

Difference Between Nicotinic and Muscarinic Receptors

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Key Difference - Nicotinic vs Muscarinic Receptors

Nervous coordination is based on the synaptic transmission of nerve impulses. Different neurotransmitters are involved in nervous transmission. Acetylcholine is one of a neurotransmitter involved in the nervous system. There are two main types of receptors in which acetylcholine acts based on the agonist. The two main acetylcholine receptors are Nicotinic Receptors and Muscarinic receptors. Acetylcholine binds to these receptors and transmits the signals via these receptors. Nicotinic receptors are the acetylcholine receptors in which the agonist is nicotine, and are ligand-gated ion channels. Muscarinic receptors are the acetylcholine receptors in which muscarine acts as the agonist, and they are G protein-coupled receptors. The **key difference** between nicotinic and muscarinic receptors is that **Nicotinic receptors are ligand-gated ion channels, whereas Muscarinic receptors are G protein-coupled receptors.**

What are Nicotinic Receptors?

Nicotinic Receptors are named based upon their specific agonist which is nicotine. Nicotine is the active compound of tobacco. Nicotine is an alkaloid and has many neuro effects upon administration to the living system. Nicotinic receptors are ligand-gated ion channels. They exist as pores in the plasma membrane, and thus, they are involved in fast synaptic nervous transmission.

Nicotinic acetylcholine receptors are involved in a variety of functions which depends on the site of the receptor. Muscle type nicotinic receptors are situated at neuromuscular junctions. They are responsible for coordinating the muscular movements which include both contractions and relaxations. Neuronal nicotinic receptors are situated in between neurons and are involved in a variety of functions including memory, learning, motor control and analgesia.

The action of nicotinic receptors is brought about by the binding of acetylcholine to the receptor. Upon binding the nicotinic receptor, its conformation changes and increases the permeability of sodium and calcium ions into the plasma membrane. This facilitates the depolarization and excitation which results in a nervous transmission.

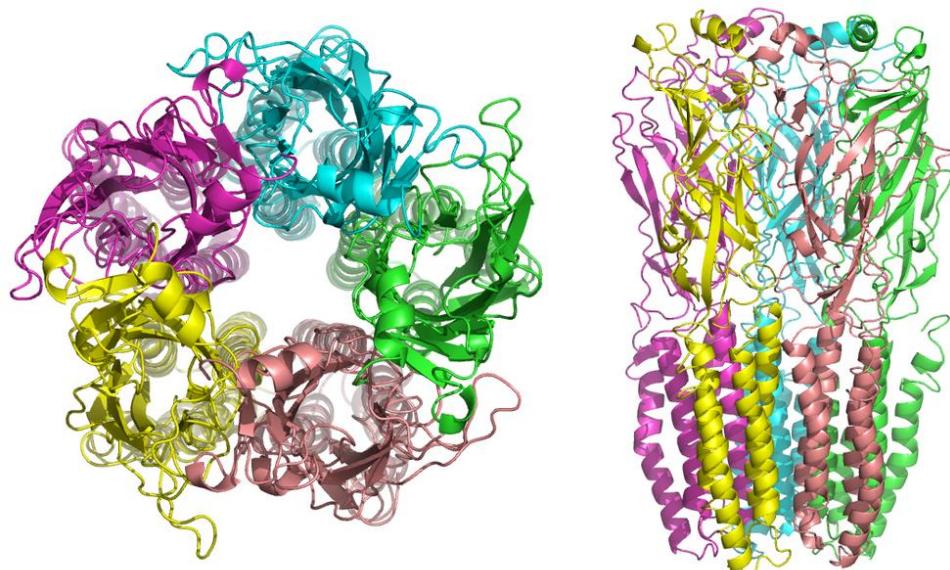


Figure 01: Nicotinic Receptor Structure

There are five types of subunits of the Nicotinic Acetylcholine receptors (AChRs) namely alpha (a₁-a₁₀), beta (b₂-b₅), delta, epsilon, and gamma. Different combinations of above five subunits can be found in different types of nicotinic receptors. Nicotinic receptors attain a pentameric structure. It is composed of Acetylcholine binding site which is an alpha dimer and an adjacent subunit which is the complementary subunit.

What are Muscarinic Receptors?

Muscarinic receptors or muscarinic acetylcholine receptors are named by its complementary agonist which is muscarine. Muscarine is an alkaloid obtained from the [mushroom](#) called *Amanita muscaria*. This is a water-soluble [toxin](#) and binds to the muscarinic receptors and can result in fatal outcomes.

Muscarinic receptors are G protein-coupled receptors and activate the secondary messenger systems to increase the transmission of [calcium](#) ions into the cell to facilitate the nerve transmission. Upon binding of acetylcholine to the muscarinic receptor, a G protein-coupled reaction cascade is activated. Since the receptor is a G protein-coupled protein, the transmission process is relatively slow. Muscarinic receptors are involved in a wide array of functions which include contraction and relaxation of the muscle, regulating the [heart rate](#) and in the release of various neurotransmitters.

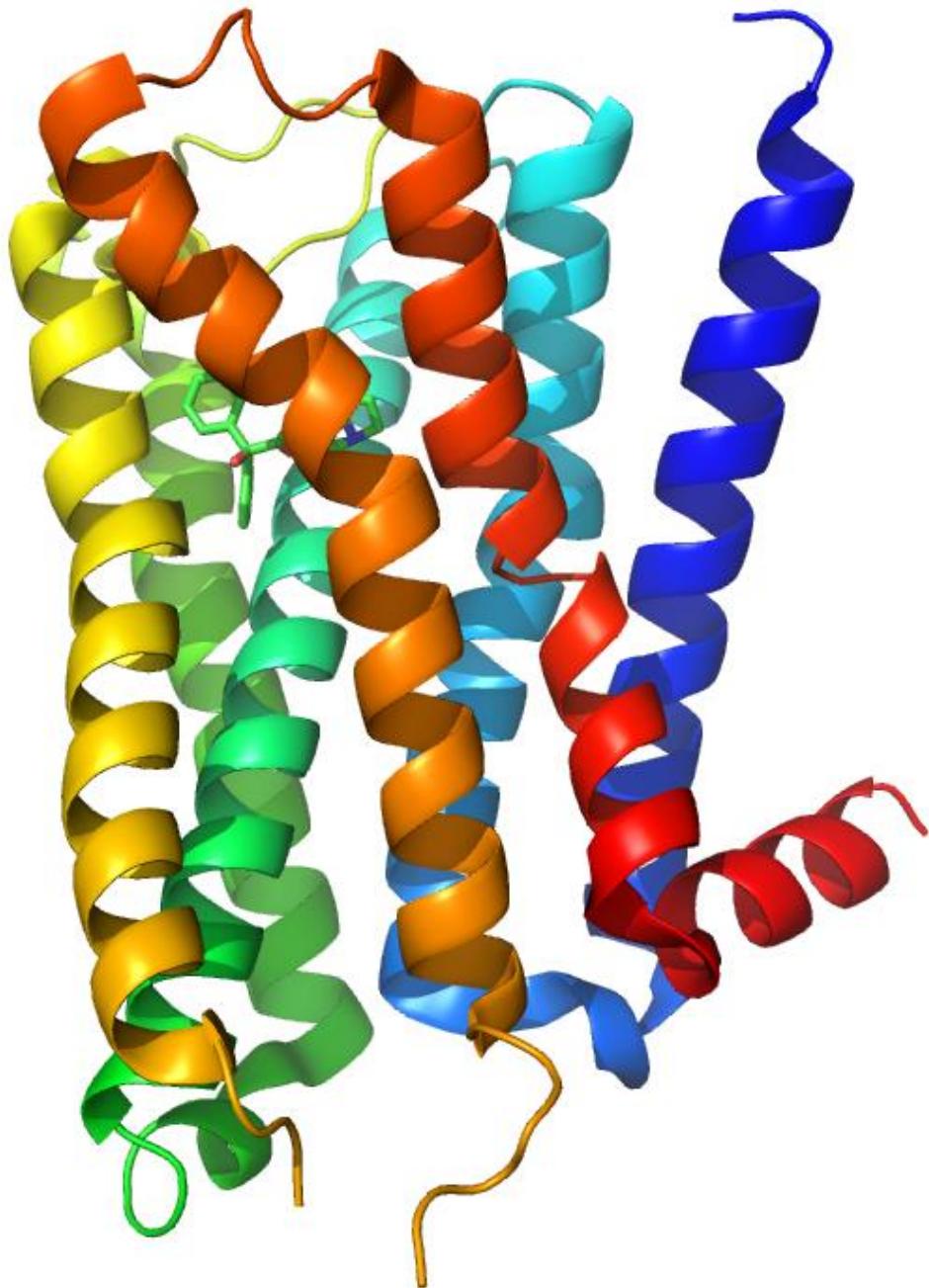


Figure 02: Muscarinic Receptors

There are five main subtypes of muscarinic receptors, and they are labeled as M₁, M₂, M₃, M₄, and M₅. All five muscarinic receptors are found in the [central nervous system](#). And M₁-M₄ are found in other types of tissues as well. M₁ Acetylcholine receptors can be found in secretory glands while M₂ Acetylcholine receptors are commonly found in cardiac tissues. M₃ Acetylcholine receptors are found in smooth muscles and secretion glands. M₁, M₃,

and M₅ receptors cause the activation of phospholipase C, leading to an intracellular increase of calcium, while M₂ and M₄ inhibit adenylyl cyclase.

What are the Similarities Between Nicotinic and Muscarinic Receptors?

- Both receptors are acetylcholine binding receptors.
- Both receptors have a five-subunit structure.
- Both receptors have agonists which are alkaloids.
- Both receptors are situated in the central nervous system which perform various functions.
- Both receptors are involved in nerve transmission.
- Both receptors are highly dynamic.
- Both are receptor proteins.
- Both are integral membrane proteins.

What is the Difference Between Nicotinic and Muscarinic Receptors?

| Nicotinic vs Muscarinic Receptors | |
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| Nicotinic receptors are the receptors in which the agonist is nicotine, and are ligand-gated ion channels in which neurotransmission is facilitated. | Muscarinic receptors are the acetylcholine receptors in which muscarine acts as the agonist, and they are G protein-coupled receptors. |
| Agonists | |
| Nicotine acts as an agonist for the Nicotinic receptor. | Muscarine acts as an agonist for the Muscarinic receptor. |
| Type of Receptor | |
| Nicotinic receptors are ligand-gated ion channels. | Muscarinic receptors are G protein-coupled receptors. |
| Speed of Nerve Transmission | |
| Nicotinic receptors mediate a fast synaptic transmission of the neurotransmitter. | Muscarinic receptors mediate a slow metabolic response via second messenger cascades. |

Summary - Nicotinic vs Muscarinic Receptors

Nervous receptors play a major role in the signal transmission of the nervous system. The main neurotransmitter (Acetylcholine) binds to two main receptors. They are nicotinic receptors and muscarinic receptors. They are named according to the agonists which bind to these receptors. Nicotine binds to nicotinic receptors, and muscarine binds to muscarinic receptors. They are involved in a variety of functions which induces nerve impulse transmission via synaptic transmission. Nicotinic receptors are ligand-gated channels which mediate a fast synaptic transmission of the neurotransmitter. Muscarinic receptors are G protein-coupled receptors mediate a slow metabolic response via second messenger cascades. This is the difference between nicotinic and Muscarinic receptors.

Reference:

- 1.Librettexts. "Cholinergic Drugs I - Nicotinic and Muscarinic Receptors." Chemistry LibreTexts, Librettexts, 13 Aug. 2017. [Available here](#)
- 2."Acetylcholine Receptors." The European Bioinformatics Institute < EMBL-EBI. [Available here](#)

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- 2.'Muscarinic acetylcholine receptor M2-3UON' By Takuma-sa - Own work (Public Domain) via [Commons Wikimedia](#)

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