Adrenergic Receptors

- Alpha and Beta Receptors
  - There are two major types of alpha receptors, alpha1 and alpha2, which are linked to different G proteins.
  - The beta receptors are divided into beta1, beta2, and beta3 receptors. The beta receptors also use G proteins for signaling
  - The beta receptors are divided into beta1, beta2, and beta3 receptors. The beta receptors also use G proteins for signaling.
  - Norepinephrine and epinephrine, both of which are secreted into the blood by the adrenal medulla, have slightly different effects in exciting the alpha and beta receptors.
  - Norepinephrine excites mainly **alpha receptors** but excites the beta receptors to a lesser extent as well
  - Epinephrine is a **universal stimulator** and can excite both types of receptors approximately equally.
  - Therefore, if an organ has just beta receptors (such as the heart), epinephrine will be the more effective excitant.

Adrenergic Receptors and Function

Alpha Receptor	Beta Receptor
Vasoconstriction (α_1)	Vasodilation (β_2)
Iris dilation (α_1)	Cardioacceleration (β_1)
Intestinal relaxation	Increased myocardial strength (β_1)
Intestinal sphincter contraction (α_1)	Intestinal relaxation (β_2)
Pilomotor contraction	Uterus relaxation (β_2)
Bladder sphincter contraction (α_1)	Bronchodilation (β_2)
Inhibits neurotransmitter release (α_2)	Calorigenesis (β_2)
Pupils dilate (α_1)	Glycogenolysis (β_2)
	Lipolysis (β_1)
	Bladder wall relaxation (β_2)
	Thermogenesis (β_3)

more effect on heart

more effect on blood vessels

α_1 → Stimulatory

α_2 → Inhibitory

Beta 1 → Stimulatory

Beta 2 → Inhibitory

Gs

Pupil dilation ⇒ mydriasis

Pupil constriction ⇒ miosis

presynaptic inhibition.

* most metabolic functions are mediated by Beta receptors ⇒ epinephrine

* increase in para S activity causes decrease in heart rate.

metabolic

Autonomic Effects on Various Organs of the Body

Organ	Effect of Sympathetic Stimulation	Effect of Parasympathetic Stimulation
Eye		
Pupil	Dilated	Constricted
Ciliary muscle	Slight relaxation (far vision)	Constricted (near vision)
Glands	Vasoconstriction and slight secretion	Stimulation of copious secretion (containing many enzymes for enzyme-secreting glands)
Nasal		
Lacrimal		
Parotid		
Submandibular		
Gastric		
Pancreatic		
Sweat glands	Copious sweating (cholinergic)	Sweating on palms of hands
Apocrine glands	Thick, odoriferous secretion	None
Blood vessels	Most often constricted	Most often little or no effect
Heart		
Muscle	Increased rate	Slowed rate
	Increased force of contraction	Decreased force of contraction (especially of atria)
Coronaries	Dilated (β_2); constricted (α)	Dilated
Lungs		
Bronchi	Dilated	Constricted
Blood vessels	Mildly constricted	? Dilated
Gut		
Lumen	Decreased peristalsis and tone	Increased peristalsis and tone
Sphincter	Increased tone (most times)	Relaxed (most times)

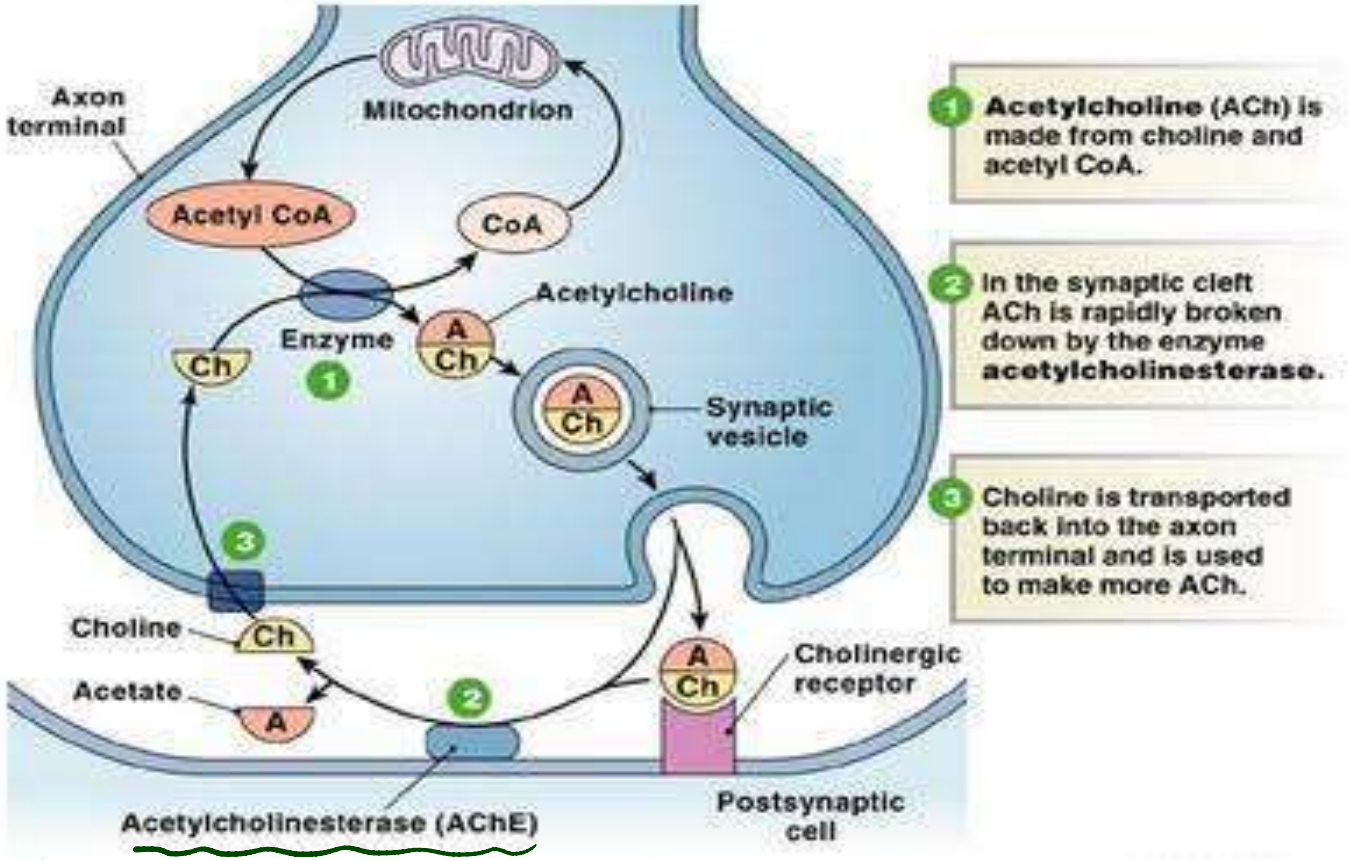
Autonomic Effects on Various Organs of the Body

Organ	Effect of Sympathetic Stimulation	Effect of Parasympathetic Stimulation
Liver	Glucose released	Slight glycogen synthesis
Gallbladder and bile ducts	Relaxed	Contracted
Kidney	Decreased urine output and increased renin secretion	None
Bladder		
Detrusor	Relaxed (slight)	Contracted
Trigone	Contracted	Relaxed
Penis	Ejaculation	Erection
Systemic arterioles		
Abdominal viscera	Constricted	None
Muscle	Constricted (adrenergic α) Dilated (adrenergic β_2) Dilated (cholinergic)	None
Skin	Constricted	None
Blood		
Coagulation	Increased	None
Glucose	Increased	None
Lipids	Increased	None
Basal metabolism	Increased up to 100%	None
Adrenal medullary secretion	Increased	None
Mental activity	Increased	None
Piloerector muscles	Contracted	None
Skeletal muscle	Increased glycogenolysis Increased strength	None
Fat cells	Lipolysis	None

Cholinergic synapse: Synthesis, release and degradation of acetylcholine

Synthesis of acetylcholine

$$\text{Acetyl-CoA} + \text{Choline} \xrightarrow{\text{Choline acetyltransferase}} \text{Acetylcholine}$$



Ways of signal termination :

① Re-uptake

② Degradation

prolongation of activity ⇐ (AChE) ليه لازم

↳ found on the surface of post-synaptic membrane

Cholinergic synapse: synthesis, release and degradation of acetylcholine

1- Choline out side, Choline enters via symport [enters alongside Na]

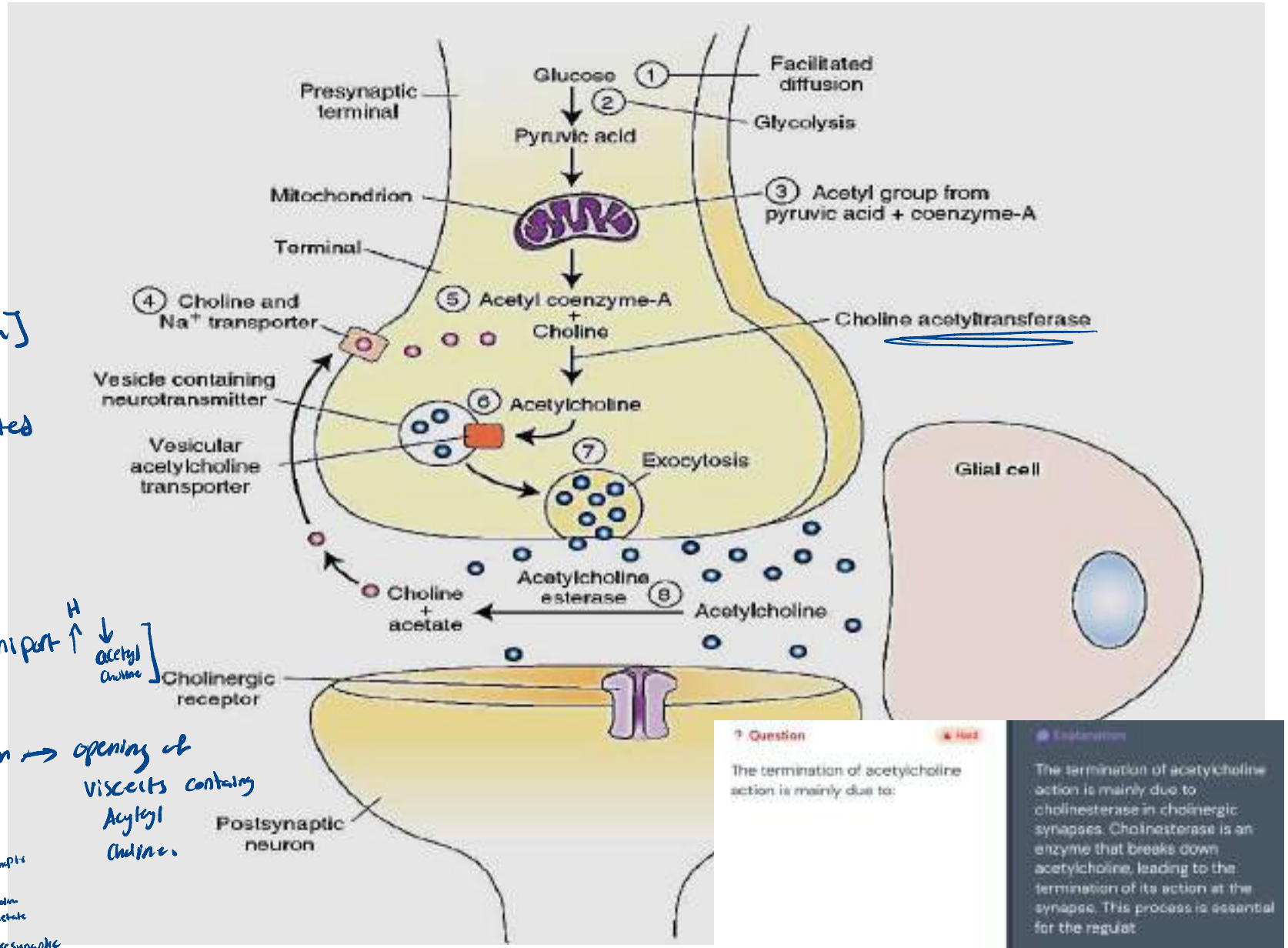
2- when Choline enters, it is acylated By Ac.CoA within neurons, now called acetyl Choline

Rate determining step (RDS)

3- Acetyl Choline is put in vesicles [antiport ↑H ↓ acetyl choline]
↳ uses energy.

4- Action potential → influx of Ca^{2+} to neuron → opening of vesicles containing Acetyl Choline.

5- Vesicles fuse with membrane releasing Acetyl Choline into the cleft
- Bind to postsynaptic
- By enzyme degradation → Choline + Acetate
- Bind again to presynaptic



? Question

The termination of acetylcholine action is mainly due to:

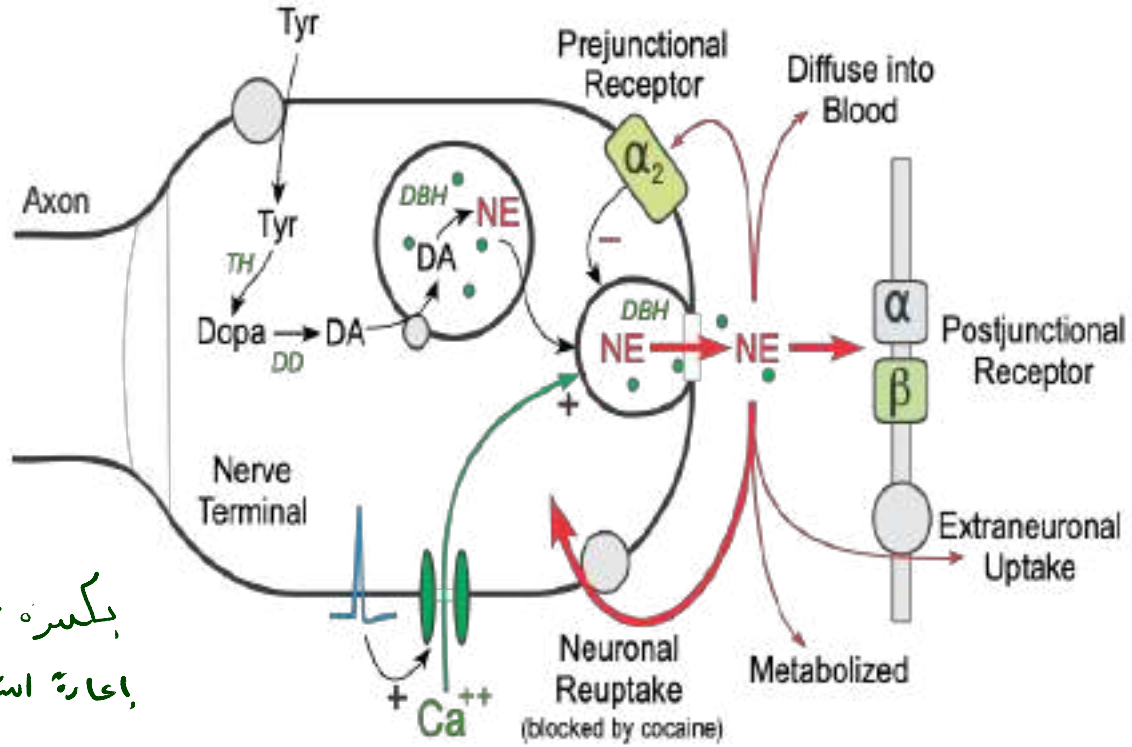
Explanation

The termination of acetylcholine action is mainly due to cholinesterase in cholinergic synapses. Cholinesterase is an enzyme that breaks down acetylcholine, leading to the termination of its action at the synapse. This process is essential for the regulat

Synthesis , release and termination of action of NE

Termination of action of NE

- Reuptake into the adrenergic nerve endings by an **active transport process**, accounting for removal of 50 to 80% of the secreted norepinephrine
- Diffusion away from the nerve endings into the surrounding body fluids and then into the blood
- Destruction of small amounts by tissue enzymes (one of these enzymes is monoamine oxidase (MAO) which is found in the nerve endings, and another is catechol-O-methyl transferase (COMT), which is present diffusely in the tissues especially the liver).



Tyr, tyrosine; *TH*, tyrosine hydroxylase; *DD*, DOPA decarboxylase; *DA*, dopamine; *DBH*, dopamine β-hydroxylase; *NE*, norepinephrine

Synthesis:

① NE is synthesized by the amino acid ⇒ thyrosine → NE , E أصل ال

② Thyrosine (with the presence of thyrosine hydrolase) becomes Dopa —(dopamine dehydrogenase)→ Dopamine —(Dopamine Beta hydrogenase)→ NE

→ لو بدنا نحول ال NE الى E بنضيف methyl CH3 من مادة اسمها methyl transferase

صار جاهز عشان يطلع من ال vesicle عن طريق exocytosis
و يرتبط بسرعة مع Beta أو alpa receptors

Termination:

① Nueronal uptake by active transport (80%)

② metabolism through one of the 2 enzymes → MAO / COMT

③ diffusion