

Types of neurotransmitter receptors

Even though there are many (>100) neurotransmitters, there are often several distinct receptors for each - mediating different types of response. (e.g. >10 receptor sub-types for glutamate).

There are 2 basic mechanisms by which receptors control ion flow across the postsynaptic membrane:

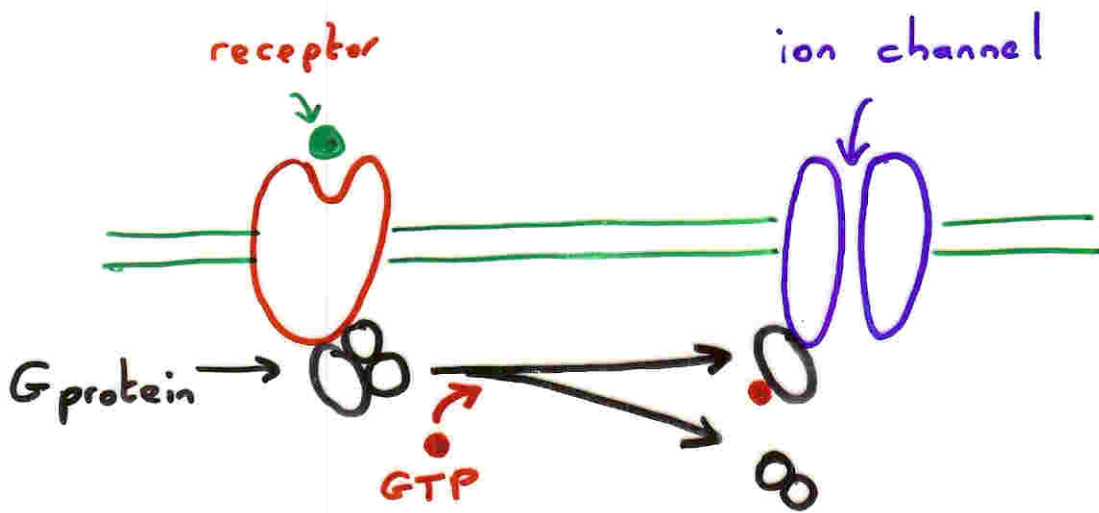
① Ionotropic Receptors

Receptor site and ion channel are part of the same molecule (e.g. ACh-activated channel at end-plate)

These mediate fast synaptic responses - direct through-put of signals in the nervous system.

② Metabotropic Receptors

Receptor and channel are different proteins, physically separated in the cell membrane. The link between them is a diffusible intracellular **second messenger**.



↑

Binding of neurotransmitter to receptor causes **GTP** to bind to G protein, which then dissociates into two subunit pieces (α and $\beta\gamma$). One of these may then control the opening of an ion channel, or ↓

A G protein subunit causes a separate effector protein (enzyme) to make a further second messenger, which in turn controls an ion channel.

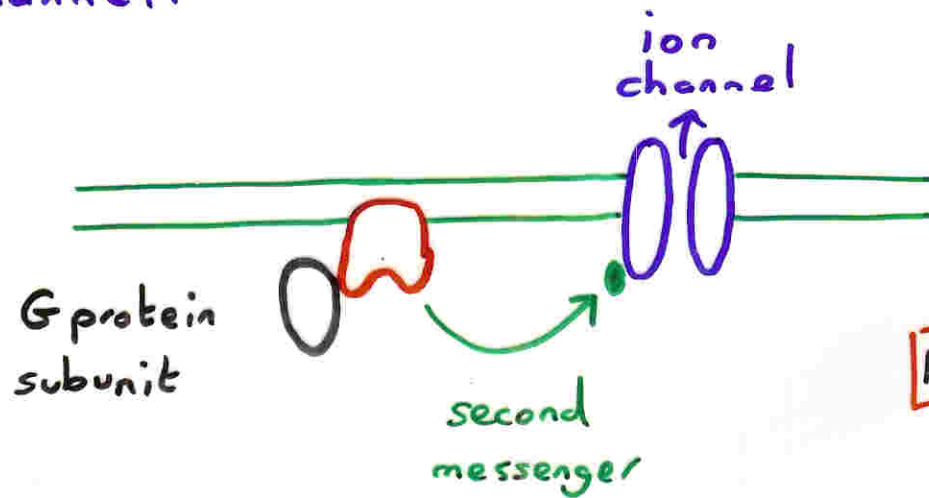


Fig. 7.5A

examples of second messengers:

cyclic AMP

cyclic GMP

inositol trisphosphate

diacylglycerol

Second-messenger-mediated responses are relatively slow and prolonged. Tend to serve to modulate the transmission of fast signals through the nervous system

Postsynaptic excitation and inhibition

Excitation - current flow through ion channels tends to depolarize cell toward threshold for triggering action potential

Inhibition - current through channels tends to stop action potentials from firing (but does not necessarily hyperpolarize the cell)

Whether a given synapse is excitatory or inhibitory depends on which ions go through the channels.

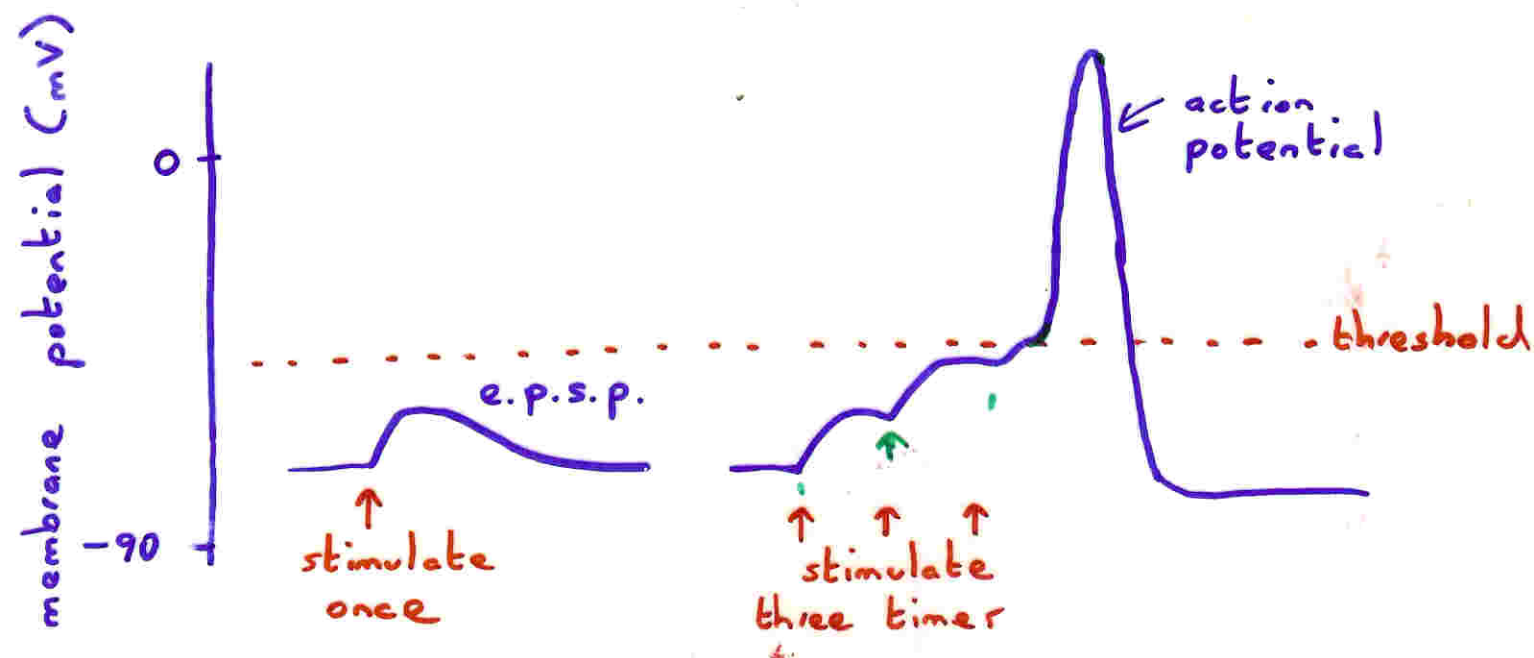
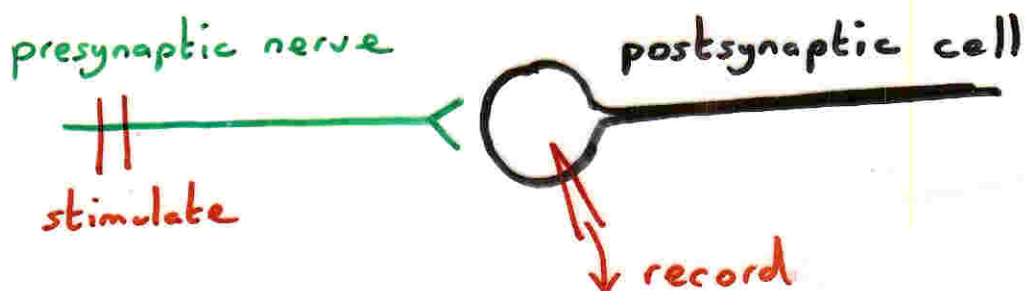
A particular neurotransmitter can be excitatory or inhibitory - depending on receptor sub-type: but some are most always excitatory (e.g. glutamate) or inhibitory (e.g. GABA).

Integration of excitatory signals

① Temporal Summation

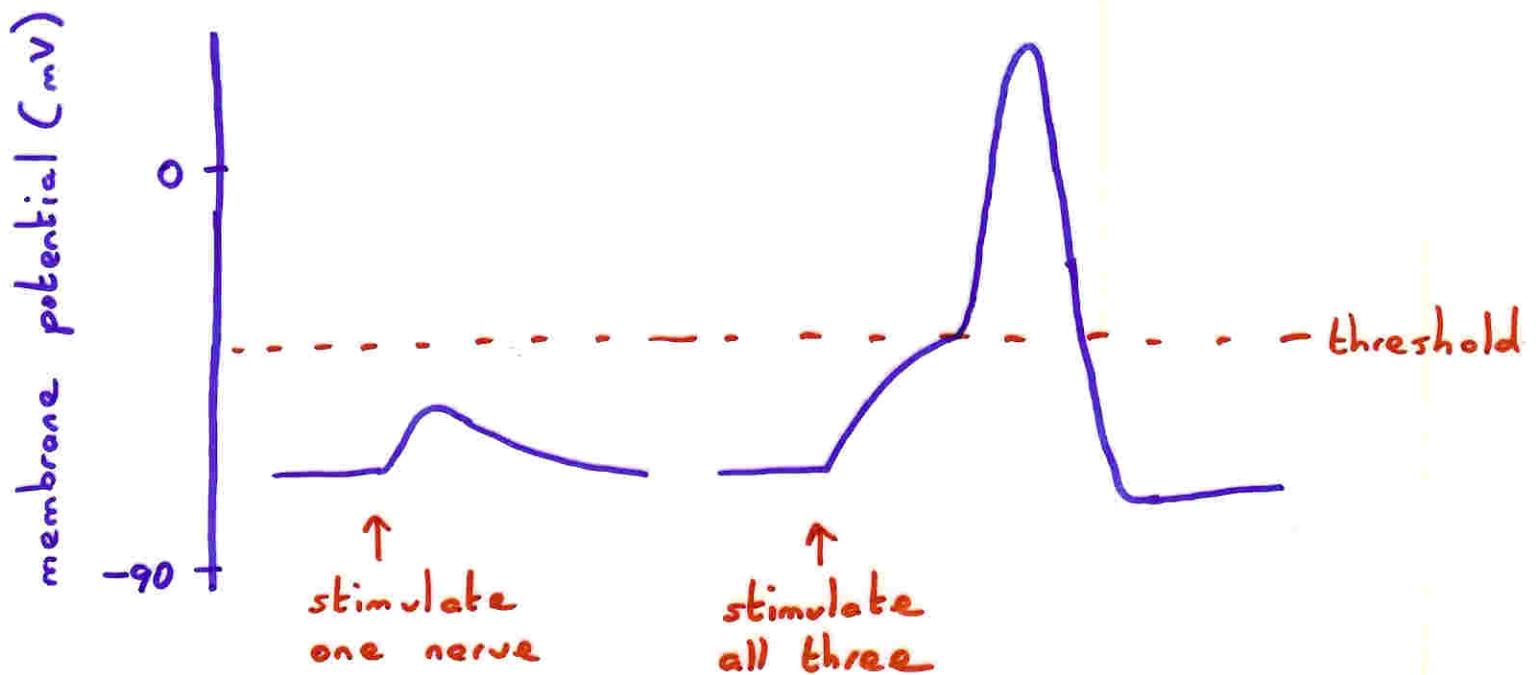
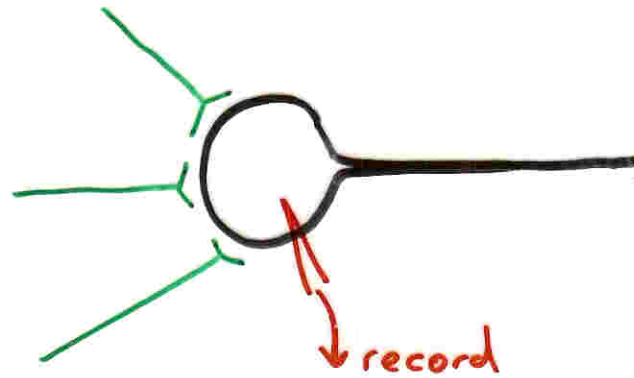
The e.p.s.p. (excitatory post-synaptic potential) produced by a single presynaptic action potential may not be enough to depolarize a postsynaptic cell to the threshold for an action potential.

But - if there are several action potentials in quick succession, e.p.s.p.s summate to depolarize above the action potential threshold.



② Spatial summation

Action potentials in several presynaptic nerves may give e.p.s.p.s that summate to reach threshold, even if e.p.s.p. from a single nerve is too small.



Inhibitory conductance changes

e.g. receptors to GABA.

GABA opens channels permeable to Cl^- ions.

Equilibrium (Nernst) potential for Cl^- in neurons is about -80mV . So action of GABA is to make cell's potential go toward -80mV .

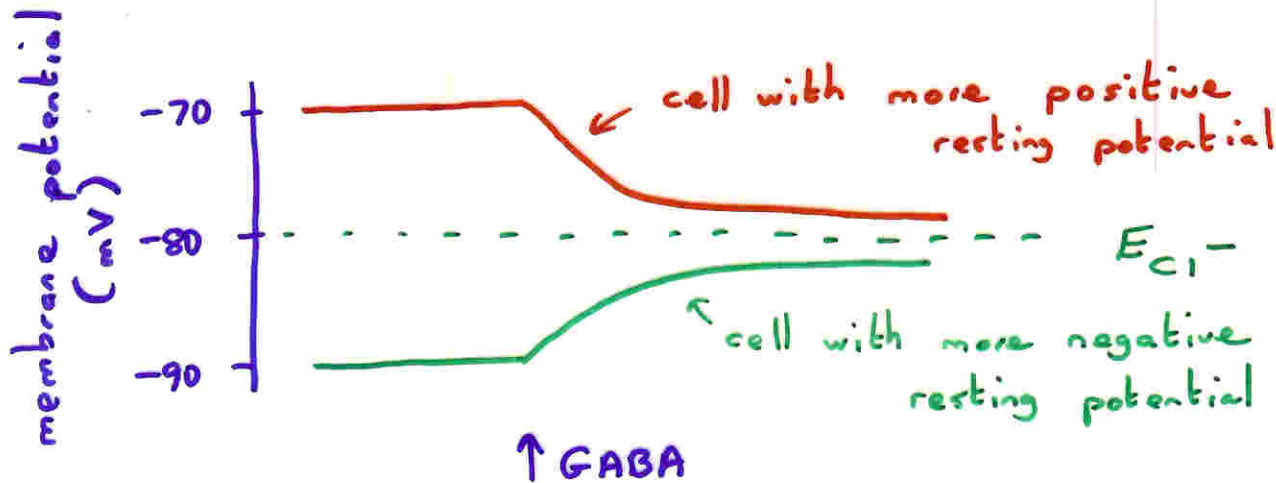


Fig.
5.19

If GABA can cause a depolarization, why is it inhibitory?

① Potential change evoked by GABA cannot go more positive than -80mV : this is well below threshold for action potential.

② Cl^- current through GABA-activated channels tends to hold cell at -80mV , opposing depolarization by excitatory synapses.

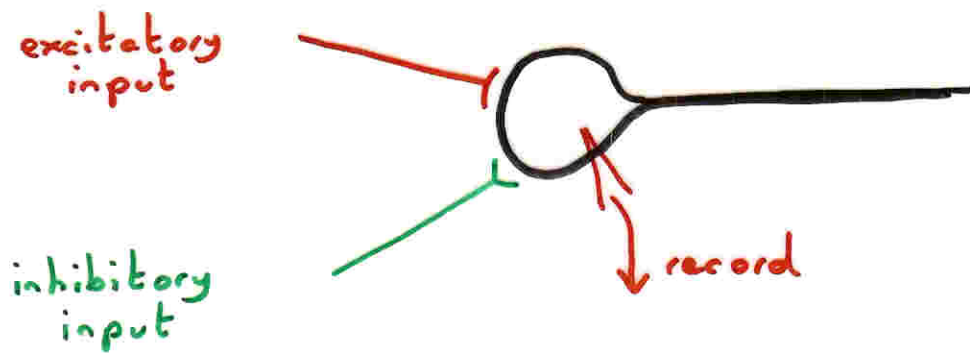


Fig. 5.20

