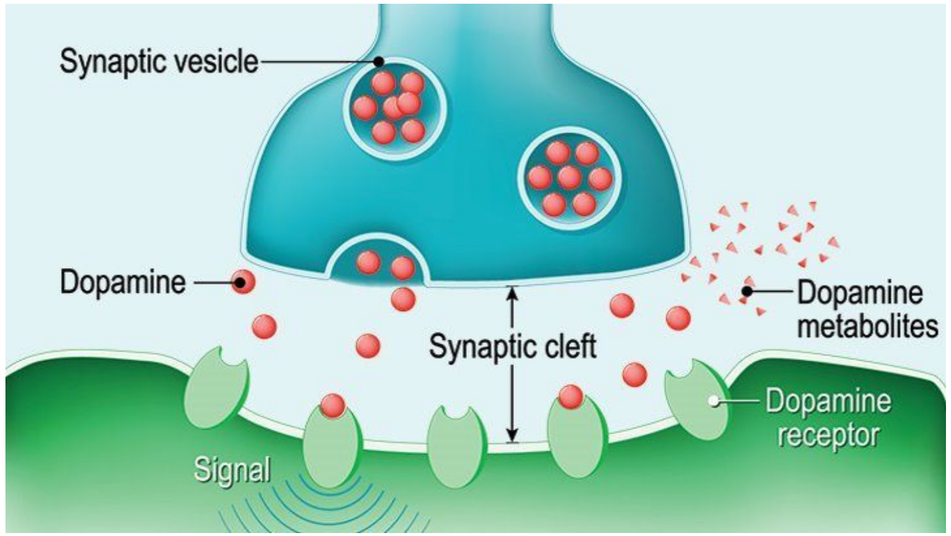
Lesson #3

How Drugs Affect The Way Brain Works

WISE Program led by Yerin Cho



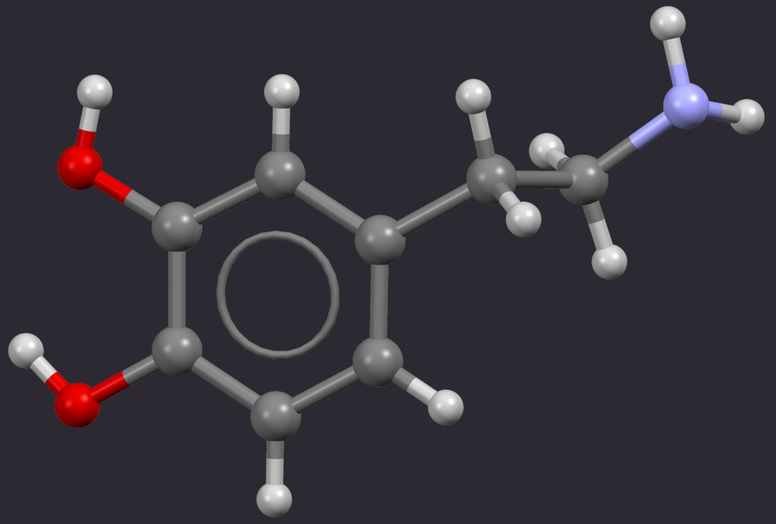




Today's Agenda

- Intro to Specific Neurotransmitters
  - Dopamine
  - Serotonin
  - GABA
- Intro to Neurotransmission

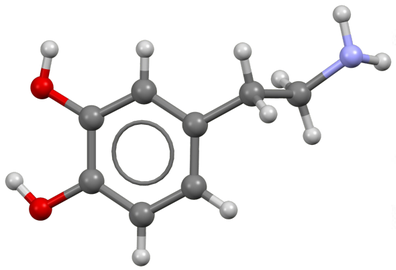
Dopamine Neurotransmitter



- "Feel good neurotransmitter"
- **Reward pathway:** released doing pleasurable activities (eating, achieving goals, sex, etc)
- Drugs dramatically **increase dopamine levels**
- Gives **powerful sense of utopia**
- Most addictive substances are related
  - ex) Cocaine, Meth, Opioids, etc
  - -> affects the most powerful pathway
  - -> the reward pathway!

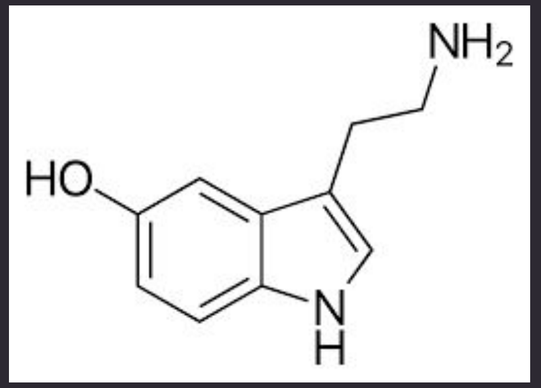
Types of Drugs Related to Dopamine

Drug	Effect on Dopamine	Impact
Cocaine	Blocks reuptake → more dopamine in the synapse	Intense euphoria, high addiction potential
Methamphetamine	Causes massive dopamine release and blocks reuptake	Powerful high, brain damage with chronic use
Nicotine	Triggers dopamine indirectly via acetylcholine system	Reinforces smoking behavior
Alcohol	Increases dopamine indirectly via GABA and endorphin systems	Relaxation, reinforcement
Opioids	Inhibit GABA (which normally suppresses dopamine release)	Increased dopamine, intense pleasure
Cannabis (THC)	Modulates dopamine indirectly	Mild euphoria, reinforcement



Serotonin Neurotransmitter

- "Feel **stable** neurotransmitter"
- Responsible for mood, sleep, appetite, & memory
- Drugs dramatically **increase/decrease serotonin**
- Processes emotion-related memories
- Too much: agitation, confusion, tremors
- Too low: depression, anxiety, irritability

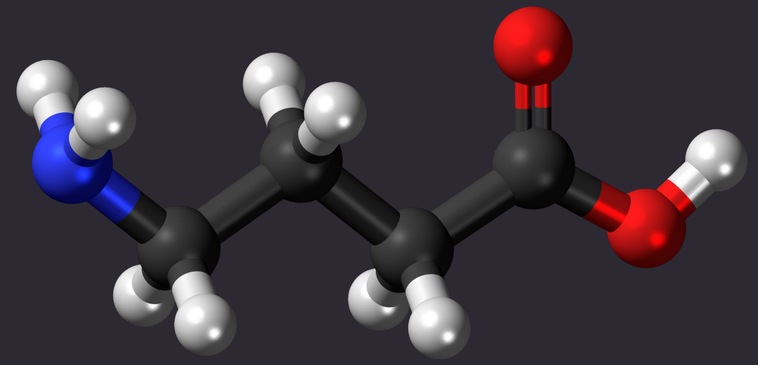


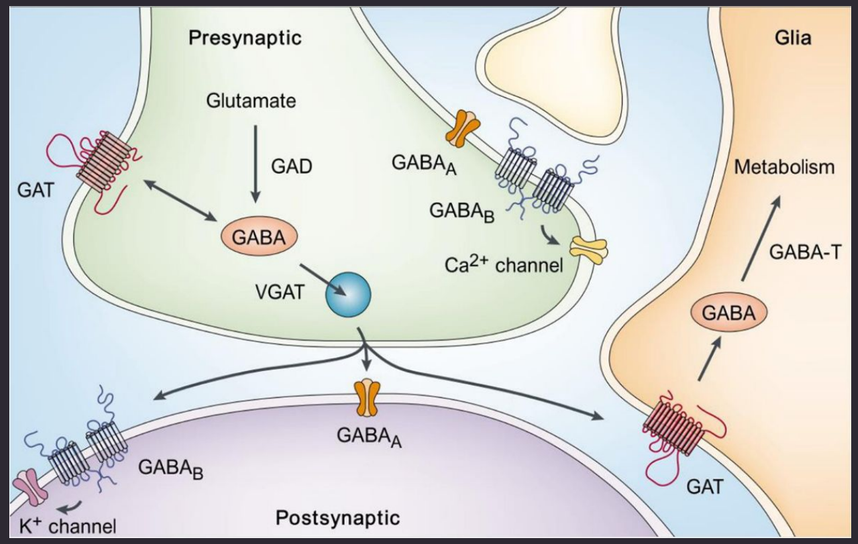
Types of Drugs Related to Serotonin

Mechanism	Example Drugs	Effect
Block serotonin reuptake	SSRIs (e.g., Prozac, Zoloft), MDMA	More serotonin in the synapse
Stimulate serotonin release	MDMA, amphetamines	Massive short-term serotonin boost
Mimic serotonin (agonists)	LSD, psilocybin	Hallucinogenic effects via 5-HT2A receptors
Block serotonin receptors	Antipsychotics, some migraine meds	Reduce or fine-tune serotonin activity
Prevent serotonin breakdown	MAOIs (e.g., phenelzine)	Increase available serotonin

GABA Neurotransmitter

- Main inhibitory -> **calming** neurotransmitter!
- **Inhibits neural activity**
  - Maintains neural balance, muscle control, mental clarity
- Stimulant drugs dramatically **decrease GABA**
  - **-> less calm, more excited**
- Alter consciousness, anxiety, motor control, etc





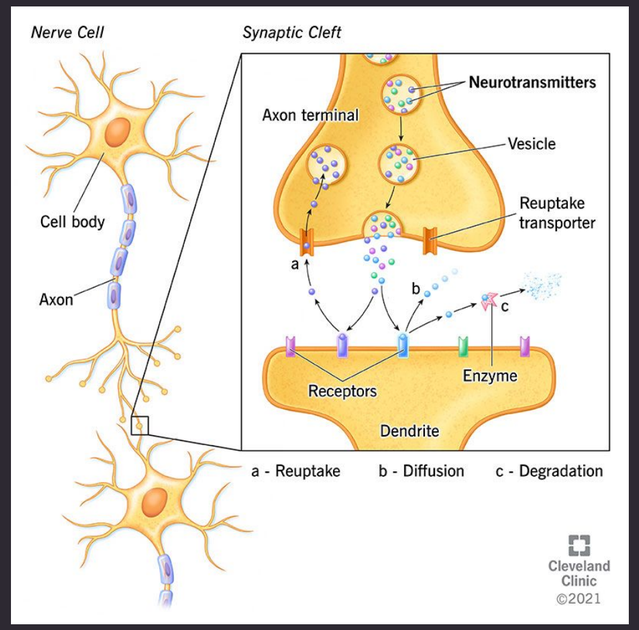
Types of Drugs Related to GABA

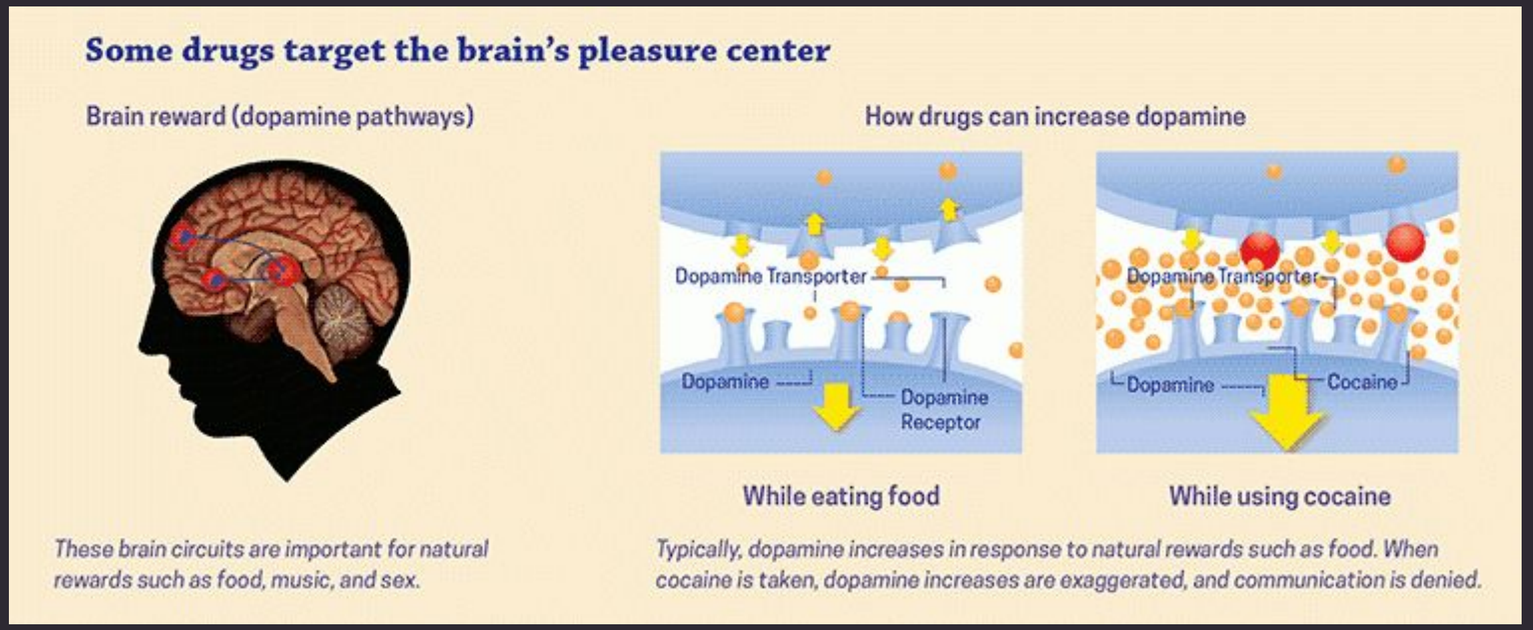
Drug	Effect on GABA	Impact
Ketamine	Mainly blocks glutamate (NMDA), but may affect GABA indirectly	Dissociation, sedation
PCP	Similar to ketamine; not a GABA drug directly	Aggression, hallucinations
LSD, Psilocybin	Primarily serotonin-acting, minimal GABA effect	May reduce anxiety via serotonin modulation

Drug	Effect on GABA	Impact
Cocaine	Increases dopamine; long-term use reduces GABA	Anxiety, overexcitation, crash
Methamphetamine	Similar to cocaine; can lower GABA tone	Paranoia, agitation, insomnia
Caffeine (legal but often abused)	Inhibits GABA weakly	Alertness, jitteriness

What's happening in your brain?

- Drugs affect the way neurons **send**, **receive**, **process** signals!
- Cause activation of neurons -> large amounts of neurotransmitters
- Continuously send out signals
  - **Amplifies** or **disrupts** the **normal communication between neurons**
  - = **feeling of high, happiness, etc** -> **NOT a good biological sign**





What's happening in your brain?

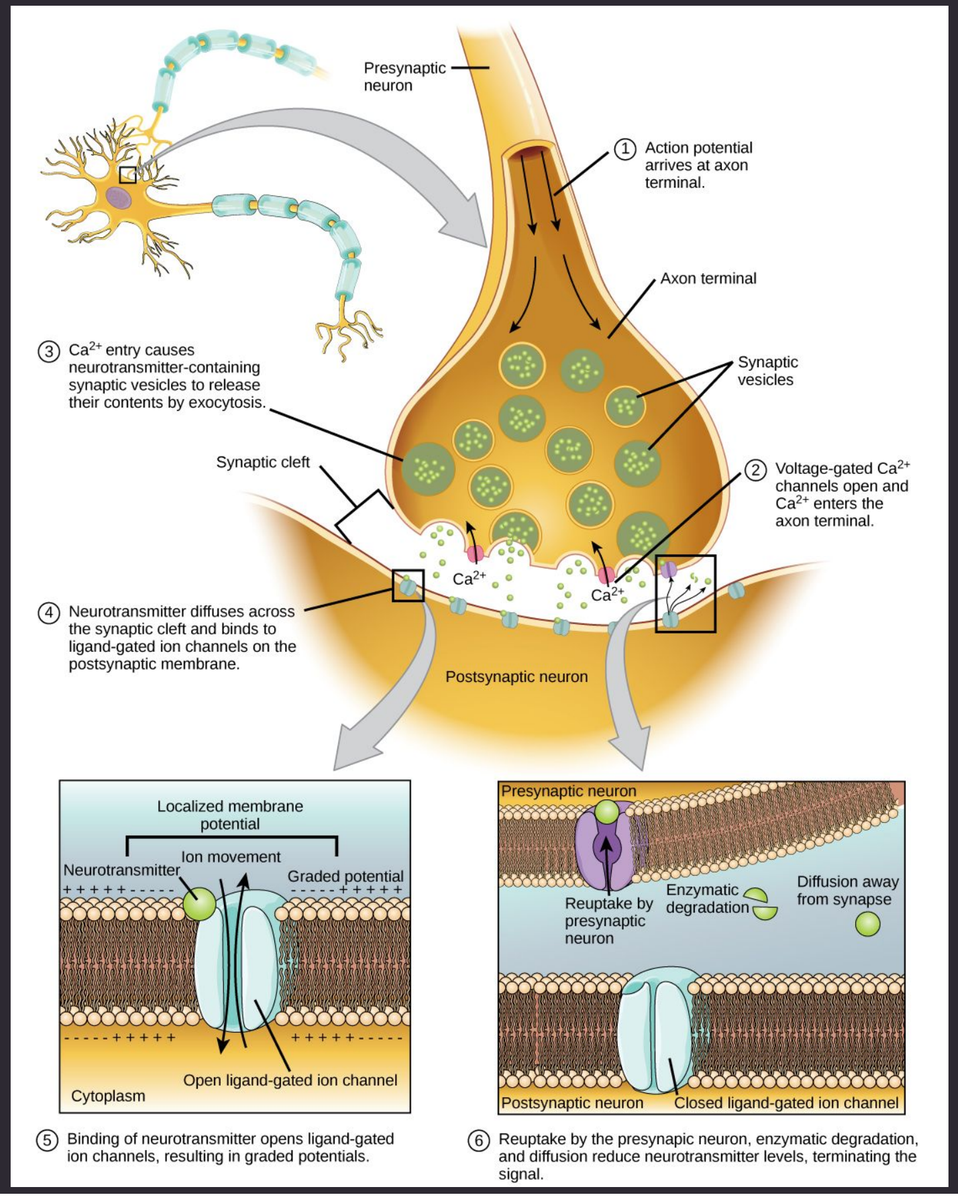
1) Electrical impulse (action potential) travels down a neuron.

2) When it reaches the **axon terminal**, it triggers the release of **neurotransmitters** into the **synaptic cleft**

3) Neurotransmitters **bind to receptors** on the next neuron, triggering a response

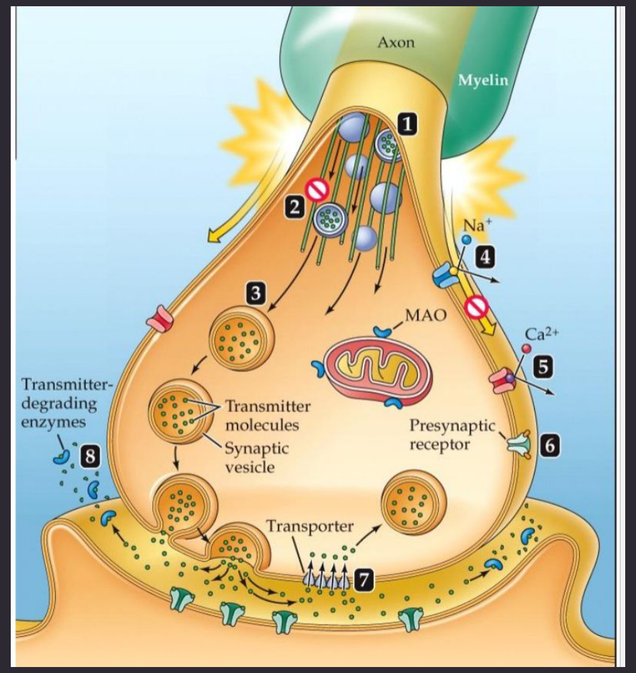
4) Neurotransmitters are then **removed** by:

- **Reuptake** (taken back into the first neuron),
- **Enzymatic breakdown**, or
- **Diffusion** away from the synapse.



Interactive Activity – Think, Pair, & Share

- What information was **most interesting**?
- What information was **new** to you?



Thank you for listening!

Short Anonymous Google Survey!! ~5 mins