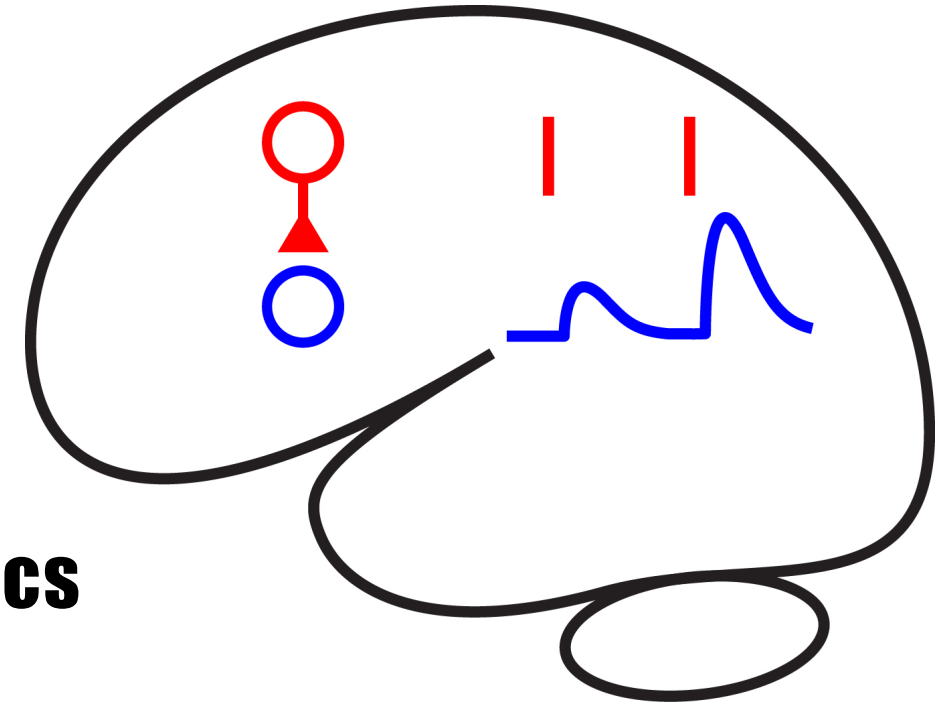
ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE



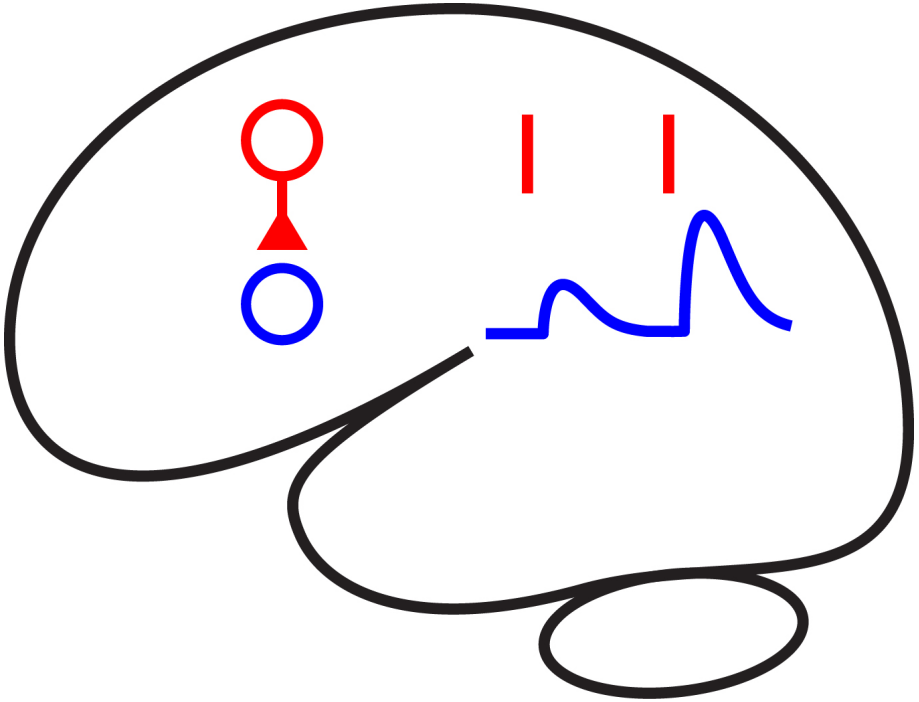
3.3 Presynaptic dynamics

Cellular Mechanisms of Brain Function

Prof. Carl Petersen

Action potential firing patterns

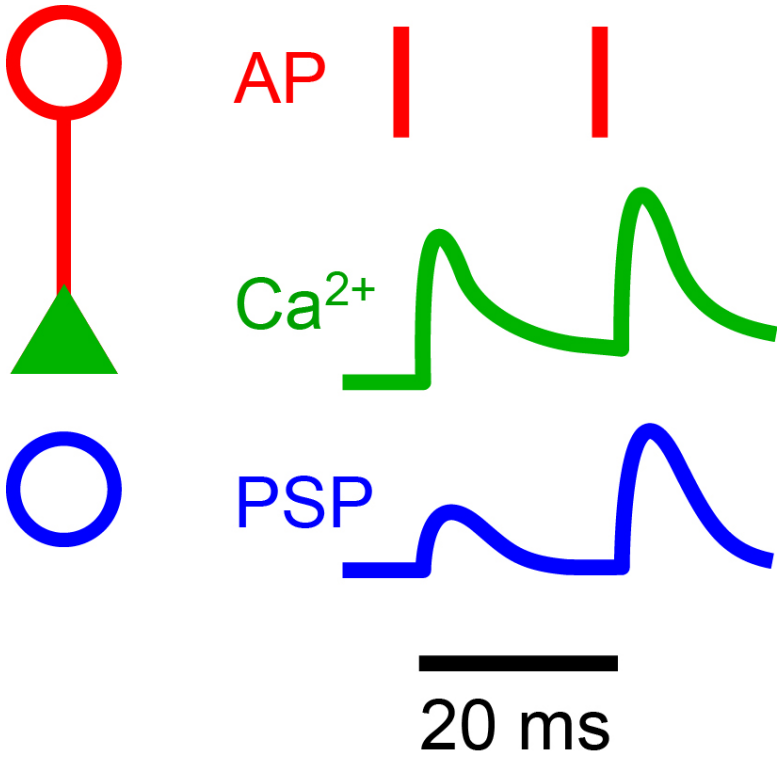
History-dependence of synaptic transmission



Presynaptic dynamics

1. Short-term (milliseconds)
   - Facilitation
   - Depression
2. Post-tetanic potentiation (minutes)
3. Long-term presynaptic plasticity (hours)

Short-term dynamics: Facilitation

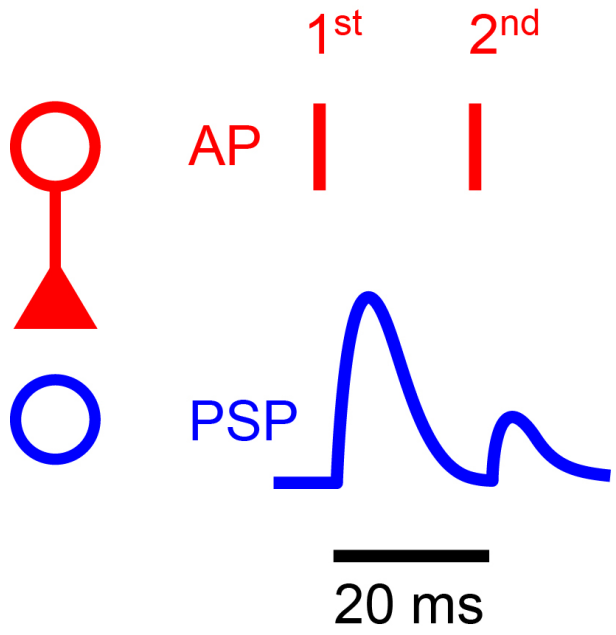


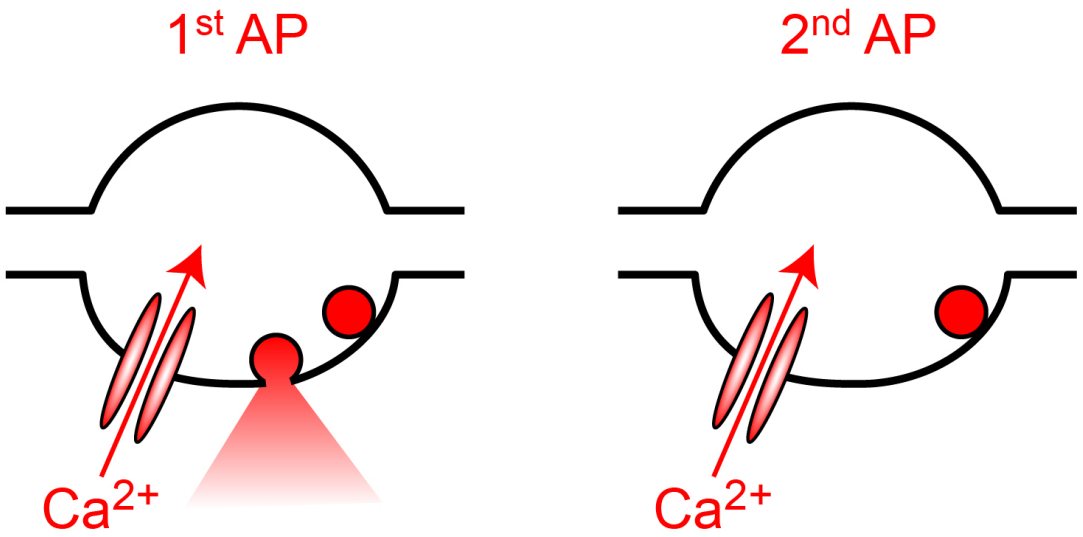
Release rate ~ $[Ca^{2+}]_i^4$

$(1.2)^4 \approx 2$

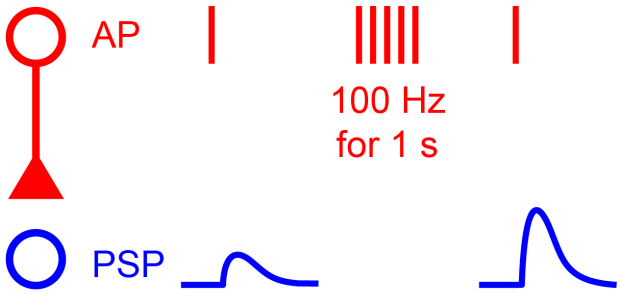
A 20% increase in Ca^{2+} causes a doubling of neurotransmitter release.

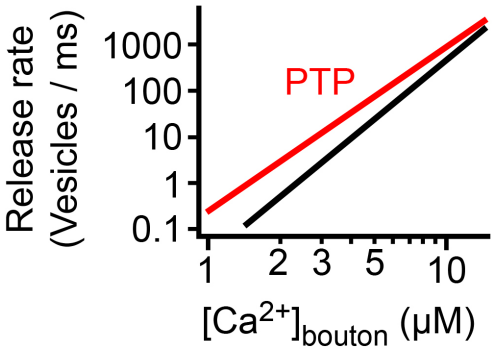
Short-term dynamics: Depression

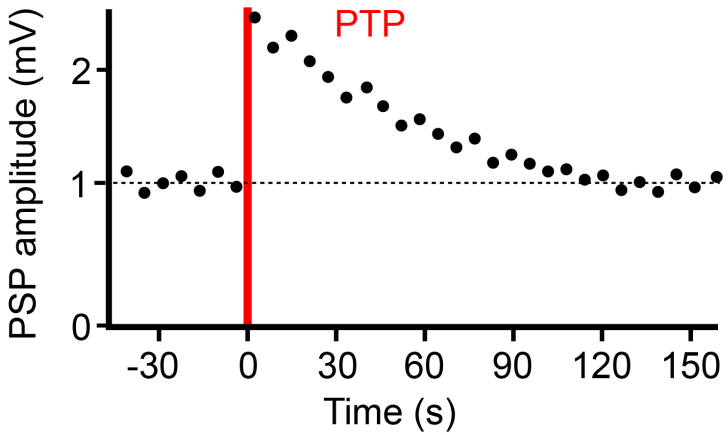


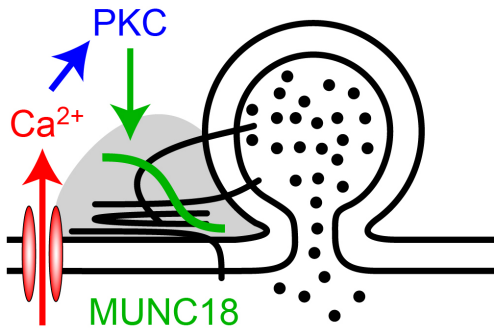


Post-tetanic potentiation

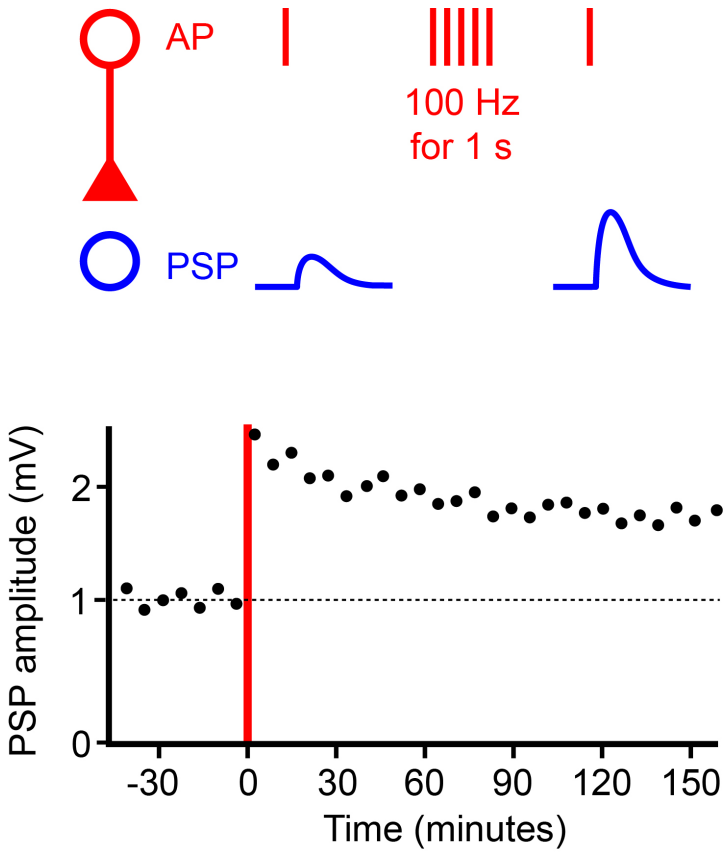


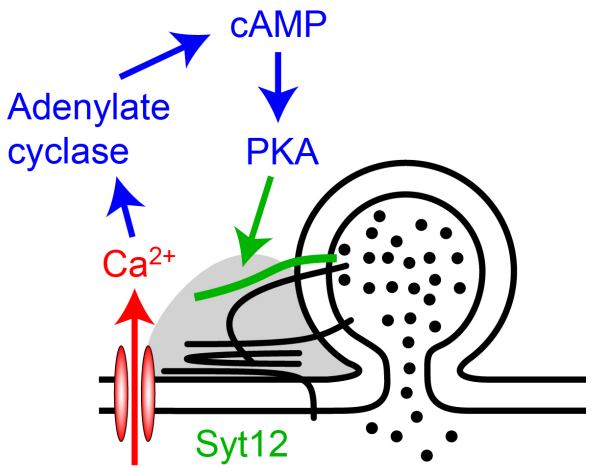






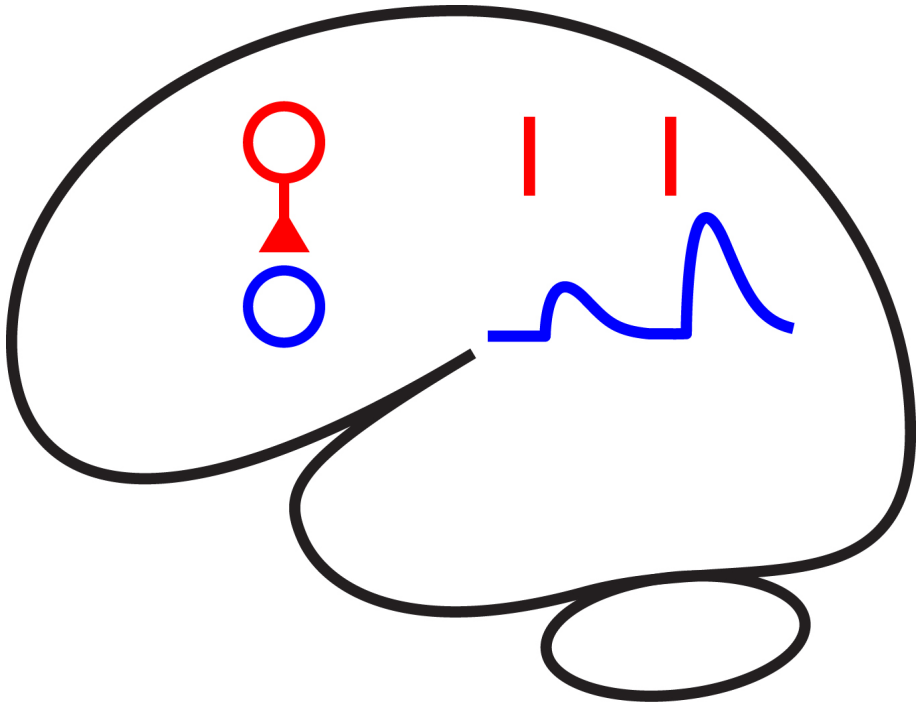
Presynaptic long-term potentiation





Syt12 = Synaptotagmin 12
(also involved Rab3a, RIM1a)

Presynaptic dynamics



Modeling of presynaptic dynamics

Presynaptic dynamics

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- Presynaptic efficacy varies depending upon recent activity.
- On the millisecond time scale: calcium summation drives facilitation, and vesicle depletion results in depression.
- Calcium-dependent kinases signal presynaptic plasticity on longer time-scales.