Teaching Enhancement by Simulated Learning Aids: Simulated animation of the lifecycle of neurotransmitter: Acetylcholine

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Acetylcholine

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2. *Biochemistry of Acetylcholine (ACh)*
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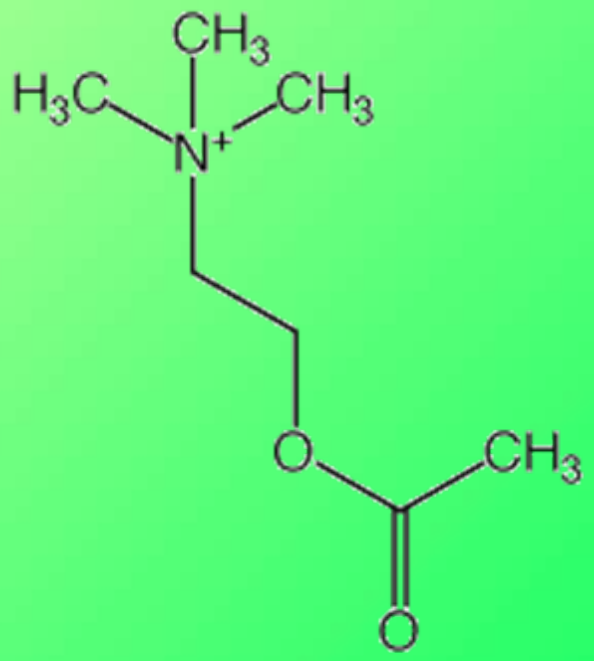
Introduction

In the course BISC 395 Neuroscience taught at HKUST, neurotransmitter is one of the most important parts in the syllabus. ***Acetylcholine*** (ACh) is the first example of neurotransmitter of this part. In the past, students were only shown and taught by descriptive texts and pictures. Some of them would feel hard to imagine the whole story by reading the texts and looking at static pictures, and therefore lose the interests to learn. To enhance student learning, a prototype of ***Simulated Learning Aids*** (***SLAs***) has been developed to simulate the biochemical reaction of the lifecycle of ACh.

Biochemistry of Acetylcholine (ACh)

Acetylcholine (ACh), the first neurotransmitter ever to be identified, is a small- molecule neurotransmitter with a wide variety of known functions



Acetylcholine

Biochemistry of Acetylcholine (ACh)

ACh synthesis

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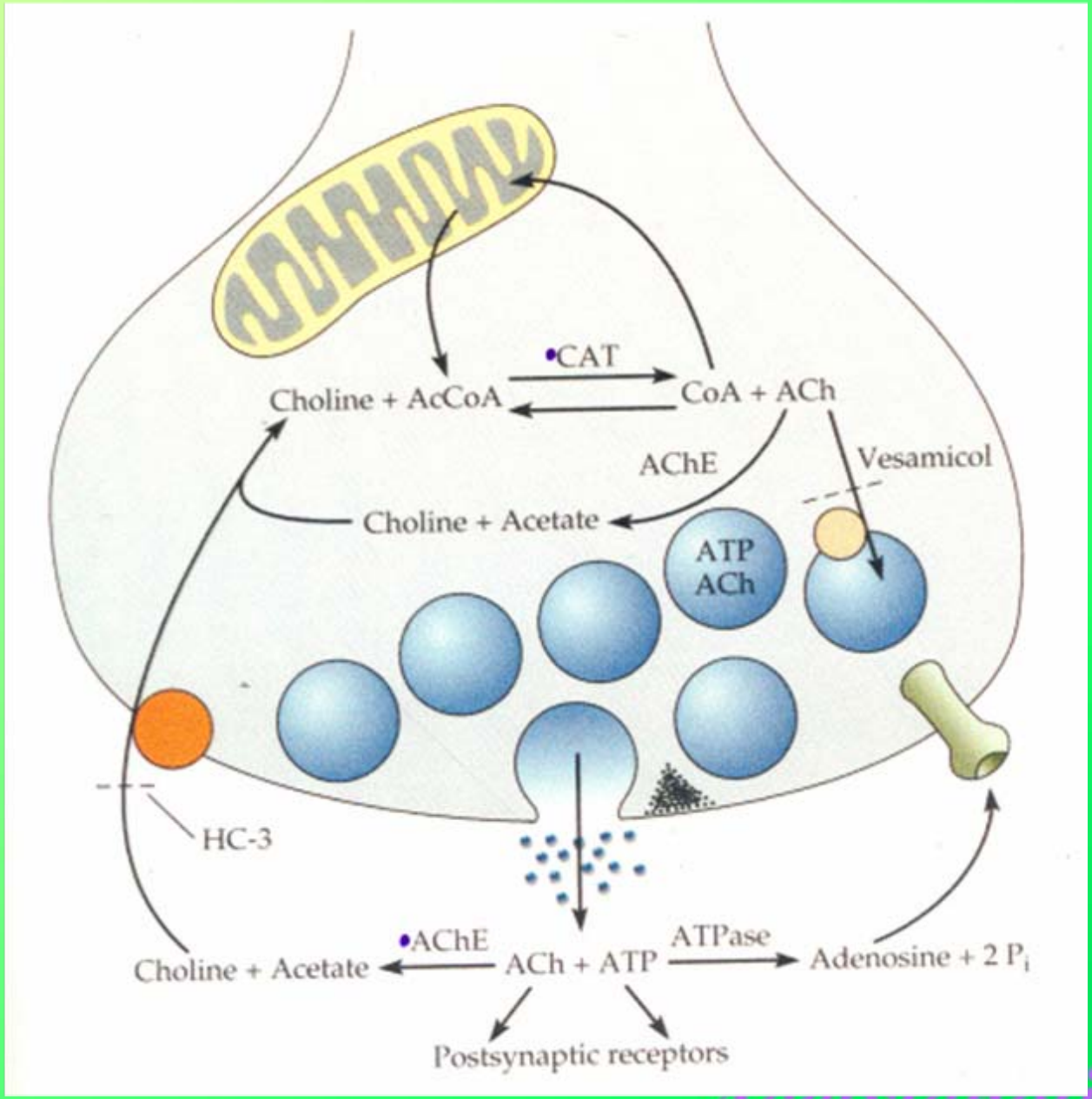
ACh storage

↓

ACh release

↓

ACh degradation



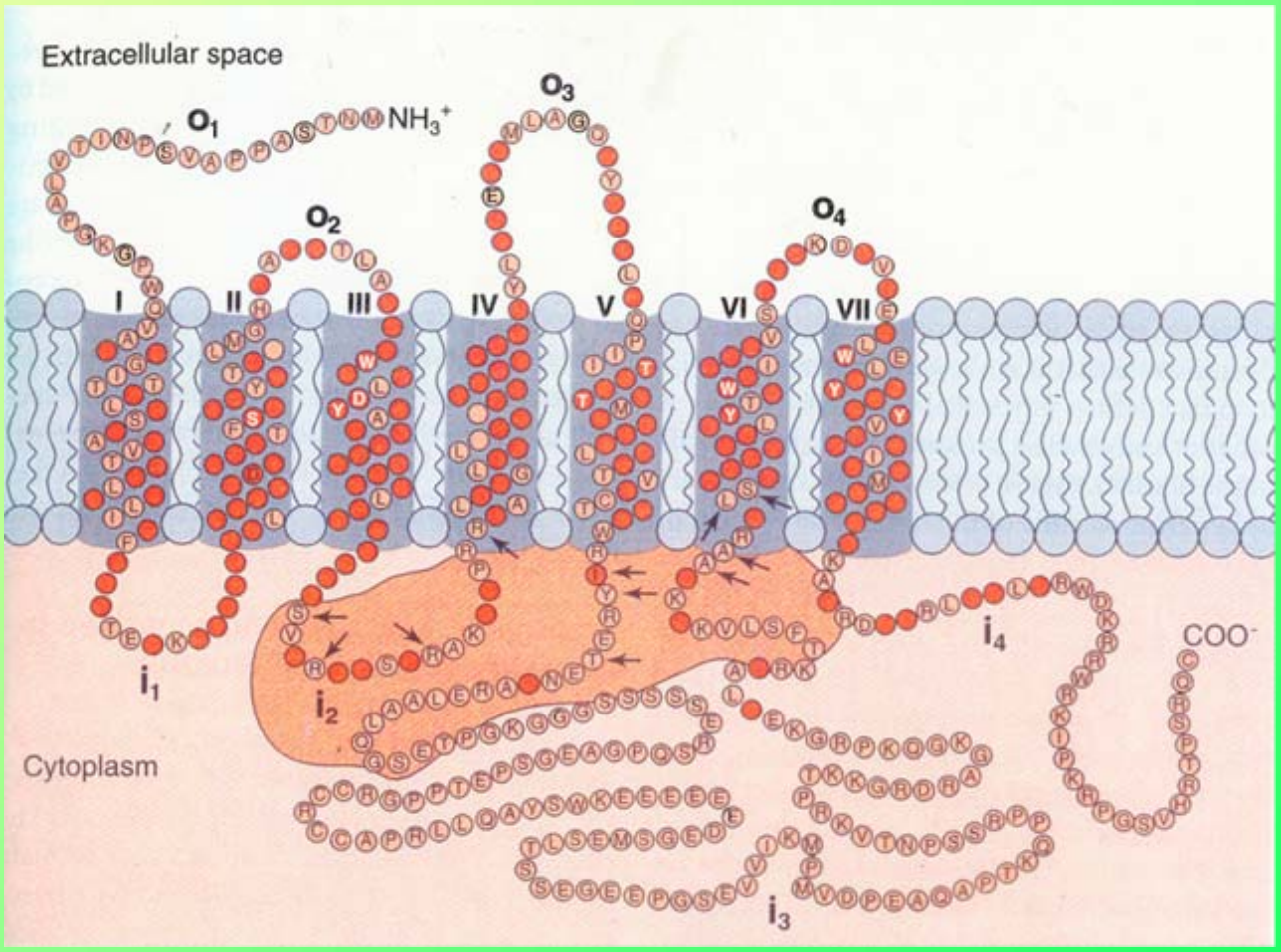
Visualization and simulations of the life cycle of ACh

- 2D animated simulation of biochemical pathway
- Label of importance parts
- Reference
- Glossary
- Narration

Biochemistry of Acetylcholine (ACh)

Nicotinic	Muscarine
1. All **skeletal muscles** and **striated muscles** of the **head** (muscles of facial expression, chewing, etc.)	1. Parasympathetically innervated cardiac and **smooth muscles** (**heart**, constrictors of the iris, **stomach**, **bronchioles**, **intestines**, etc.)
2. Postganglionic parasympathetic neurons	2. Salivary, tear, and sweat glands
3. Postganglionic sympathetic neurons	3. Cholinergic receptors in **cortical** and subcortical neurons
4. Some cholinergic receptors in the **cortex** and **subcortical** structures	4. Organs innervated by the parasympathetic sacral division (lower colon, bladder, **urogenital organs**)
5. Sacral postganglionic parasympathetic fibers	

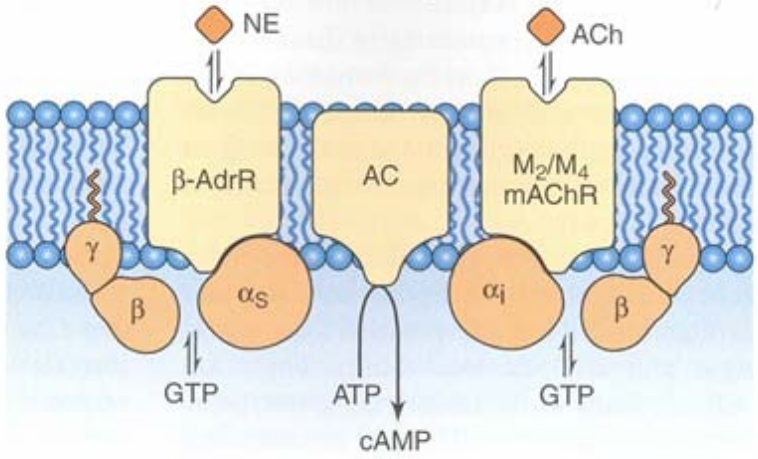
Human M_1 muscarinic ACh Receptors (mAChR)



- Predicted amino acid sequence and transmembrane domain structure of the human **M_1** muscarinic receptor.
- Amino acids that are identical among the **M_1, M_2, M_3**,and **M_4** receptors are **darked**.
- The shaded cloud represents the approximate region that determines **receptor-G-protein coupling.**

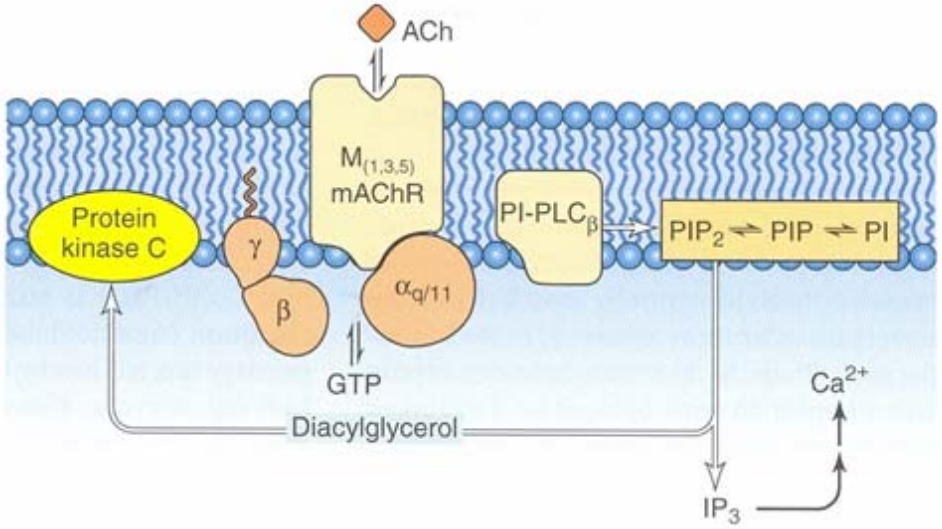
Primary biochemical responses mediated by muscarinic acetylcholine receptors

Inhibition of adenylyl cyclase



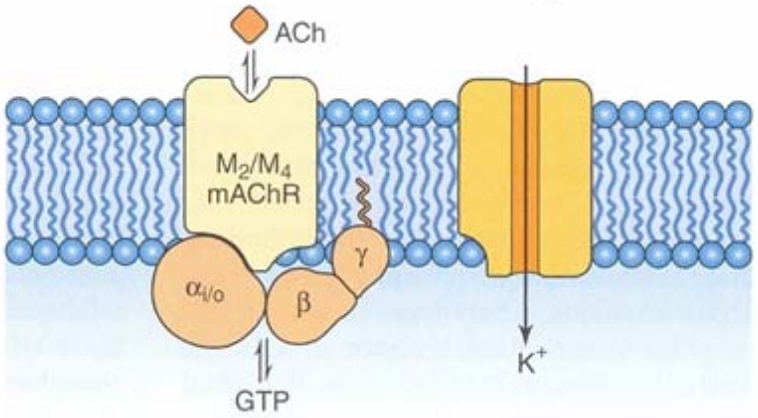
M_2/M_4

Stimulation of phospholipase C



$M_{1,3,5}$

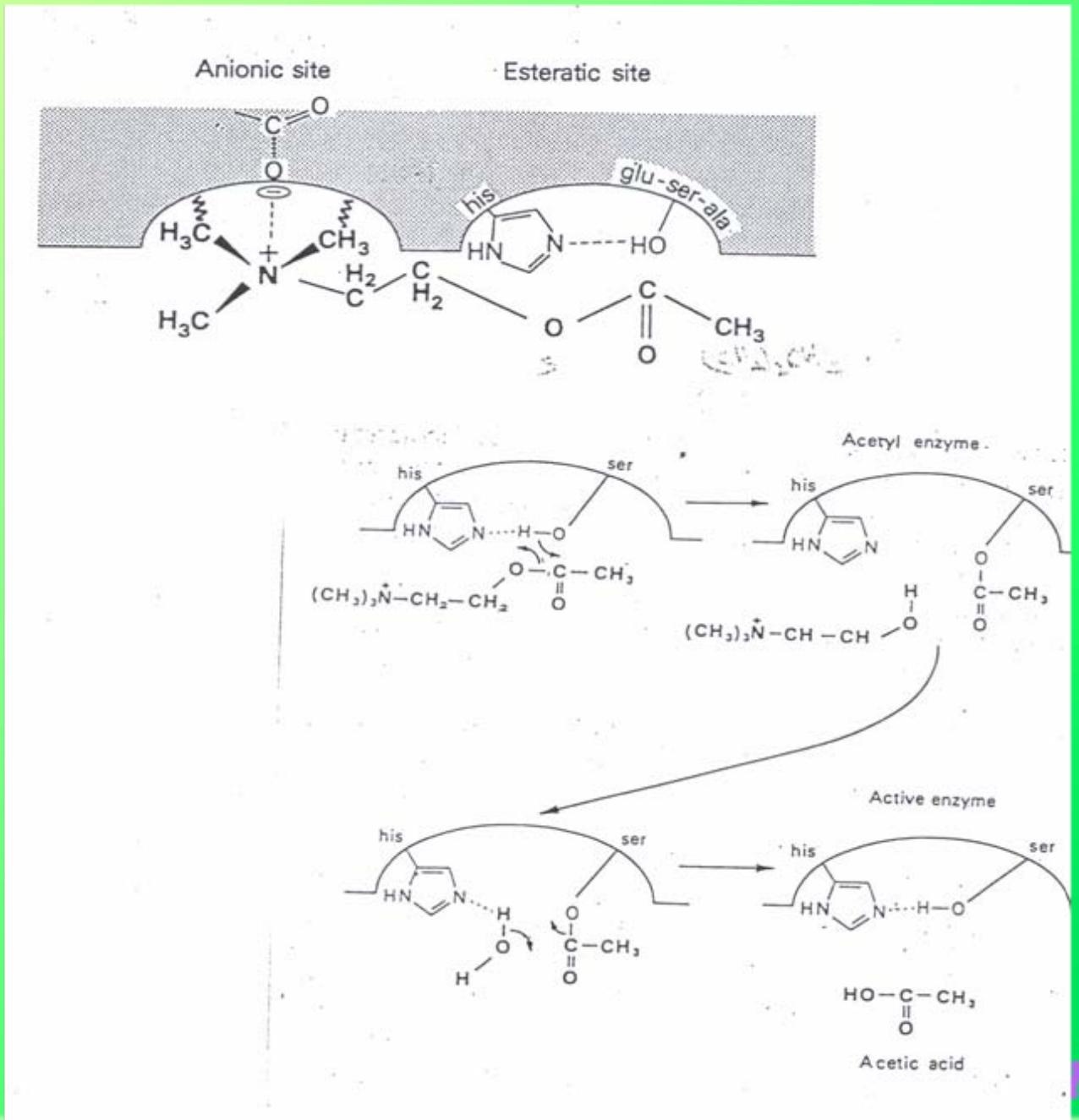
Regulation of K^+ channels



M_2/M_4

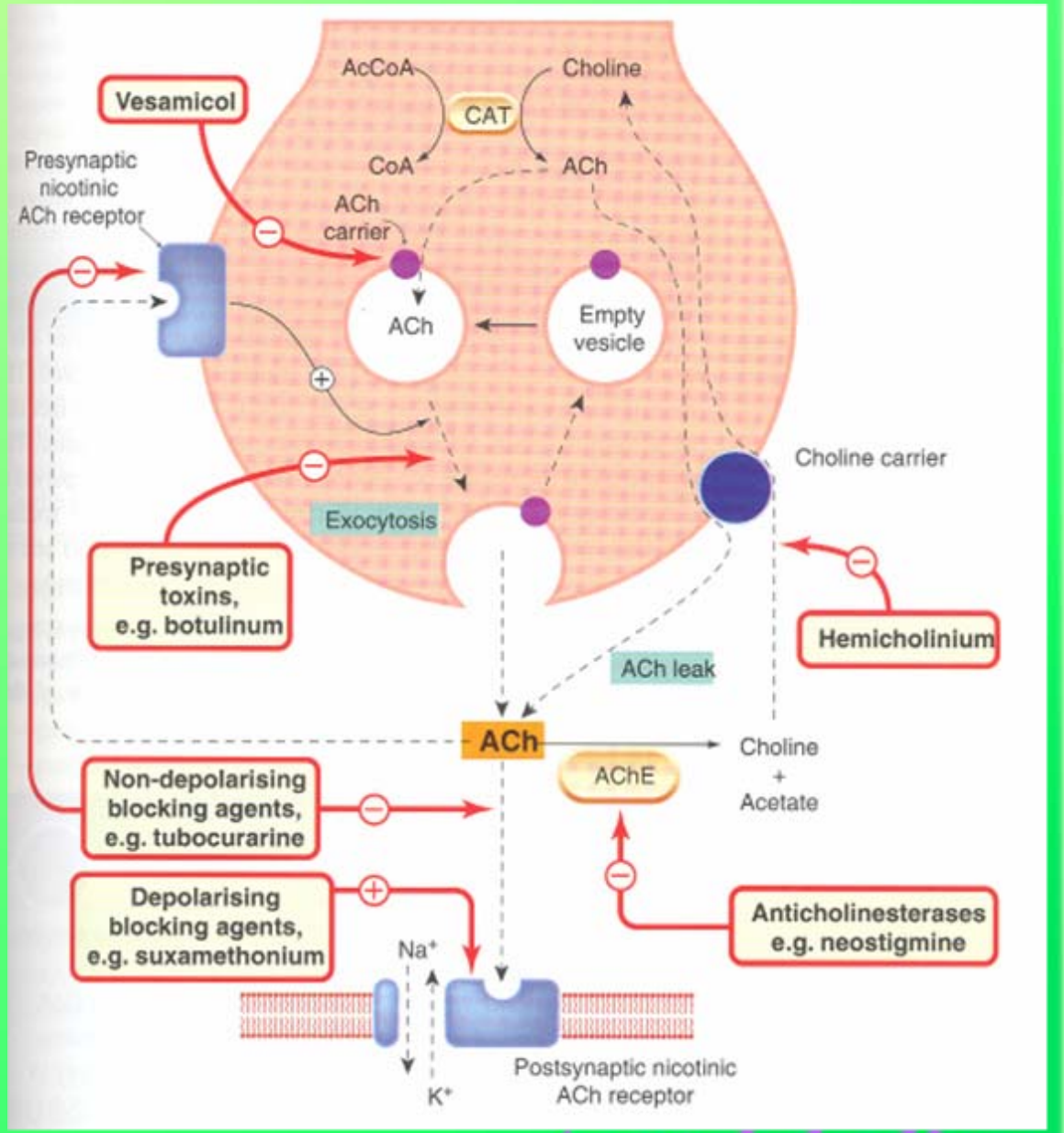
The catalytic mechanism for ACh hydrolysis

The reaction of AChE with ACh involves ***three*** steps:



Events and sites of drug action at a nicotinic cholinergic synapse

When **AChE** is inhibited, the amount of **free ACh**, and the rate of leakage of ACh via the **choline carrier**, are **increased**.



Students' responds

1. The 3D animation prototype **increases my interest** in learning the life cycle of ACh.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	a.Strongly Agree	5	16.7	16.7	16.7
	b.Agree	21	70.0	70.0	86.7
	c.Disagree	3	10.0	10.0	96.7
	d.Strongly Disagree				
	e.No opinion	1	3.3	3.3	100.0
	Total	30	100.0	100.0	

2. The 3D animation prototype **improves my understanding** of the life cycle of ACh.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	a.Strongly Agree	6	20.0	20.0	20.0
	b.Agree	24	80.0	80.0	100.0
	c.Disagree				
	d.Strongly Disagree				
	e.No opinion				
	Total	30	100.0	100.0	

Students' responds

3. The **appearance** of the 3D animation prototype is clear and good.

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	a.Strongly Agree	8	26.7	26.7	26.7
	b.Agree	19	63.3	63.3	90.0
	c.Disagree	1	3.3	3.3	93.3
	d.Strongly Disagree				
	e.No opinion	2	6.7	6.7	100.0
	Total	30	100.0	100.0	

4. Does the **keyword explanation** help you understand the contents?

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	a.Very much	9	30.0	30.0	30.0
	b.Quite	17	56.7	56.7	86.7
	c.To some extent	4	13.3	13.3	100.0
	d.Little				
	e.Not at all				
	Total	30	100.0	100.0	

Conclusion

By using the SLAs, the pathways of lifecycle of ACh can be simulated. Students can have a better understanding of the lifecycle of ACh.