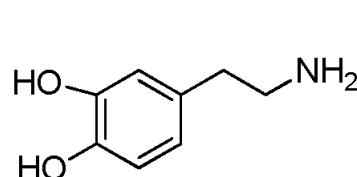
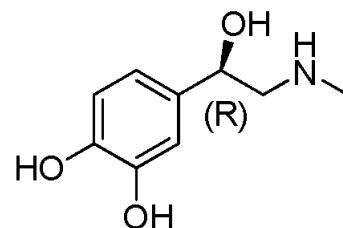


# Chapter 16:

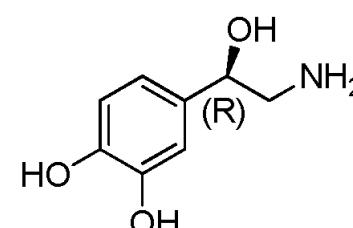
## Neurotransmitters



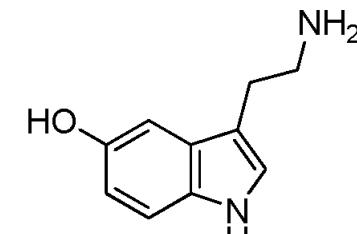
Dopamine



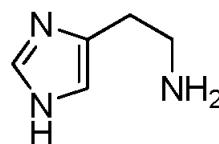
Epinephrine



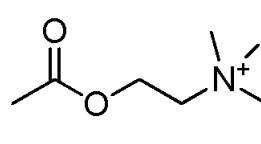
Norepinephrine



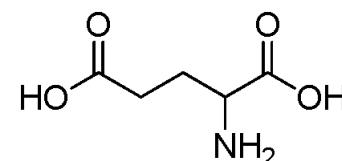
Serotonin



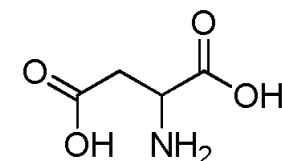
Histamine



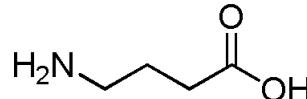
Acetylcholine



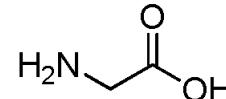
Glutamic Acid



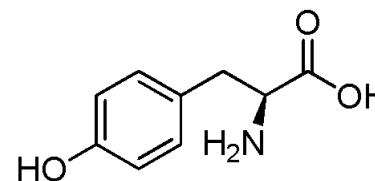
Aspartic Acid



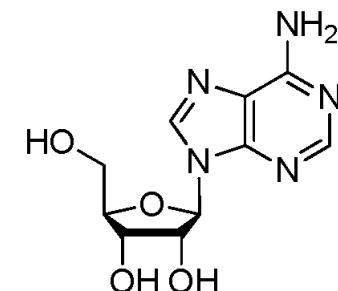
GABA



Glycine



Tyrosine



Adenosine

# Small Neurotransmitters

## Acetylcholine

## Biogenic Amines (*Monoamines*)

- Catecholamines
  - Dopamine
  - Norepinephrine
  - Epinephrine
- Serotonin
- Histamine

## Amino Acids

- Glutamate
- GABA
- Glycine

## Purines

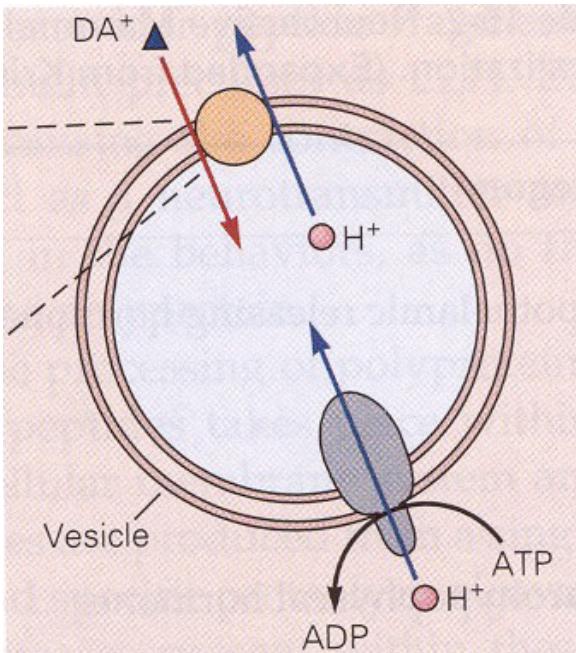
- ATP
- Adenosine

## Non-Traditional

- Nitric Oxide
- Endocannabinoids
- Derivatives of arachidonic acid

# Neurotransmitter Transporters

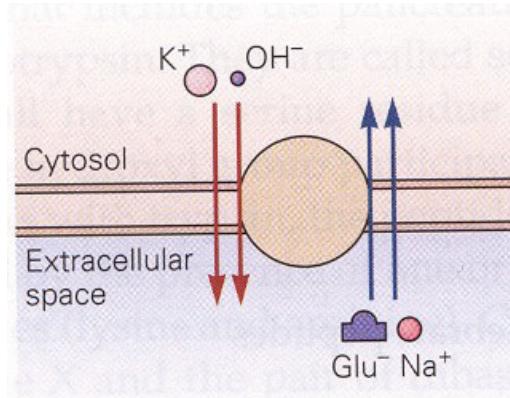
## Vesicular ATPase and Vesicular transporters



$[H^+]$  gradient is the energy source used to load vesicles with transmitter

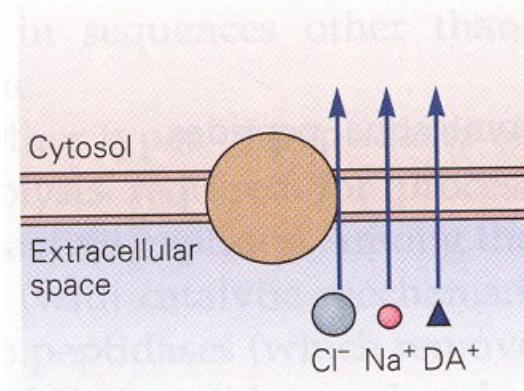
## Reuptake transporters

### Glutamate reuptake



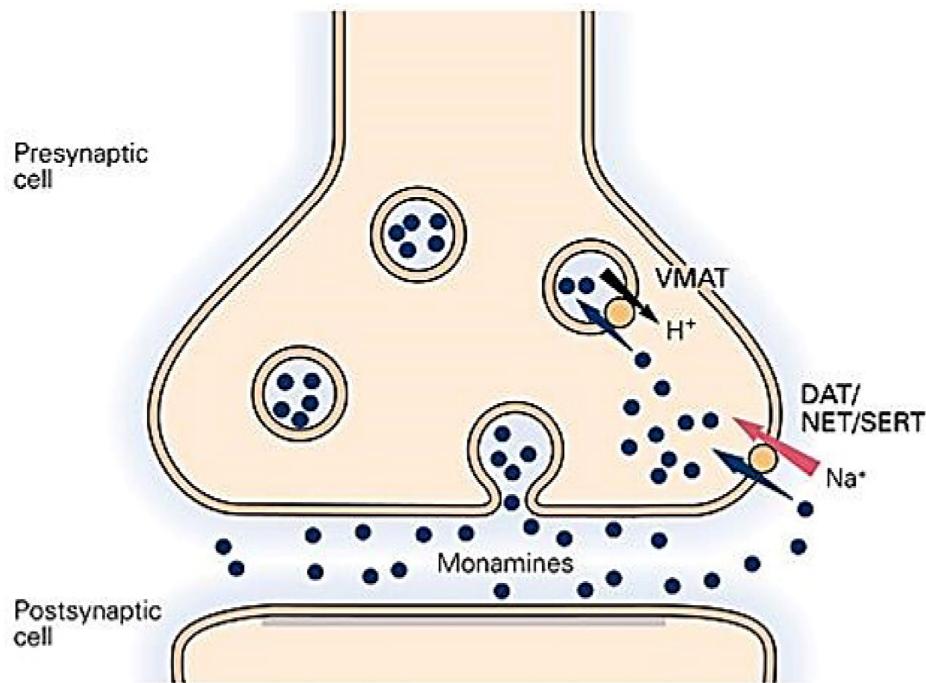
$[Na^+]$  gradient is the energy source used to pull transmitter from the synaptic cleft back into the presynaptic cell

### Reuptake of other transmitters

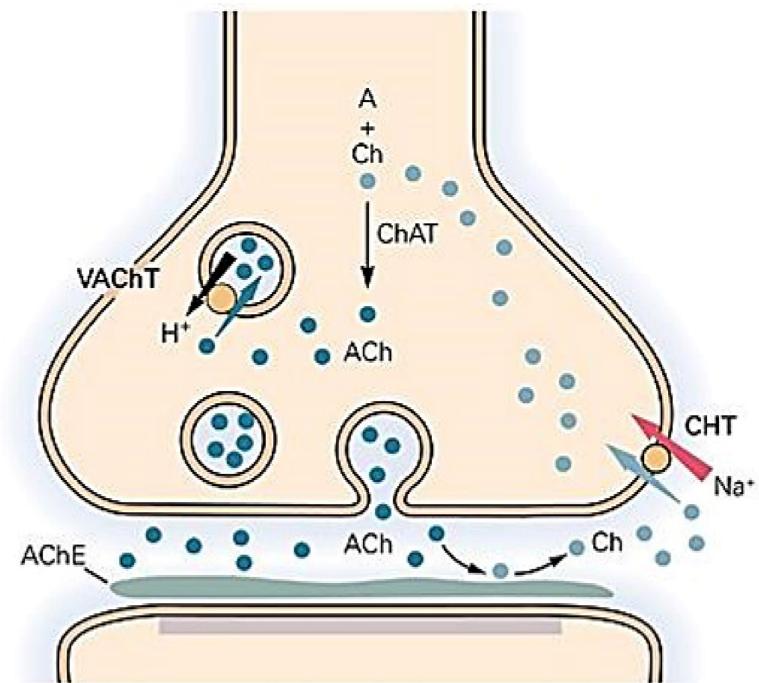


# Neurotransmitter Transporters

Monoamines (DA, NE, SER)

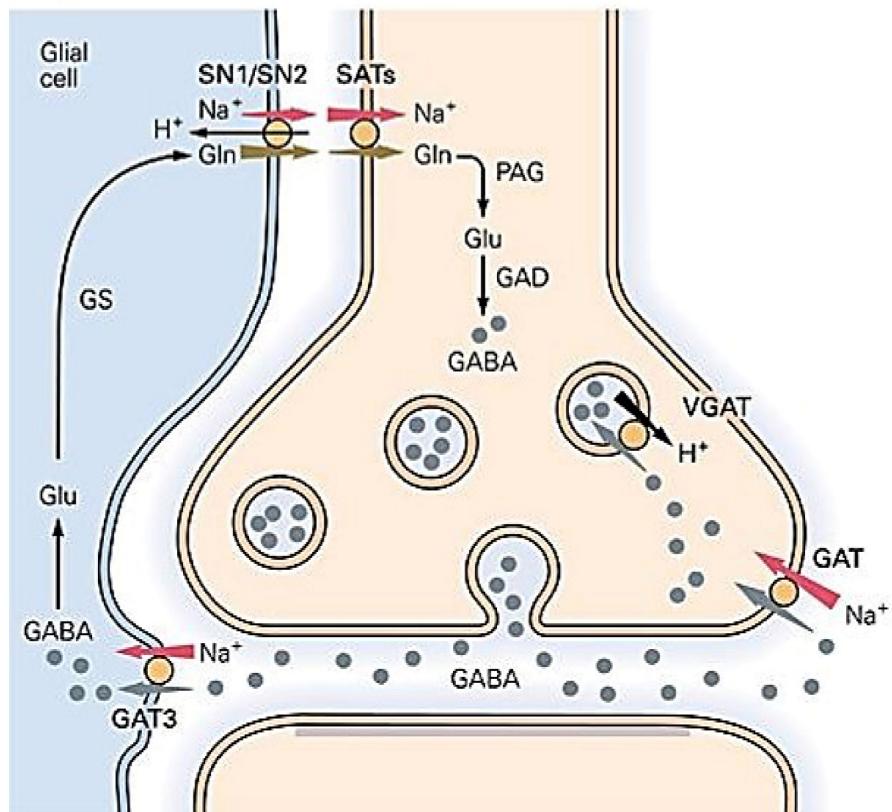


Acetylcholine

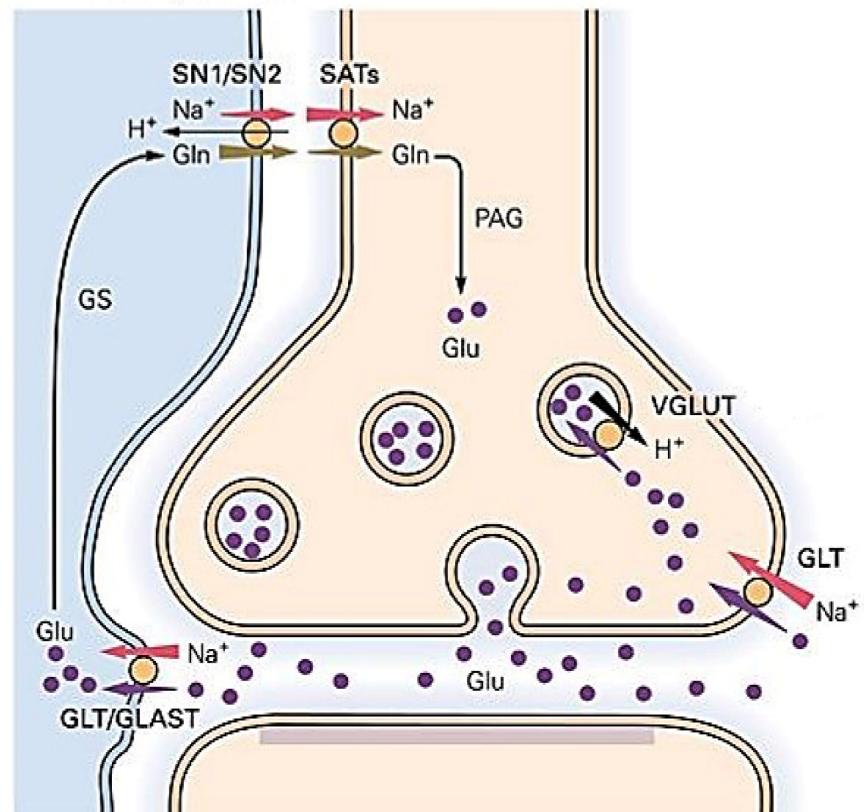


# Neurotransmitter Transporters

GABA



Glutamate



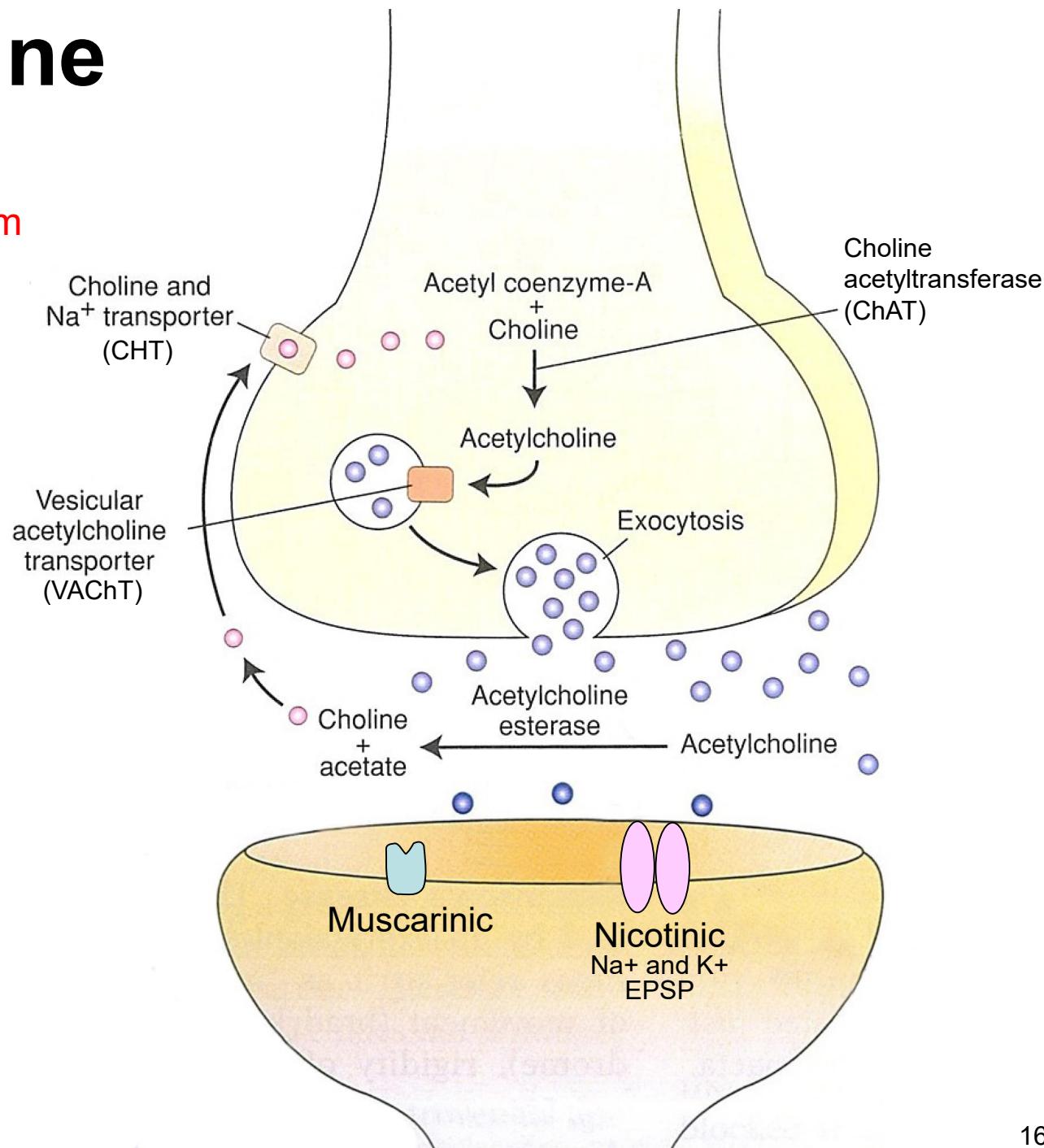
# Acetylcholine

Neuromuscular junction

Autonomic nervous system

Sleep and wakefulness

Alzheimer's disease

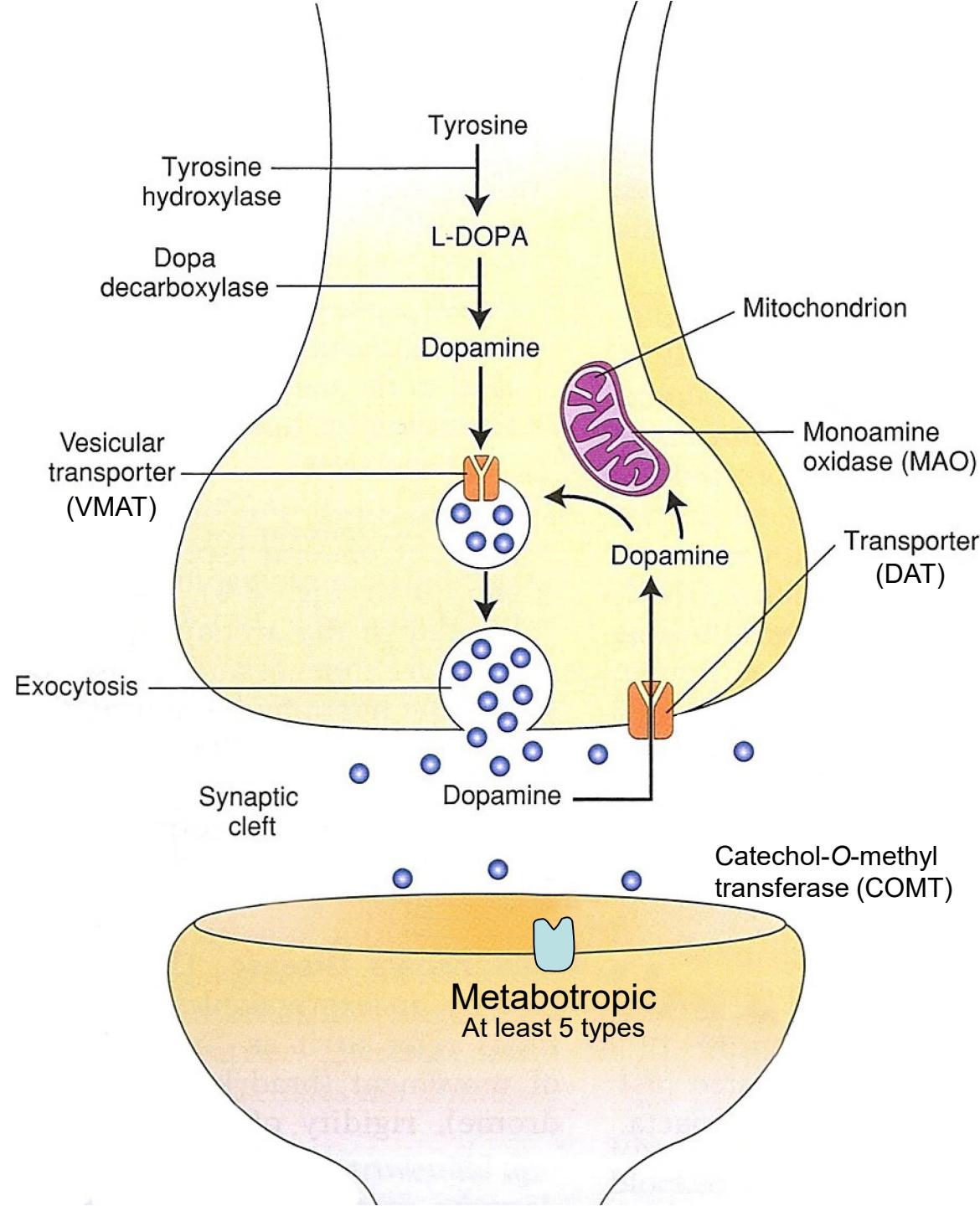


# Dopamine

Parkinson's Disease

Schizophrenia

Drug abuse (cocaine, amphetamine, etc)



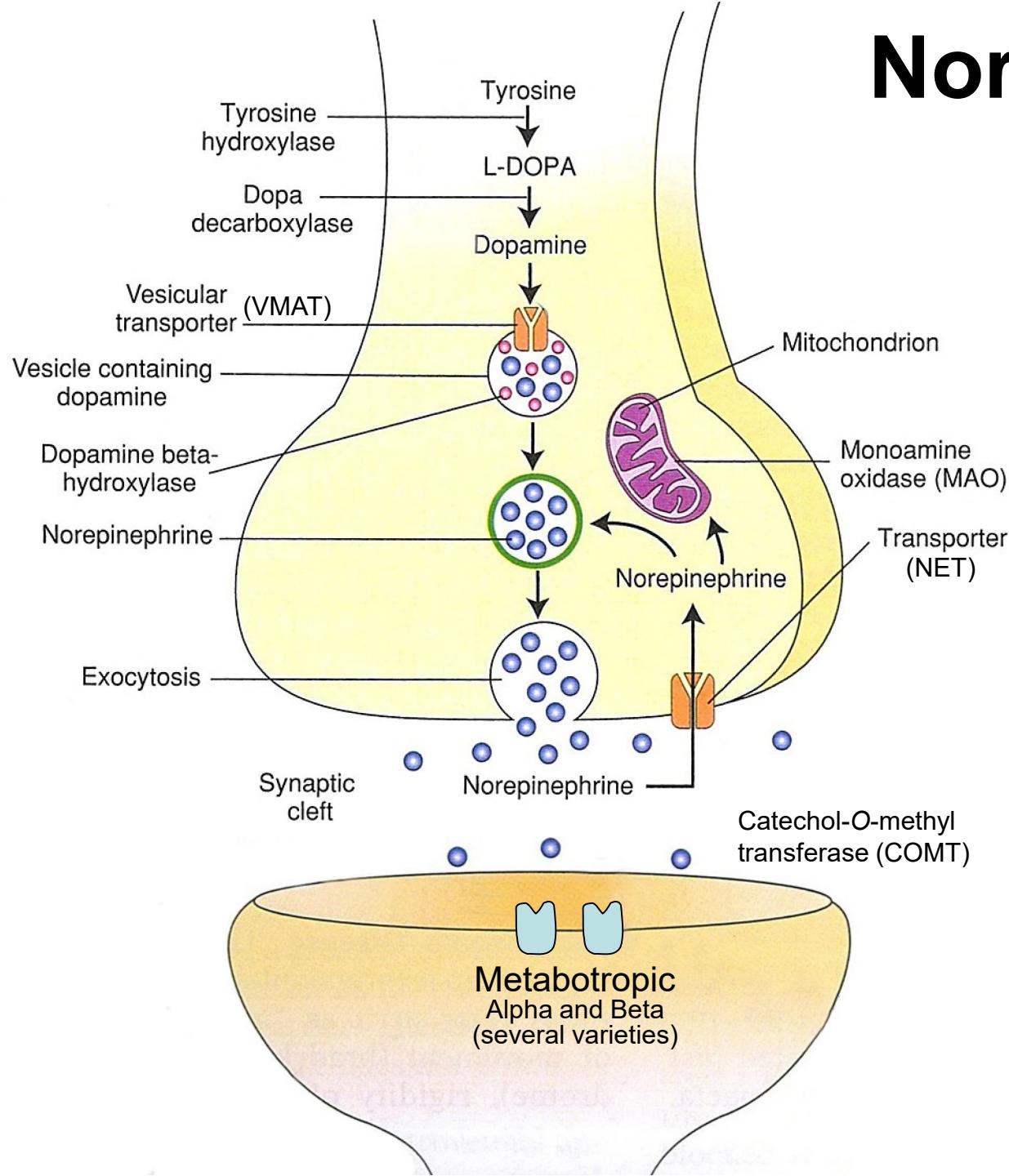
# Norepinephrine

Autonomic nervous system

Attention and arousal

Pain perception

Depression and Anxiety



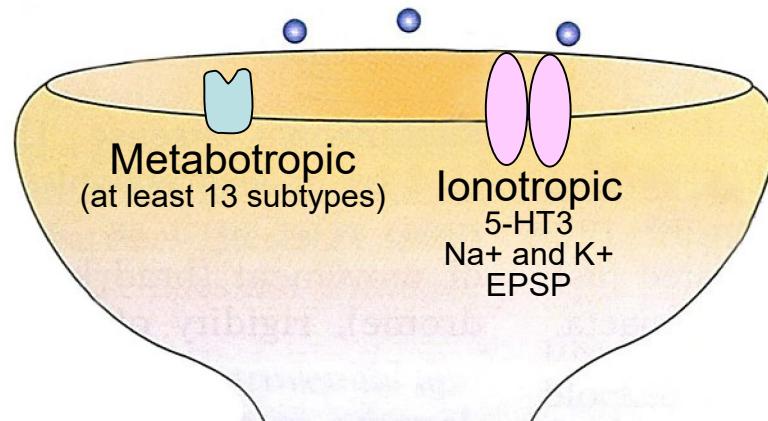
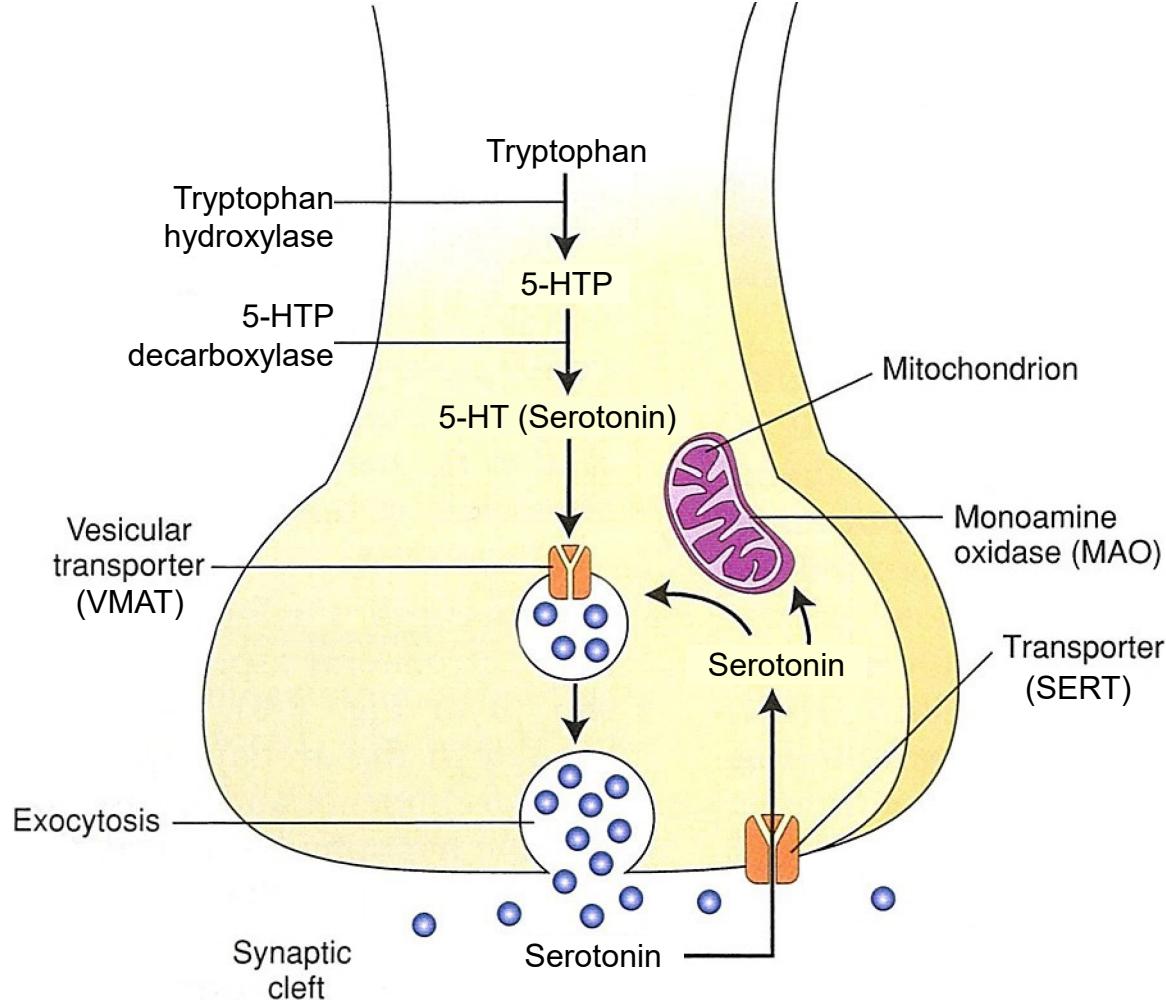
# Serotonin

Arousal and Sleep

Aggression

Pain perception

Depression and Anxiety

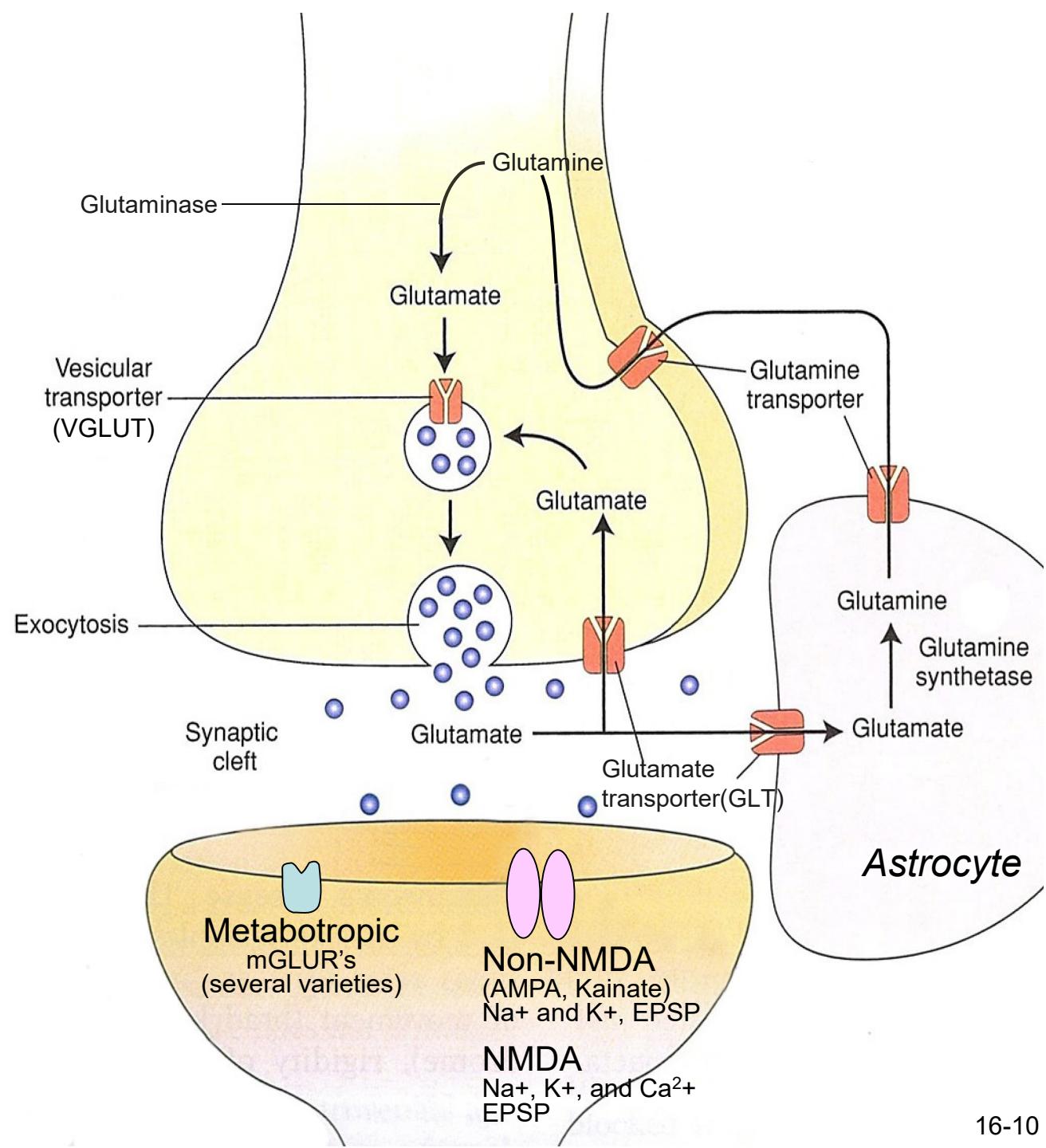


# Glutamate

Major CNS excitatory transmitter

Learning and Memory

Excitotoxicity during seizure or stroke

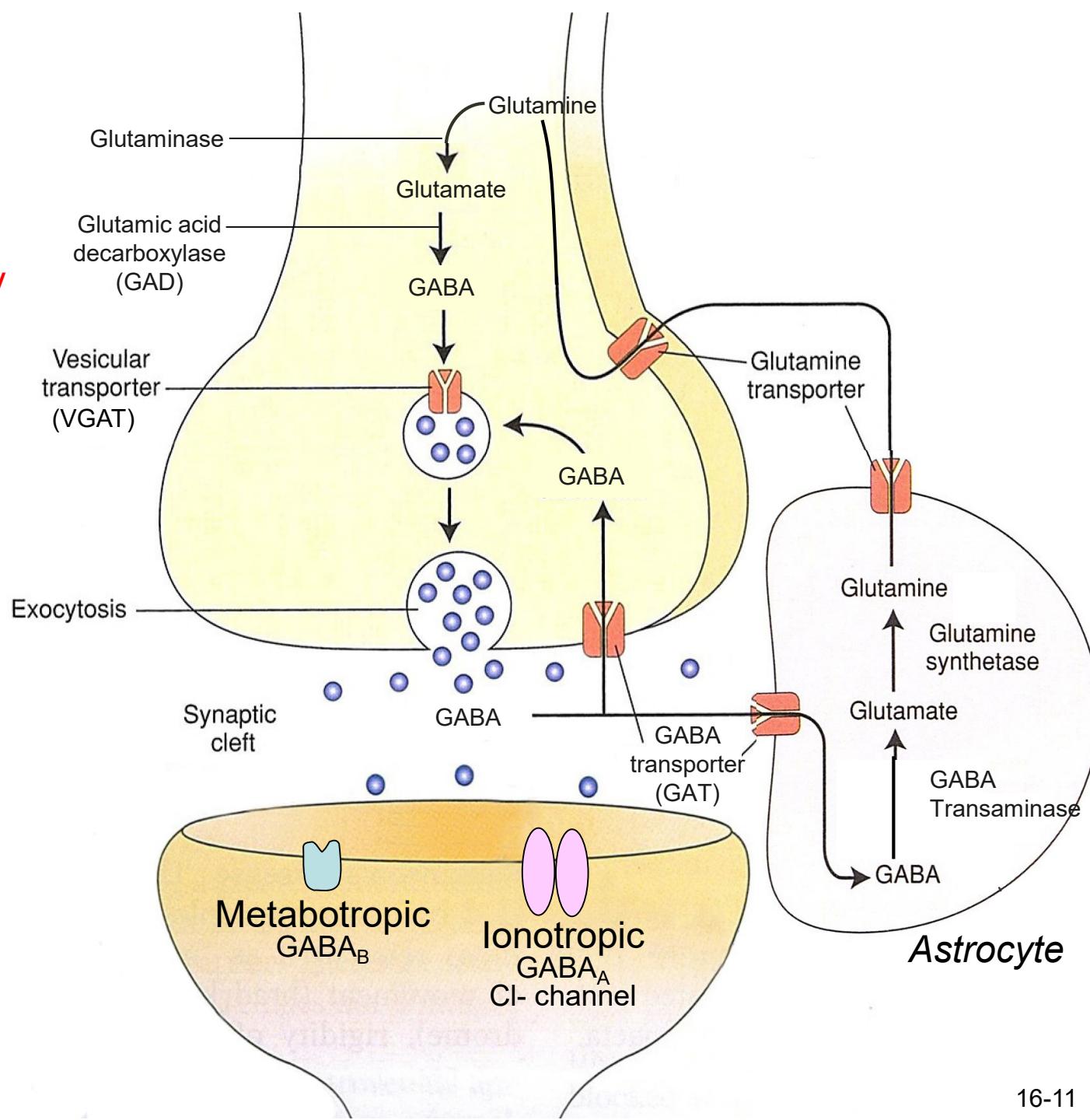


# GABA

Major CNS inhibitory transmitter

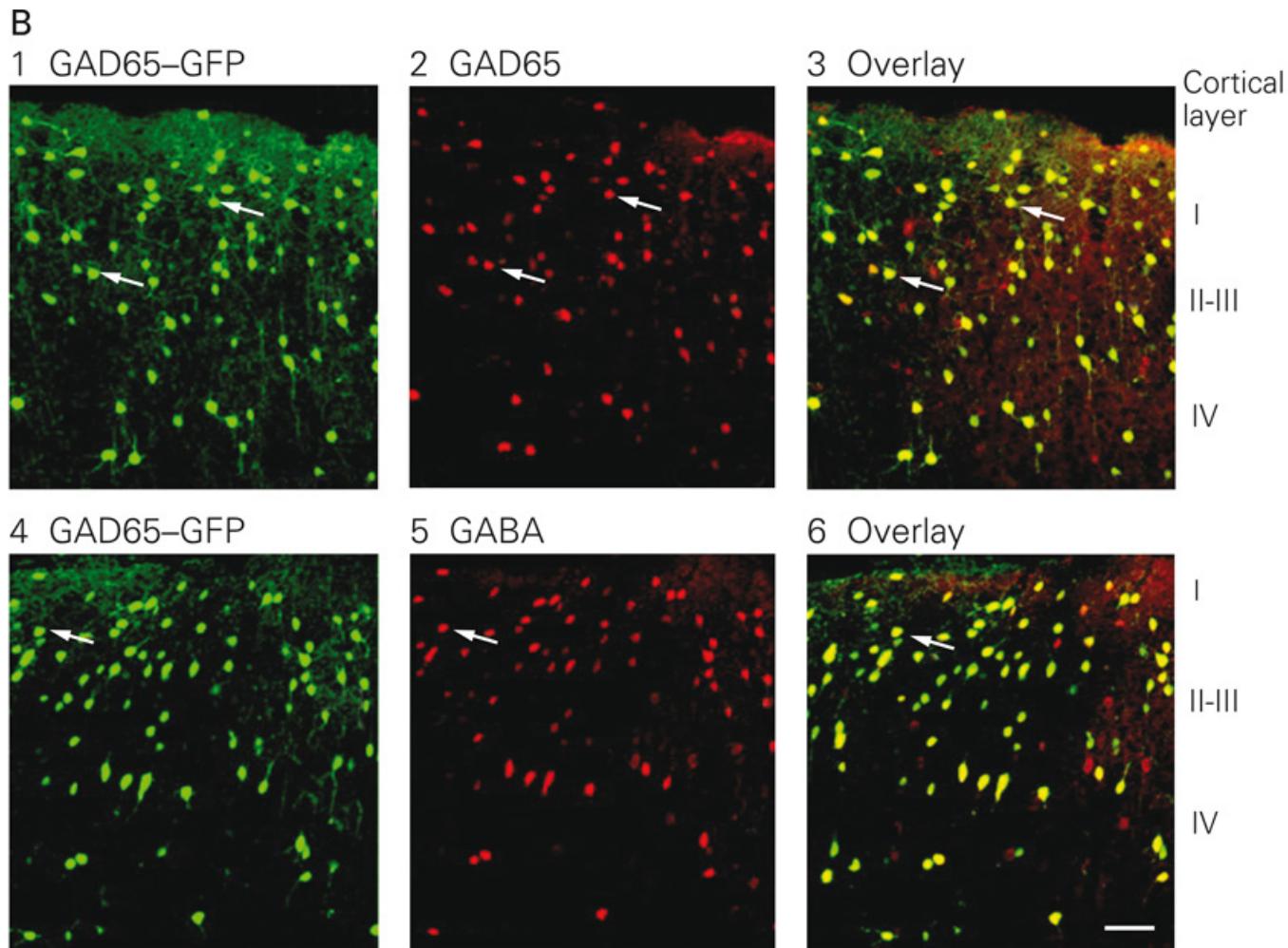
Loss of GABA activity causes seizure

Target of many “depressant” drugs



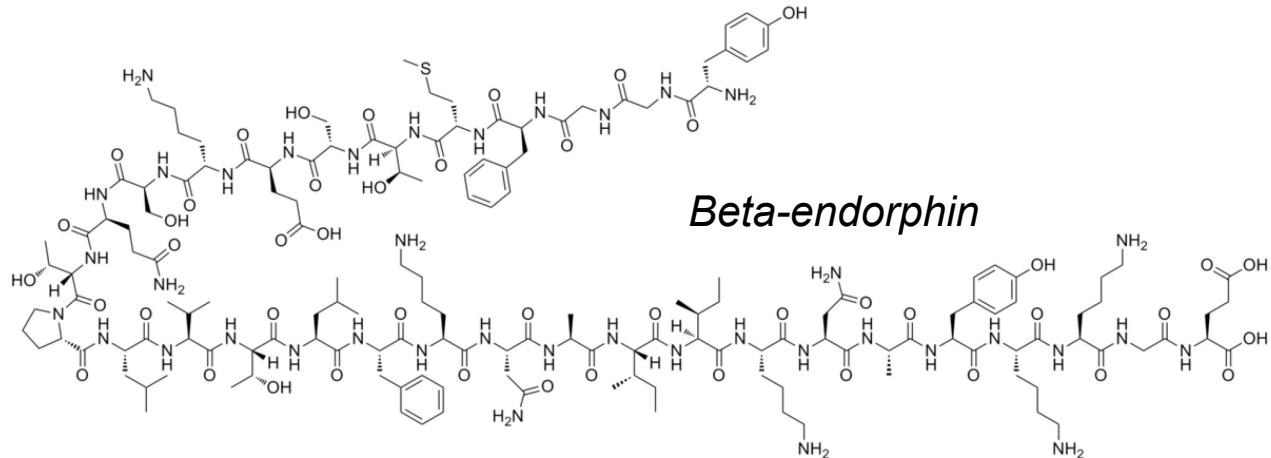
# Research Application

B. Images of neocortex from a GAD65GFP transgenic mouse in which green fluorescent protein (GFP) is expressed under the control of the GAD65 promotor. GFP is co-localized with GAD65 (1-3) and GABA (4-6) (both detected by indirect immunofluorescence) in neurons in the supragranular layers. Most of the GFP-positive neurons are immunopositive for GAD65 and GABA (**arrows**). Scale bar = 100  $\mu$ m. (Adapted, with permission, from López-Bendito et al. 2004.)



# Peptide Neurotransmitters

Large transmitters typically containing chains of 3 to 36 amino acids



## Opioid peptides

- Enkephalin
- Endorphin
- Dynorphin

## Miscellaneous peptides

- Angiotensin II
- Neuropeptide Y
- Neurotensin

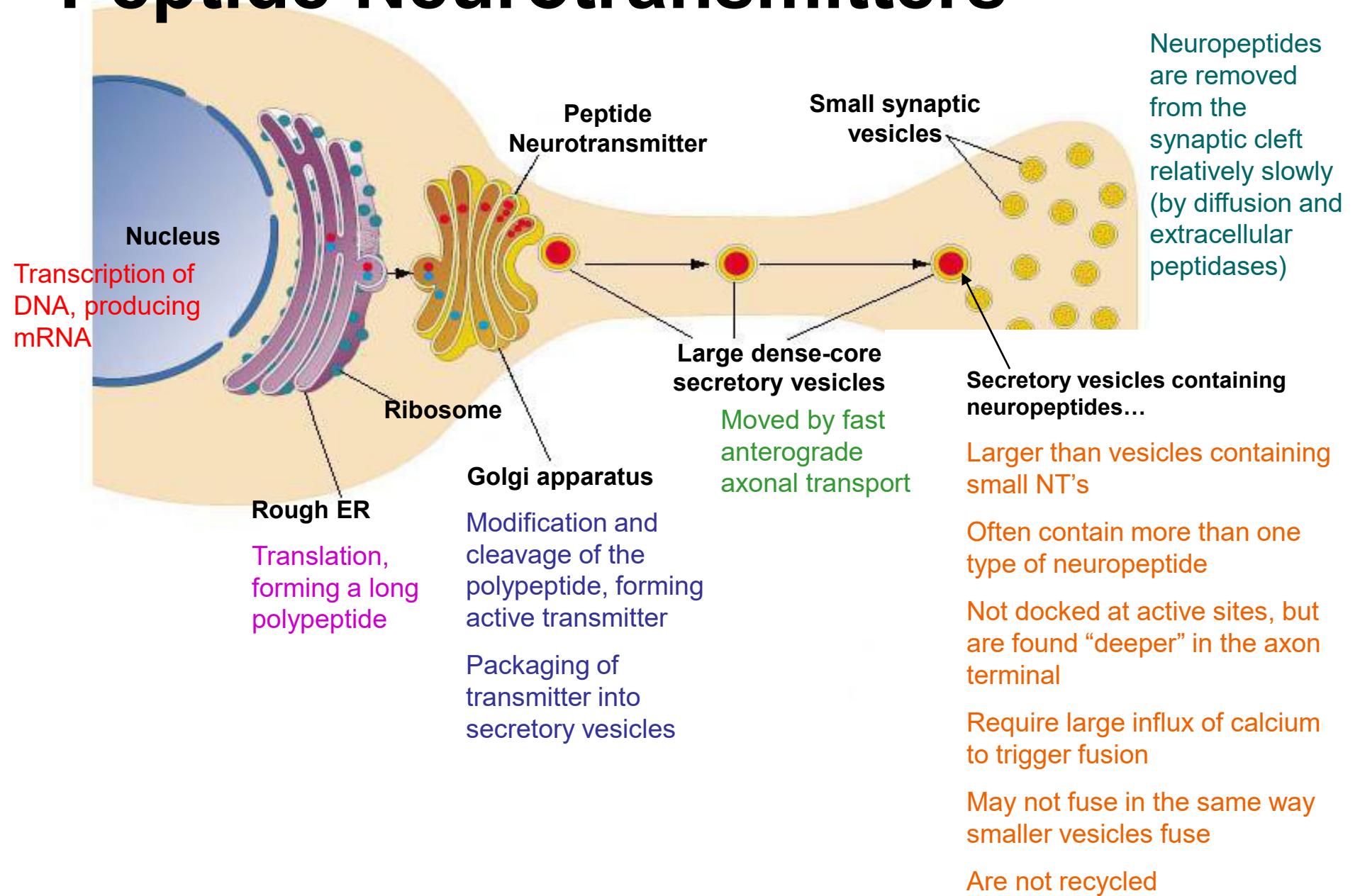
## Brain-gut peptides

- Cholecystokinin
- Substance P
- Vasoactive intestinal peptide (VIP)

## Pituitary peptides

- Oxytocin
- Vasopressin
- Adrenocorticotrophic hormone (ACTH)

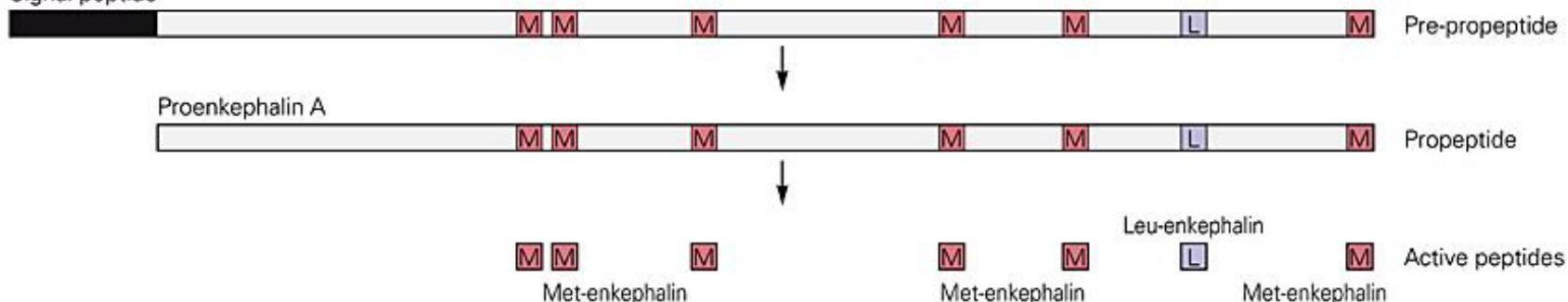
# Peptide Neurotransmitters



# Processing of Neuropeptide Precursors

## B Pre-proenkephalin A

Signal peptide



## C Pre-prodynorphin

Signal peptide

