Theoretical & computational Neuroscience:

Programming the Brain

(BM 6140)

2-credit

Synapse physiology

Problems with signal transfer between neurons

- Can’t signals jump from pre to post synaptic neurons ?
- This was dominant belief in 1940s
- R values
  - terminal membranes ~ $1000\ \mathrm{M\Omega}$
  - Extracellular leakage $\sim 1\ \mathrm{M\Omega}$
  - Input resistance of Neuron 2 $\sim 100\ \mathrm{M\Omega}$
- V1 ~ 100 mV => V2 ~ 10 μV

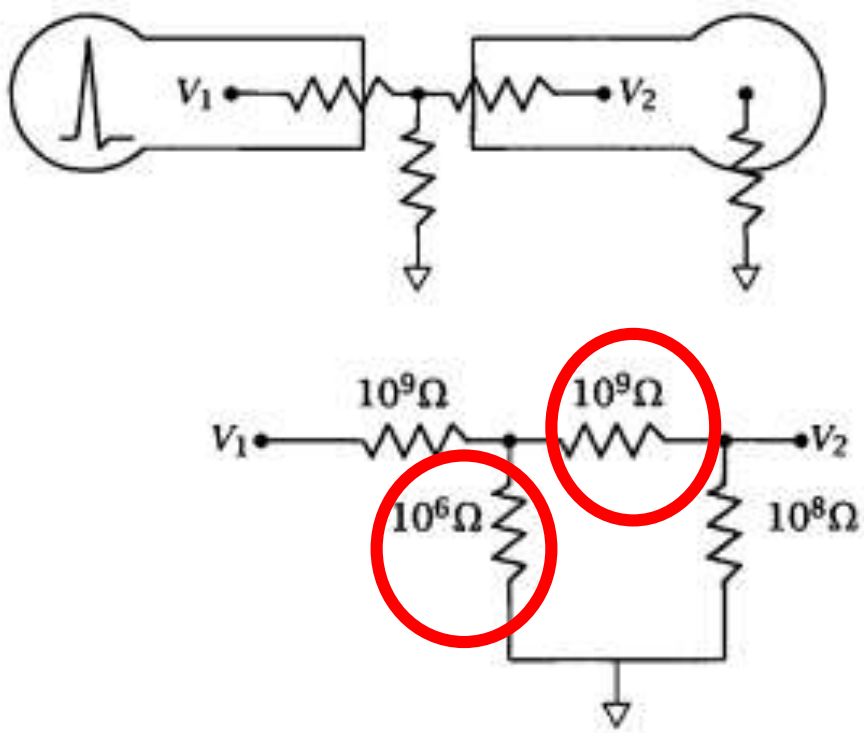


Figure 11.1 Schematic for the transfer of electrical signals between neuro
sence of any direct electrical connections.

Gap junction

- Reduced leakage to extracellular medium

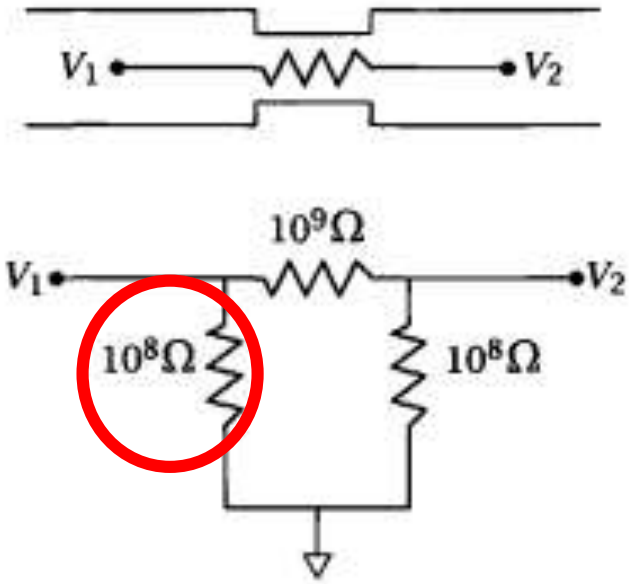
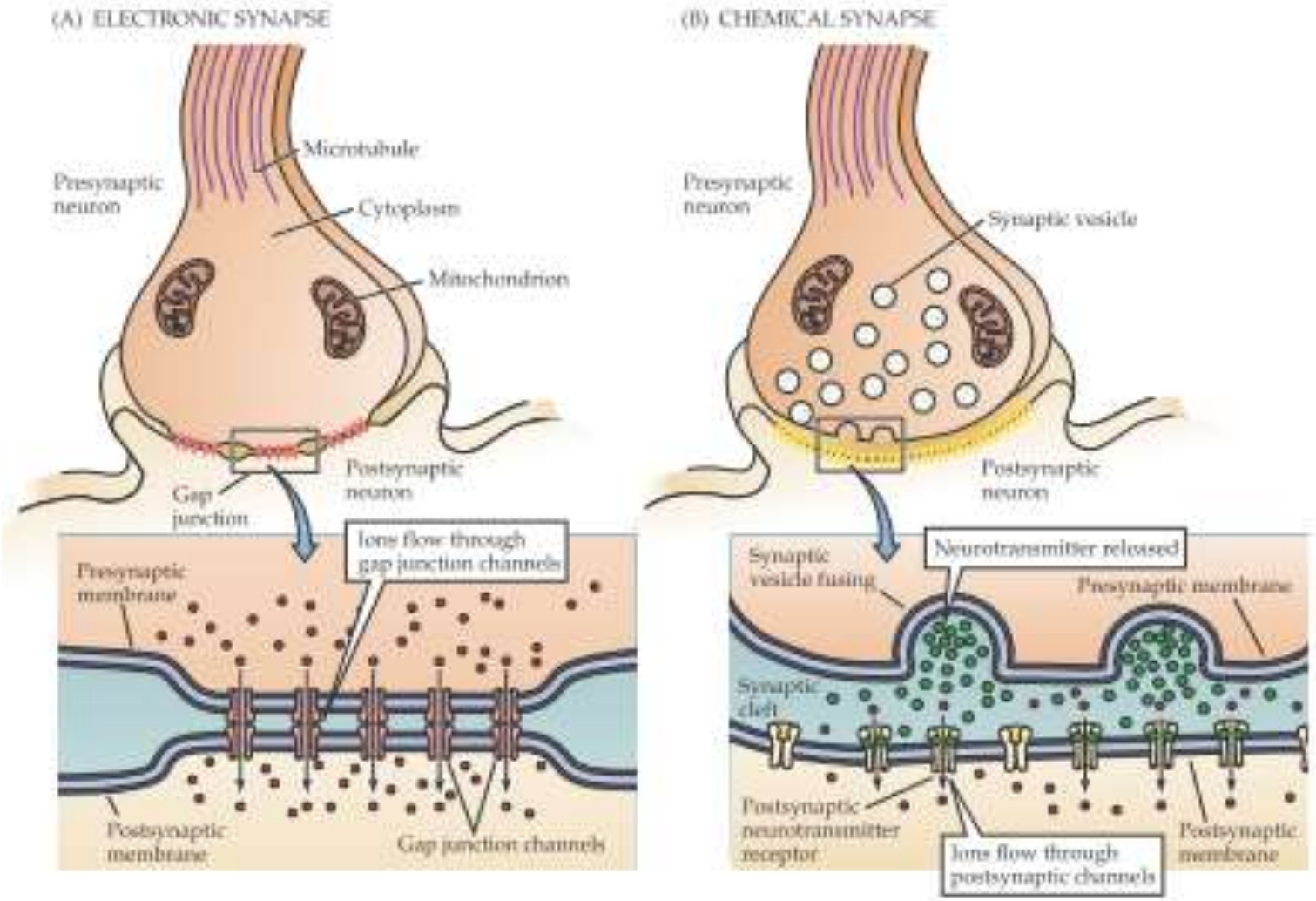


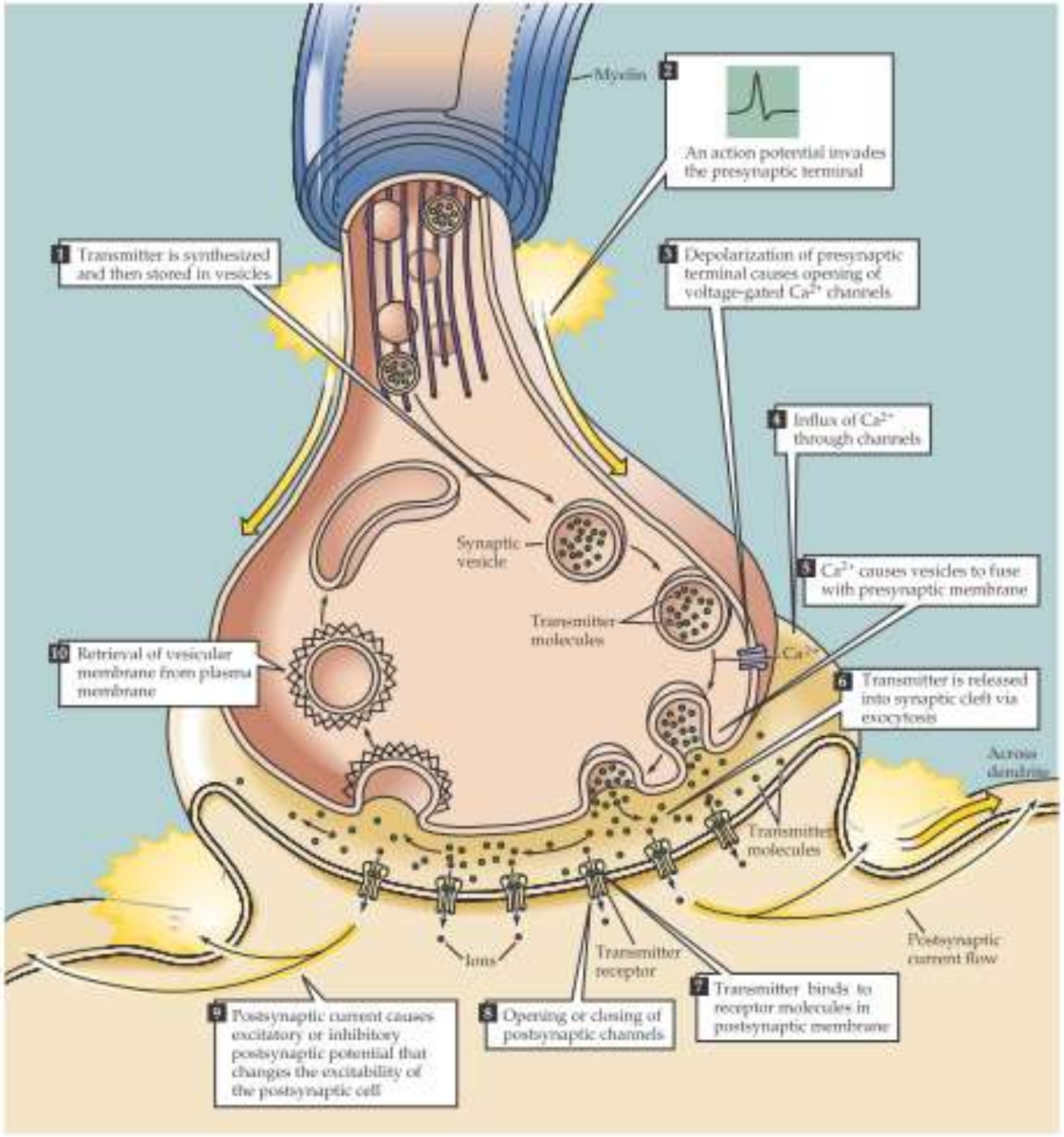
Figure 11.2 Transfer of electrical signals between neurons through a gap junctio

Electrical and chemical synapses

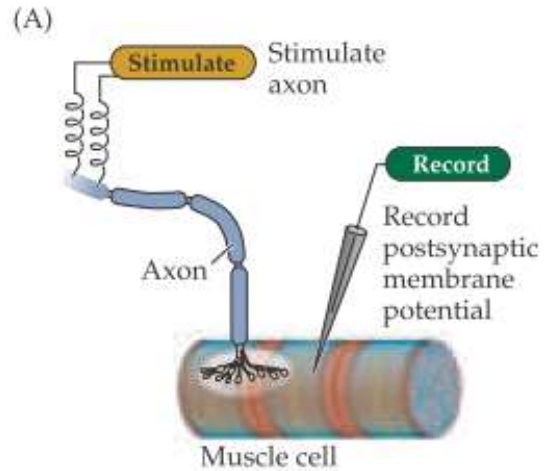


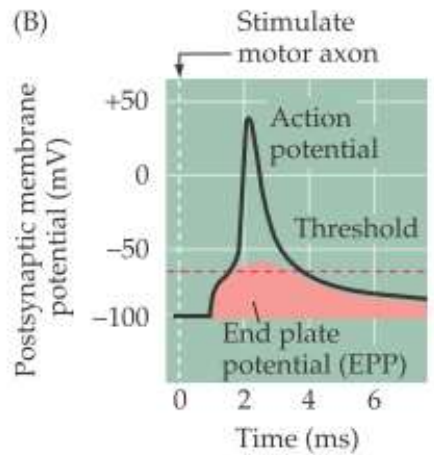
Chemical synapse

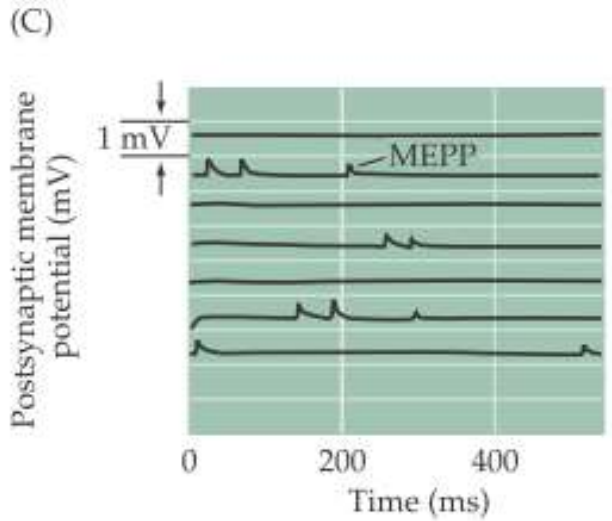
- Event sequence

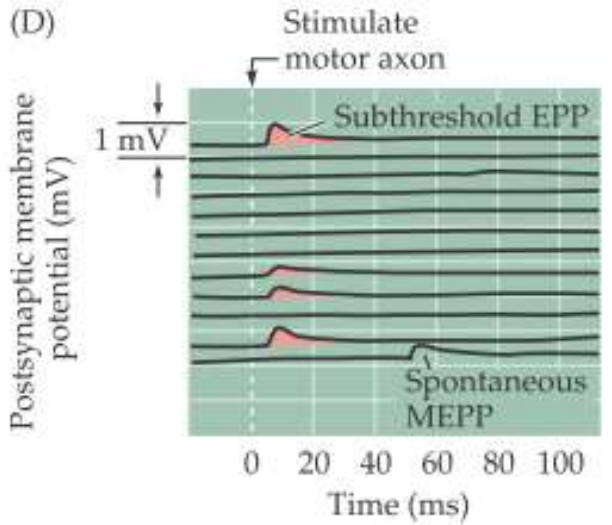


Deducing quantal release of neurotx









Post synaptic potentials

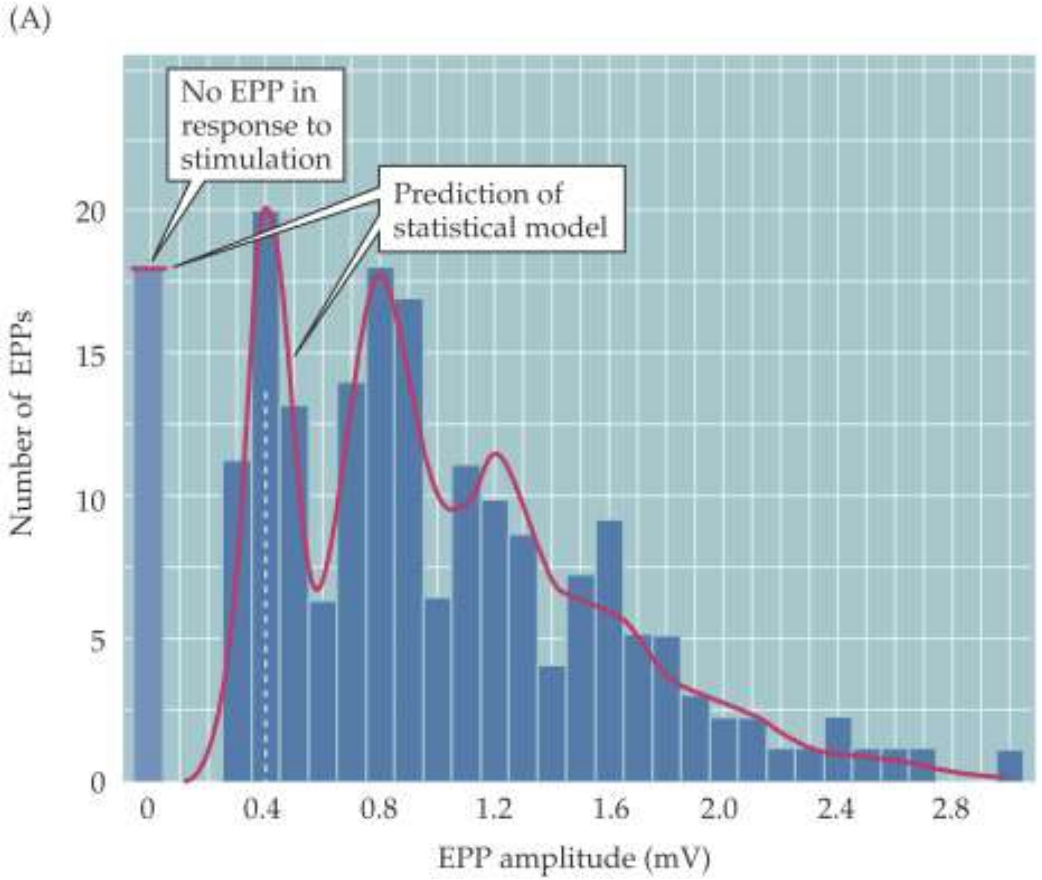
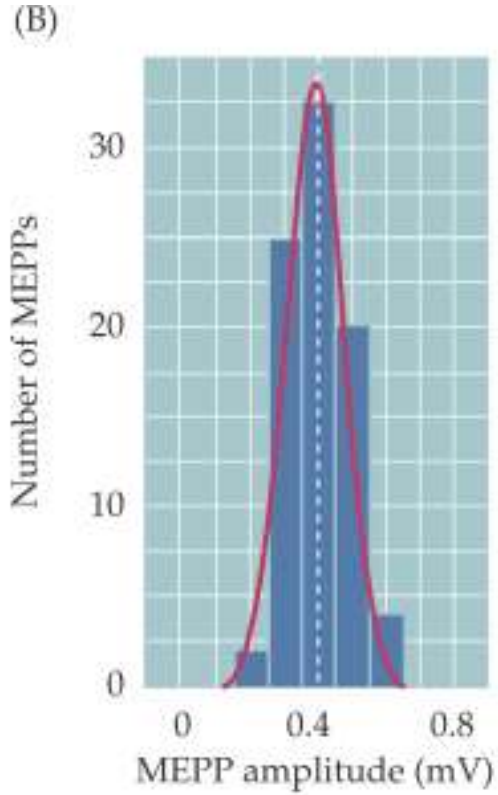


Figure 5.7 Quantized distribution of EPP amplitudes evoked in a low Ca^{2+} solution. Peaks of EPP amplitudes (A) tend to occur in integer multiples of the mean amplitude of MEPPs, whose amplitude distribution is shown in (B). The leftmost bar in the EPP amplitude distribution shows trials in which presynaptic stimulation failed to elicit an EPP in the muscle cell. The red curve indicates the prediction of a statistical model based on the assumption that the EPPs result from the independent release of multiple MEPP-like quanta. The observed match, including the predicted number of failures, supports this interpretation. (After Boyd and Martin, 1955.)



Excitatory and Inhibitory synapses

- Increase or decrease probability of firing in post synaptic neuron
- Excitatory synapses :
  - Glutamate/ AMPA, NMDA receptors
- Inhibitory synapses :
  - GABA

Reversal potential of synapse

- $E_{AMPA} = 0$
  - So what is permeability of Na^+ and K^+in this synapse ?