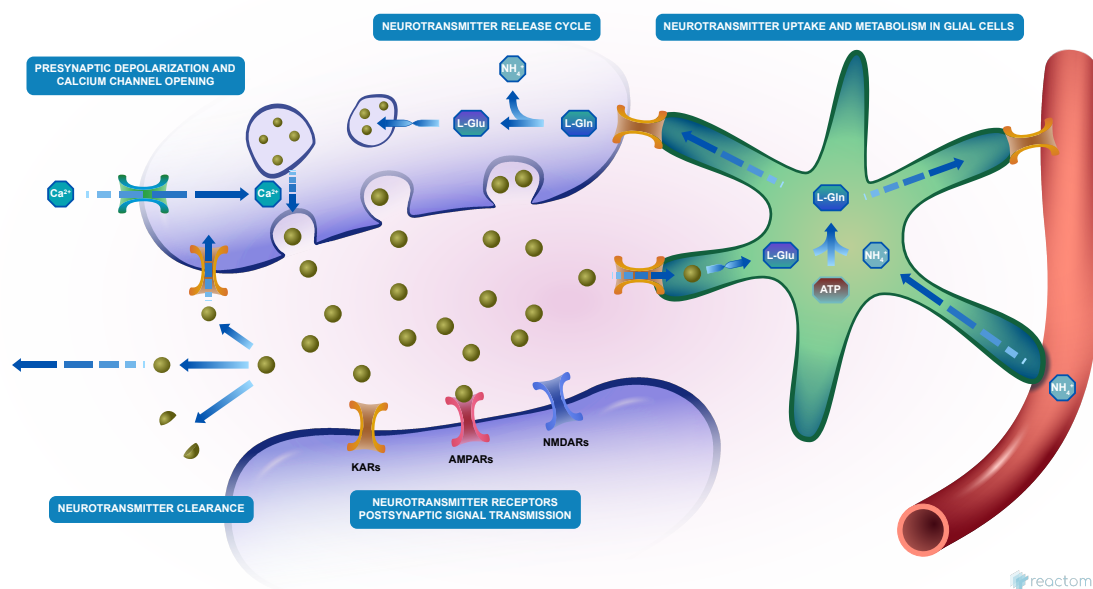


Transmission across Chemical Synapses



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This is just an excerpt of a full-length report for this pathway. To access the complete report, please download it at the [Reactome Textbook](#).

25/04/2024

Introduction

Reactome is open-source, open access, manually curated and peer-reviewed pathway database. Pathway annotations are authored by expert biologists, in collaboration with Reactome editorial staff and cross-referenced to many bioinformatics databases. A system of evidence tracking ensures that all assertions are backed up by the primary literature. Reactome is used by clinicians, geneticists, genomics researchers, and molecular biologists to interpret the results of high-throughput experimental studies, by bioinformaticians seeking to develop novel algorithms for mining knowledge from genomic studies, and by systems biologists building predictive models of normal and disease variant pathways.

The development of Reactome is supported by grants from the US National Institutes of Health (P41 HG003751), University of Toronto (CFREF Medicine by Design), European Union (EU STRP, EMI-CD), and the European Molecular Biology Laboratory (EBI Industry program).

Literature references

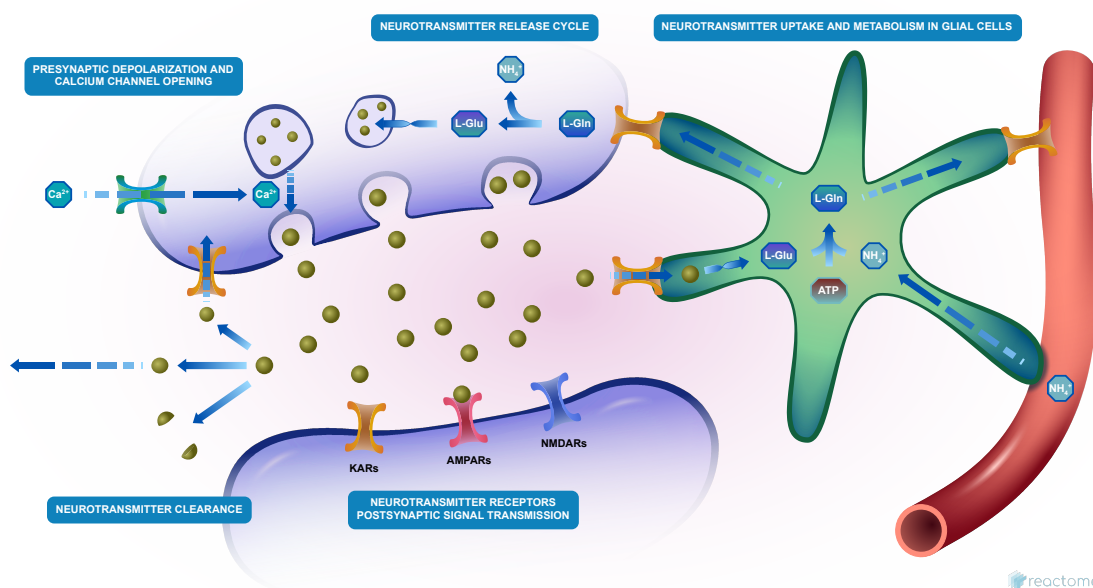
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Reactome database release: 88

This document contains 6 pathways ([see Table of Contents](#))

Transmission across Chemical Synapses ↗

Stable identifier: R-HSA-112315



Chemical synapses are specialized junctions that are used for communication between neurons, neurons and muscle or gland cells. The synapse involves a presynaptic neuron and a postsynaptic neuron, muscle cell or gland cell. The pre and the postsynaptic cell are separated by a gap (space) of 20 to 40 nm called the synaptic cleft. The signals pass in a single direction from the presynaptic to postsynaptic neuron (cell). The presynaptic neuron communicates via the release of neurotransmitter which bind the receptors on the postsynaptic cell. The process is initiated when an action potential invades the terminal membrane of the presynaptic neuron.

Action potentials occur in electrically excitable cells such as neurons and muscles and endocrine cells. They are initiated by the transient opening of voltage dependent sodium channels, causing a rapid, large depolarization of membrane potentials that spread along the axon membrane.

When action potentials arrive at the synaptic terminals, depolarization in membrane potential leads to the opening of voltage gated calcium channels located on the presynaptic membrane. The external Ca^{2+} concentration is approximately 10^{-3} M while the internal Ca^{2+} concentration is approximately 10^{-7} M. Opening of calcium channels causes a rapid influx of Ca^{2+} into the presynaptic terminal. The elevated presynaptic Ca^{2+} concentration allows synaptic vesicles to fuse with the plasma membrane of the presynaptic neuron and release their contents, neurotransmitters, into the synaptic cleft. These diffuse across the synaptic cleft and bind to specific receptors on the membrane of the postsynaptic cells. Activation of postsynaptic receptors upon neurotransmitter binding can lead to a multitude of effects in the postsynaptic cell, such as changing the membrane potential and excitability, and triggering intracellular signaling cascades.

Literature references

Fitzpatrick, D., Augustine, DJ., Katz, LC., Williams, JM., Purves, D., McNamara, JO. et al. (2001). Neuroscience 2nd Edition. Oxford University Press.

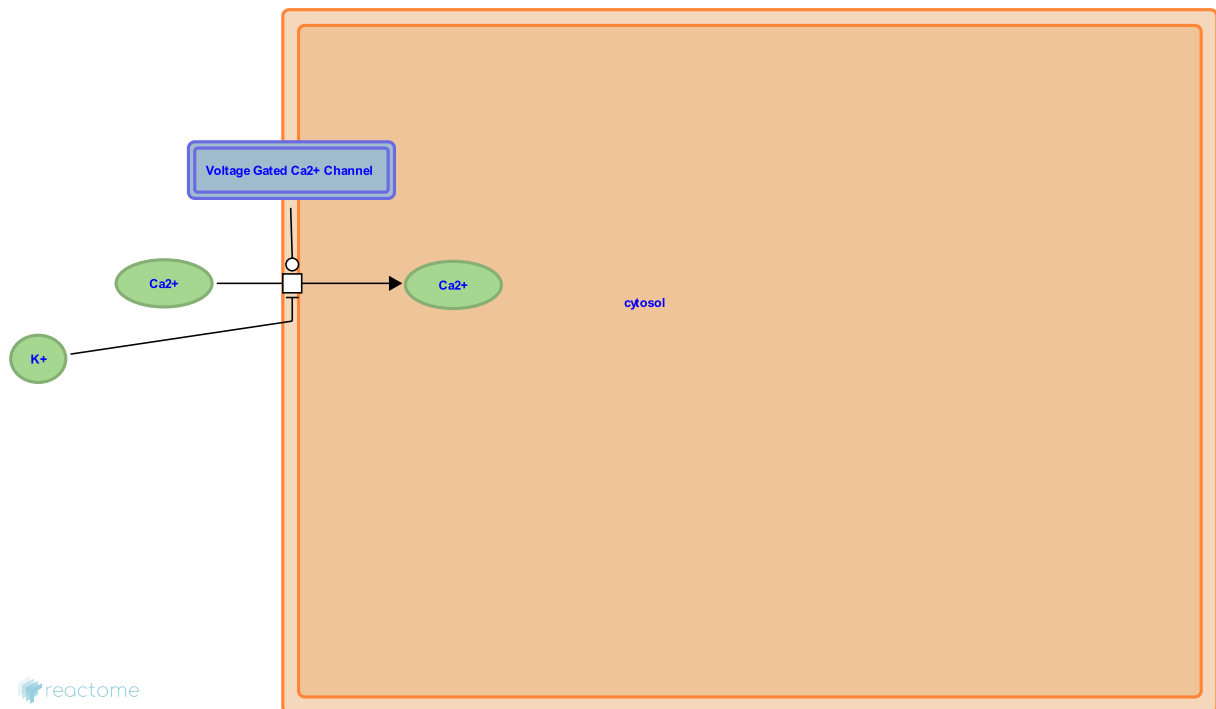
Editions

2008-01-14	Authored, Edited	Mahajan, SS.
2008-12-02	Reviewed	Kavalali, E., Restituito, S.
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Presynaptic depolarization and calcium channel opening ↗

Location: [Transmission across Chemical Synapses](#)

Stable identifier: R-HSA-112308



Action potentials occur in electrically excitable cells such as neurons, muscles, and endocrine cells. They are initiated by transient opening of voltage dependent sodium channels, causing a rapid, large depolarization of membrane potentials that spread along the axon membrane.

The action potential travels down the axon and reaches the presynaptic terminal depolarizing the membrane in the pre synaptic terminal. The depolarization causes the voltage gated Ca²⁺ channels to open allowing the influx of Ca²⁺ that signals the release of neurotransmitter into the synaptic cleft.

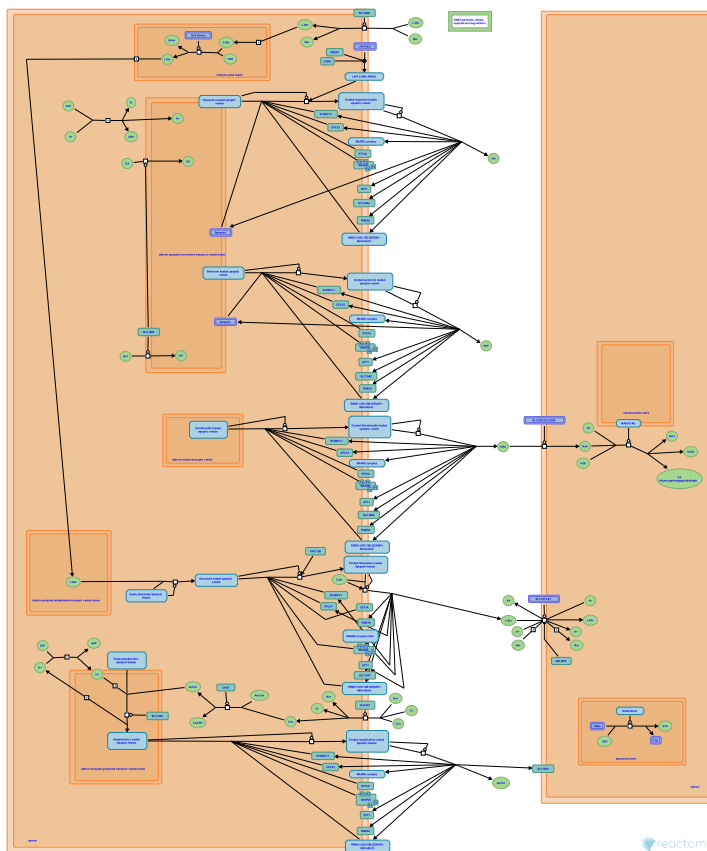
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Neurotransmitter release cycle ↗

Location: [Transmission across Chemical Synapses](#)

Stable identifier: R-HSA-112310



Neurotransmitter is stored in the synaptic vesicle in the pre-synaptic terminal prior to its release in the synaptic cleft upon depolarization of the pre-synaptic membrane. The release of the neurotransmitter is a multi-step process that is controlled by electrical signals passing through the axons in form of action potential. Neurotransmitters include glutamate, acetylcholine, nor-epinephrine, dopamine and serotonin. Each of the neurotransmitter cycle is independently described.

Literature references

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Südhof, TC. (2004). The synaptic vesicle cycle. *Annu Rev Neurosci*, 27, 509-47. ↗

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Editions

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Mahajan, SS.

2008-12-02

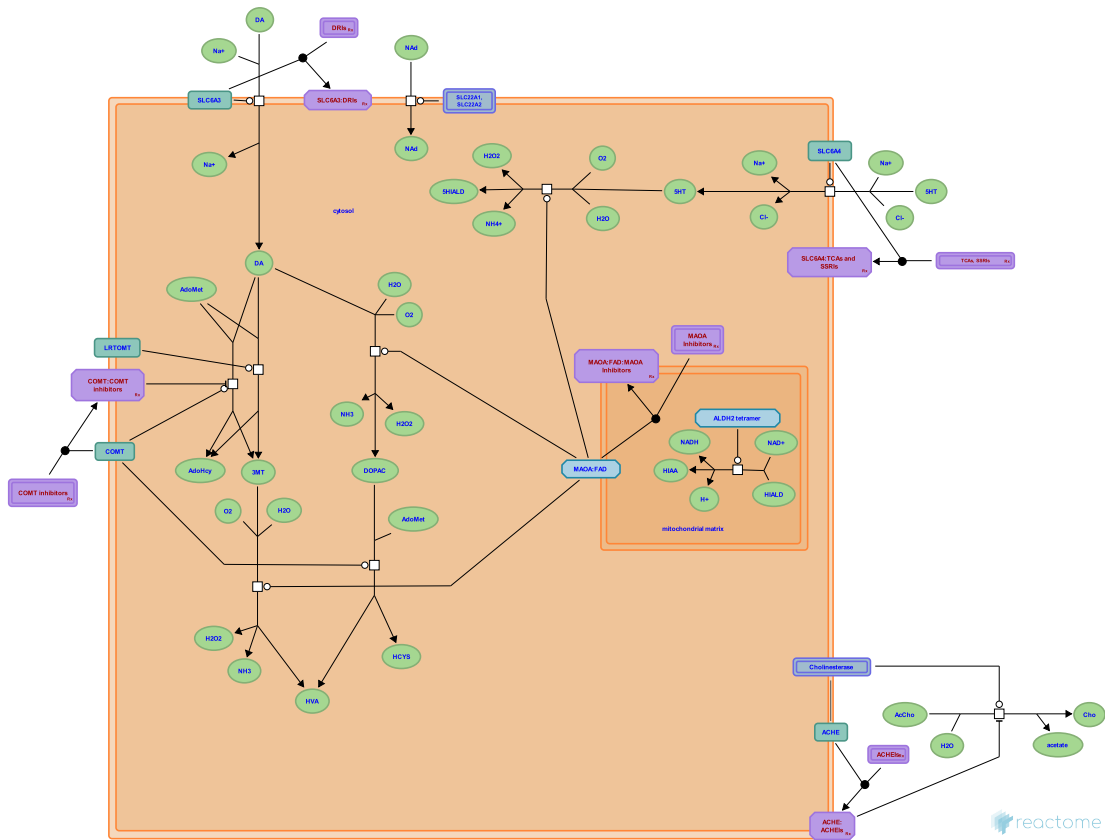
Reviewed

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Neurotransmitter clearance ↗

Location: Transmission across Chemical Synapses

Stable identifier: R-HSA-112311



Neurotransmitter released in the synaptic cleft binds to specific receptors on the post-synaptic cell and the excess of the neurotransmitter is cleared to prevent over activation of the post-synaptic cell. The neurotransmitter is cleared by either re-uptake by the pre-synaptic neuron, diffusion in the perisynaptic area, uptake by astrocytes surrounding the synaptic cleft or enzymatic degradation of the neurotransmitter.

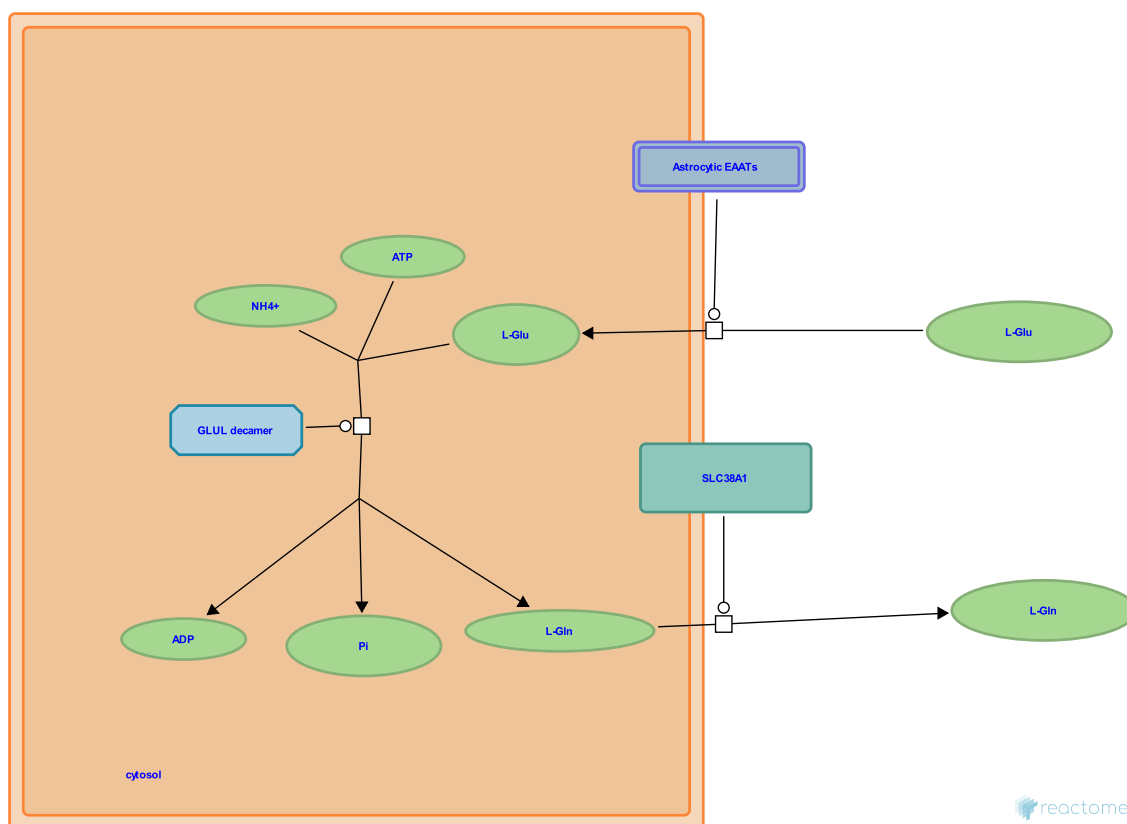
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Neurotransmitter uptake and metabolism In glial cells ↗

Location: [Transmission across Chemical Synapses](#)

Stable identifier: R-HSA-112313



Neurotransmitter uptake by astrocytes is mediated by a specific transporter located on the astrocytic membrane. The imported neurotransmitter is metabolized and transported back to the neuron.

Editions

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2008-12-02

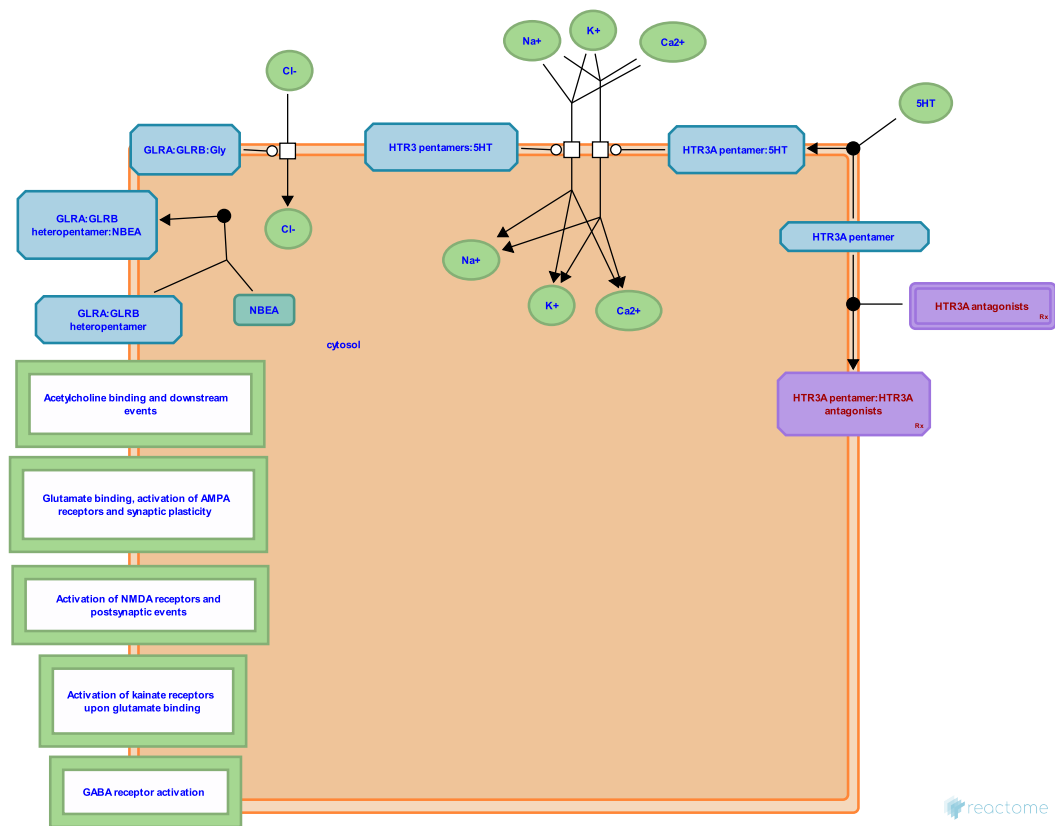
Reviewed

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Neurotransmitter receptors and postsynaptic signal transmission ↗

Location: [Transmission across Chemical Synapses](#)

Stable identifier: R-HSA-112314



The neurotransmitter in the synaptic cleft released by the pre-synaptic neuron binds specific receptors located on the post-synaptic terminal. These receptors are either ion channels or G protein coupled receptors that function to transmit the signals from the post-synaptic membrane to the cell body.

Editions

2008-01-14

Authored

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2008-12-02

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