Lecture 5, Question 3

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Some types of connections in neurons

My algorithm for choosing the following was based on the idea to look for a interesting (unusual) synapse in all major ares of neuronal activity e.g. vision, brain, hearing, touch, etc. It turned out that all of these areas have synapses which are common to other areas. This approached failed miserably in finding unusual type of connection. Nonetheless, as far as writing a answer to this problem, I could find some quite interesting one.

Ribbon Synapse: the unusually fast chemical synapse

Usual connection type but slightly different structure of synapse

Found in retinal photoreceptor cells, vestibular organ receptors, cochlear hair cells and retinal bipolar cells.

This type of sysnapse are often compared to *conveyor belt* See on which neurotranmitters move. This picture is a easy visualization of how a synapse is able to release a large amount of neurotranmitters into synaptic cleft but there seems to be serious objection to this picture (ibid).

A neuron can encodes the information by changing the rate of action potential (which is few tens of mV per ms); this encoding is not enough for visual system which is faster and very complex Ribbon synapse of retina and required high information exchange rate. The article suggests that such large information exchange can happen if neuron encodes the neurotranmitter release.

The presynaptic neuron can release hundreds of vescicles per second at their ribbon synapse and the behaviour of ribbon synapse changes according to the input they recieve: they adjust the release of glutamate to changing inputs. The overall mechanism of such a performace seems to elusive. The current hypothesis of $[Ca^{+}]$ depedent exocytoses is used to explain the mechanism. It is useful to remember the ribbn are part of pre-synaptic terminal. They contain two types of vescicles: one which is easily released and other which is not; both of them

may be chemically same. The easeness with which vescicles are released perhaps depends on their distance from pre-synaptic membrane.

Gap junction: the fast electrical connection

membrane to membrane connection

When two cells comes very close (approx 3-5 nm) to each other, gap-junction can occurs. Gap juctions are like a pipe going from one membrane to other. They allow ions (and even simple molecules) to pass through them according to the potential gradient across the gap. They are fast: usually takes 0.1 - 0.3 ms to do what they do compared to few tens of ms in many types of chemical synapses. The travelling of ions can be both bi-directional (a simple conductance) and uni-directional (a ideal diode connected with a conductance). Historically, they were st

Granule and Mitral cell in Olfactory bulb

Dendrite to dendrite connection

In olfactory bulb, Granule and Mitral cells dendrites makes a reciprocal connection i.e. both can release neurotranmitter into each other through same connection. Whenever Granule cell excites the Mitral cell, it inhibit the Granule cell. These type of connections are believed to play a major role in the process of olfactory information.

Isaacson, J.S. and Strowbridge, B.W. (1998) Olfactory reciprocal synapses: dendritic signaling in the CNS. Neuron 20:749-761