Excitatory Postsynaptic Potential
The postsynaptic cell can either hyperpolarize or hypopolarize in response to the transmitter substance. It is possible to study the postsynaptic events by puncturing the soma of a cell with a microelectrode to pick up the changes in membrane potential that result from activity in a presynaptic axon.

If we stimulate a peripheral nerve at weak intensity while recording from a motoneuron, we see in the record a hypopolarization with a latency of 1-2 msec, followed shortly by a repolarization of the cell. This response is the Excitatory Postsynaptic Potential, Or EPSP. It has a decay time-constant of about four msec and, like the generator potential, is a local or nonpropagated event. The EPSP is in fact a generator potential; it is sufficiently important to warrant special consideration and a name of its own. The amplitude of the EPSP varies with the strength of the stimulus (that is, with the number of fibers stimulated), and if it hypopolarizes the membrane to or beyond its critical firing level, the motoneuron will discharge an action potential.

Inhibitory Postsynaptic Potential
Another difference between neuronal and neuromuscular synapses is the possibility of inhibition at neuronal synapses. Inhibition is not seen in mammalian neuromuscular junctions. With an appropriate stimulus, the response of the motoneuron can be an hyperpolarization, beginning 3-4 msec after the stimulus, followed by a return to the resting potential, again with a decay time-constant of about four msec. This response is called the Inhibitory Postsynaptic Potential, or IPSP, because it drives the membrane 1-4 mV away from the critical firing level and therefore reduces the frequency or, alternatively, the probability of firing of the postsynaptic cell. Like the EPSP, the IPSP is a nonpropagated event. IPSPs can sum either spatially or temporally to hyperpolarize the cell to an even greater extent than a single IPSP. IPSPs are never seen in mammalian muscles.

Postsynaptic Potentials
- Neurotransmitter can cause postsynaptic cell to either depolarize or hyperpolarize. Inhibitory neurotransmitter generally cause hyperpolarization making postsynaptic cell less likely to generate action potential whereas Excitatory neurotransmitters generally cause depolarization, making the postsynaptic cell more likely to generate action potential. The resulting changes in membrane potential is referred as IPSP & EPSP.
- Are graded potentials that develop in postsynaptic membrane in response to a neurotransmitter. Two major types of postsynaptic potentials develop at neuron to neuron synapse
  1. Excitatory postsynaptic potentials
  2. Inhibitory postsynaptic potentials

EXCITATORY POSTSYNAPTIC POTENTIALS (EPSP)
- Is a graded depolarization caused by the arrival of a neurotransmitter at the postsynaptic membrane.
- An EPSP results from the opening of the chemically regulated membrane channels that lead to depolarization of the cell membrane. For eg the graded depolarization produced by the binding of Ach is an EPSP.
- Because it a graded potential, an EPSP affects only the area immediately surrounding the synapse.

INHIBITORY POSTSYNAPTIC POTENTIALS (IPSP)
- IS a graded hyperpolarization of the postsynaptic membrane.
- For eg an IPSP may result from the opening of chemically regulated potassium channels.
- While the hyperpolarization continues, the neuron is said to be inhibited, because a larger than usual depolarizing stimulus must be provided to bring the membrane potential to threshold.
- A stimulus sufficient to shift the transmembrane potential by 10 mV (from -70 mV to -60mV) would normally produce as A.P.
**Bioelectricity**

- If the transmembrane potential were reset at -85mV by an IPSP, however the same stimulus would depolarize it only -75 mV which is below threshold.

![Diagram showing EPSP and IPSP](image)

**Excitatory synapses**
The neurotransmitter at excitatory synapses **depolarizes** the postsynaptic membrane (of a neuron in this diagram). Example: acetylcholine (ACh)

- Binding of acetylcholine to its receptors on the postsynaptic cell opens up ligand-gated sodium channels.
- These allow an influx of Na⁺ ions, reducing the membrane potential.
- This reduced membrane potential is called an **excitatory postsynaptic potential** or **EPSP**.
- If depolarization of the postsynaptic membrane reaches **threshold**, an **action potential** is generated in the postsynaptic cell.

**Inhibitory synapses**
The neurotransmitter at inhibitory synapses **hyperpolarizes** the postsynaptic membrane. Example: gamma aminobutyric acid (GABA) at certain synapses in the brain.

- The GABAₐ receptor is a **ligand-gated chloride channel**. Binding of GABA to the receptors increases the influx of chloride (Cl⁻) ions into the postsynaptic cell raising its membrane potential and thus inhibiting it. This is a **fast** response — taking only about 1 millisecond.

In both cases, the resulting **facilitated diffusion** of ions (chloride IN; potassium OUT) **increases** the membrane potential (to as much as ~80 mV). This increased membrane potential is called an **inhibitory postsynaptic potential** (IPSP) because it counteracts any excitatory signals that may arrive at that neuron.

A hyperpolarized neuron appears to have an increased threshold. Actually, the threshold voltage (about ~50 mv) has not changed. It is simply a question of whether the depolarization produced by excitatory synapses on the cell **minus** the hyperpolarizing effect of inhibitory synapses can reach this value or not.