

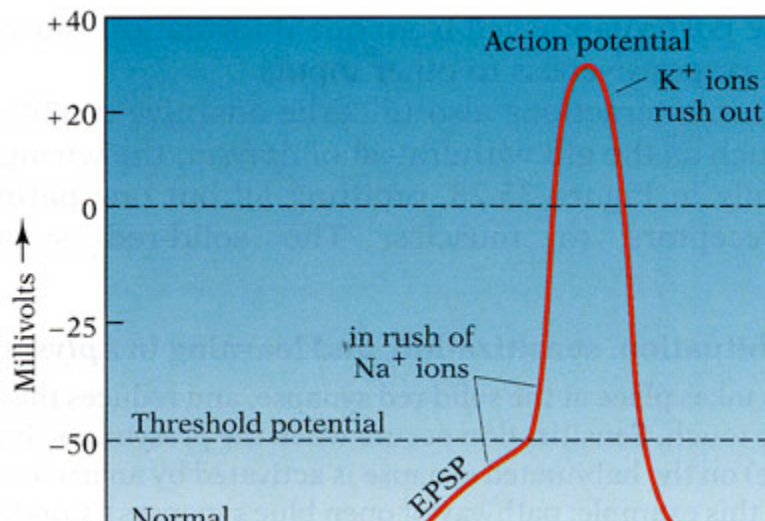
Effect of Neurotransmitters on Membrane Permeability

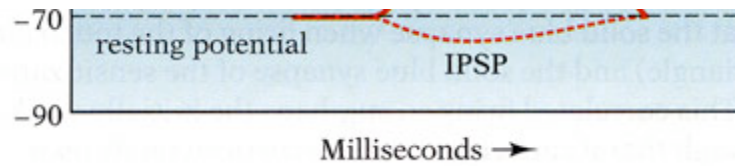
We now focus on the effects of transmitter substances on postsynaptic membranes. When such a substance has diffused across the synaptic cleft, how does it affect the polarization of the postsynaptic membrane of the next neuron? You learned in your text that some neurotransmitters have an excitatory effect. Apparently the binding of such a transmitter to the receptor opens Na^+ gates in the postsynaptic membrane. The resulting increased inward flow of Na^+ ions slightly decreases the polarization of the neuron; i.e., the inside becomes less negative relative to the outside, a condition known as an **excitatory postsynaptic potential (EPSP)** (See Figure below). If the EPSP is sufficient, it may spread to the base of the cell's axon and, if it is above threshold, trigger an action potential, which will move down the axon to the next synapse.

The neurotransmitters, released by the axons of some neurons have the opposite effect-an inhibitory one. They increase the polarization of the postsynaptic membrane and thus make the neuron harder to fire. These substances may produce their inhibitory effects by opening K^+ gates in the postsynaptic membrane, and K^+ ions rush out of the cell, or by opening chloride ion (Cl^-) gates. The Cl^- ion concentration is always higher outside the cell than inside, so Cl^- ions enter the cell by diffusion when the Cl^- gates are open. Either the efflux of the positively charged K^+ ions or the influx of negatively charged Cl^- ions will cause the membrane to become hyperpolarized; i.e., the inside of the cell becomes even more negative relative to the outside, a condition known as an **inhibitory postsynaptic potential (IPSP)**. (See diagram below). More than the usual number of excitatory impulses would be needed to reduce the polarization of such an inhibited neuron to the threshold level for triggering an impulse. *The balance between EPSPs and IPSPs underlies all neural processing.*

Notice that *the transmitter substance itself is not excitatory or inhibitory*; it is the ion specificity of the gated channels, in the postsynaptic membrane that determines the effect. If the transmitter binds to receptors that open Na^+ gates, the neuron will be easier to fire, but if the transmitter binds to receptors that open Cl^- , or K^+ gates, the neuron will be hyperpolarized and more difficult to fire. Thus the receptor makes the synapse excitatory or inhibitory.

EFFECT OF TRANSMITTER SUBSTANCE ON THE MEMBRANE POTENTIAL OF A NEURON





The normal resting potential of a typical neuron is about -70 mv. An excitatory transmitter substance slightly reduces that polarization – that is, makes the inner surface of the membrane less strongly negative – thereby creating an excitatory postsynaptic potential (EPSP). If the EPSP reaches the threshold level (usually about -50 mv), an impulse (action potential) is triggered. If the transmitter substance had been inhibitory, the membrane could have become hyperpolarized (to perhaps -75 mv), a condition called an inhibitory postsynaptic potential (IPSP) (dashed curve), and no action potential would have resulted; the neuron would slowly have returned to its resting potential after release of the transmitter had ceased.

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