Neuronal signalling

Cell membrane

- fosfolipid doublelayer
- ion channels
- transporters
- receptors
- synaptic membrane proteins

Extracellular and intracellular ion concentration

Ion channels and transporters

Electrochemical balance

Resting membrane potential

A difference in the electrical potential (=voltage) across the plasma membrane of an unstimulated excitable cell.

In a typical resting neuron the electrical potential difference is about 65 (70) mV. Because the net charge outside of the membrane is arbitrarily defined as zero, we say the **resting membrane potential is -65 (-70) mV**.

•**<u>two factors</u>**:

(1) the unequal distribution of electrically charged ions in ECF and ICF,

(*Na^+-K^+ pump)*

(2) the selective permeability of the membrane to K^+

(ion channels).

Information processing

- dendrites and body - input and integration
- axon - information transmission

- information:
  - processes and soma: **electrical changes (local or action potentials)**
  - synapses: **chemical transmitter release**

Neuronal signalling

- **local (graded)** – receptor potential
- **local (graded)** – synaptic potentials
- **propagated** – action potential

Action potential

- short-lived reversal of membrane potential reaching + 30 mV

- physiologically, is triggered at the axon hillock
- threshold
- amplitude 70-100 mV
- duration 1-10 ms
- uniform response all-or-none
- propagation: without decrement, active, one direction
- refractory period

Receptor and synaptic potentials

- amplitude 0,1-10 mV (graded responses)
- duration: 5-100 ms (receptor p.),
  5 ms-20 min (synaptic p.)
- propagation: with decrement, passive, electrotonic
- depolarization or hyperpolarization

Postsynaptic (=synaptic) potential

- **Excitatory** (Na^+, Ca^{2+} entering the cell)
- **Inhibitory** (K^+ leaving the cell, Cl^- entering the cell)

Ion currents

Simplified view:

- Na^+, Ca^{2+} enter the cell: **depolarization**
- K^+ leave the cell: **repolarization, hyperpolarization**
- Cl^- enter the cell: **hyperpolarization**

Neuronal signalling

Passive current flow in an axon

Propagation of action potential in myelinated axon

Toxins

- **Na+ channel:**

tetrodoxin (puffer fish), saxitoxin and brevetoxin (dinoflagellatae→shellfish)
α-toxin, β-toxin (scorpion), batrachotoxin (frog)

- **K+ channels:**

dendrotoxin (wasps), apamine (bees), charybdotoxin (scorpion)

Integrating mechanisms:

Spatial summation

Temporal summation

Divergence

Convergence

Information coding