

Recitation 4 Worksheet

- (modified from midterm 2004, q 2) A CNS synapse has a total of 10 synaptic vesicles available for release at any one time. The probability of any of those vesicles fusing upon the action potential invading the nerve terminal is 20%, and the mean quantal size is 1mV.
 - What is the mean quantal content of the synapse?
 - What is the average postsynaptic response to a presynaptic stimulus?
 - What is the probability of failure of synaptic transmission $P(0)$ at this synapse?
- Describe the Miledi and Katz ionophoresis experiment that provided evidence that Ca induces vesicle exocytosis and neurotransmitter release.
 - What setup did they use and what were their variables?
 - What response did they record and use as a readout?
 - What were their major findings?

Answers:

- $m = n * p = 10 * 0.2 = 2$ quanta per evoked response
 - average postsynaptic response = $v_1 * m = 1\text{mV}/\text{quantum} * 2 \text{ quanta}/\text{stimulus} = 2\text{mV}$ per stimulus
 - The probability of failure here is NOT given by the Poisson distribution, because one of the assumptions of this distribution is that n is very large, whereas here, n is small. Therefore, we must use the binomial distribution to calculate the probability of failure.

$$P(0) = (1 - p)^n = (1 - 0.2)^{10} = 0.8^{10} = 0.11$$

Using the Poisson distribution would have yielded:

$$P(0) = e^{-m} = e^{-2} = 0.14$$

- Katz and Miledi used a preparation of the frog Sartorius muscle and motor neuron. They bathed the preparation in a low Ca bath, also applying Mg to block some of the voltage gated Ca channels (could have also used Co). They used an ionophoretic pipette to add Ca in the vicinity of the presynaptic terminal and vary the timing of Ca release with respect to applied depolarizing stimulation of the neuron.
 - They recorded postsynaptic EPSPs from the muscle.
 - They found that when Ca was released a long time before the presynaptic depolarization, no response was measured in the muscle. If Ca was released at the same time as or a little after the depolarizing stimulus, again, no response was recorded. If Ca was released a very short time before the stimulation, they saw a postsynaptic response. They concluded that extracellular Ca moving into the presynaptic terminal somehow causes neurotransmitter release, and that the timing discrepancy between Ca application and the presynaptic pulse was due to the fact that Ca needed to diffuse to the extracellular surface of the presynaptic membrane.

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