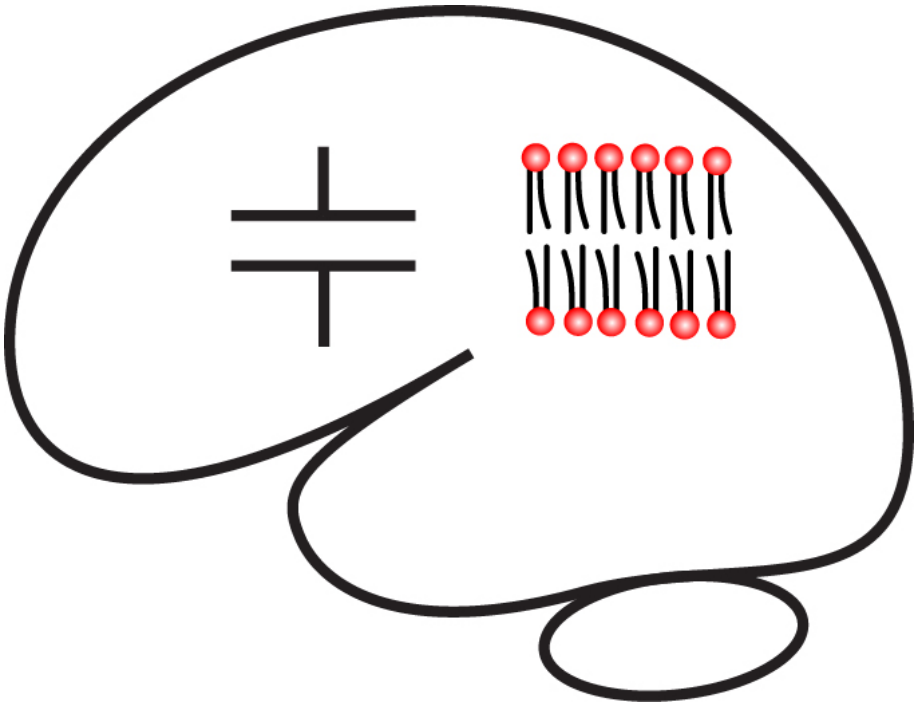
ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE



1.2 The cell membrane

Cellular Mechanisms of Brain Function

Prof. Carl Petersen

The brain is made of cells

The brain is made of cells

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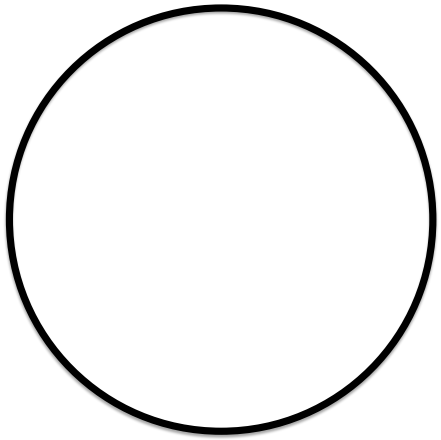
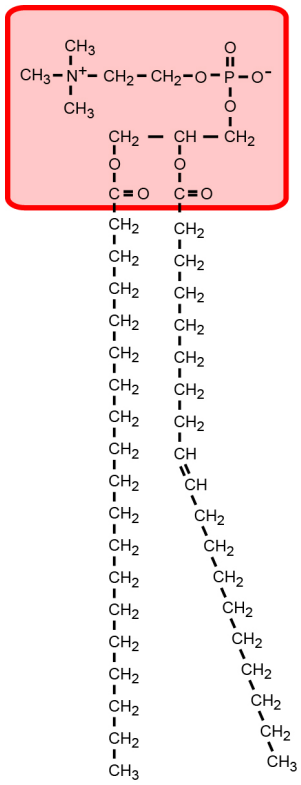
Cell



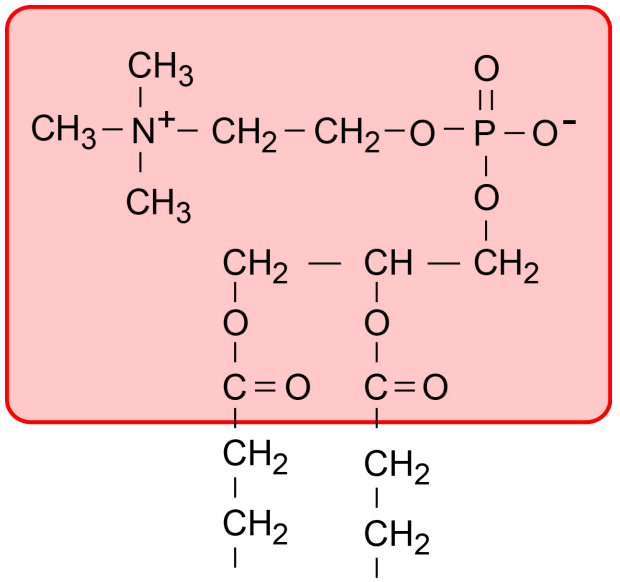
Phospholipids

Phosphate head group
- Polar, Hydrophilic

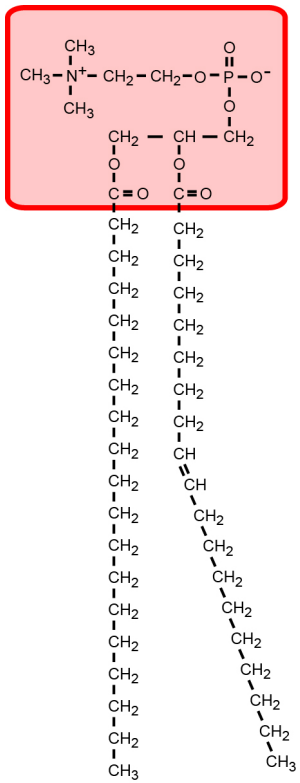
Hydrocarbon tails
- Non-polar, Lipophilic

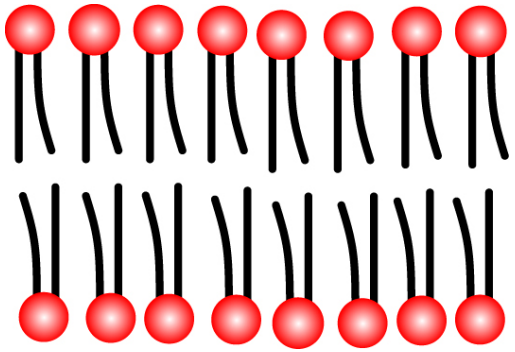


Phosphatidylcholine

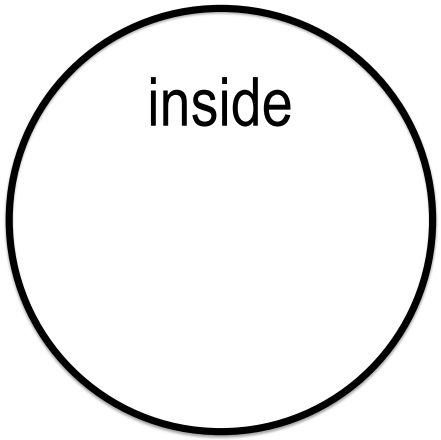


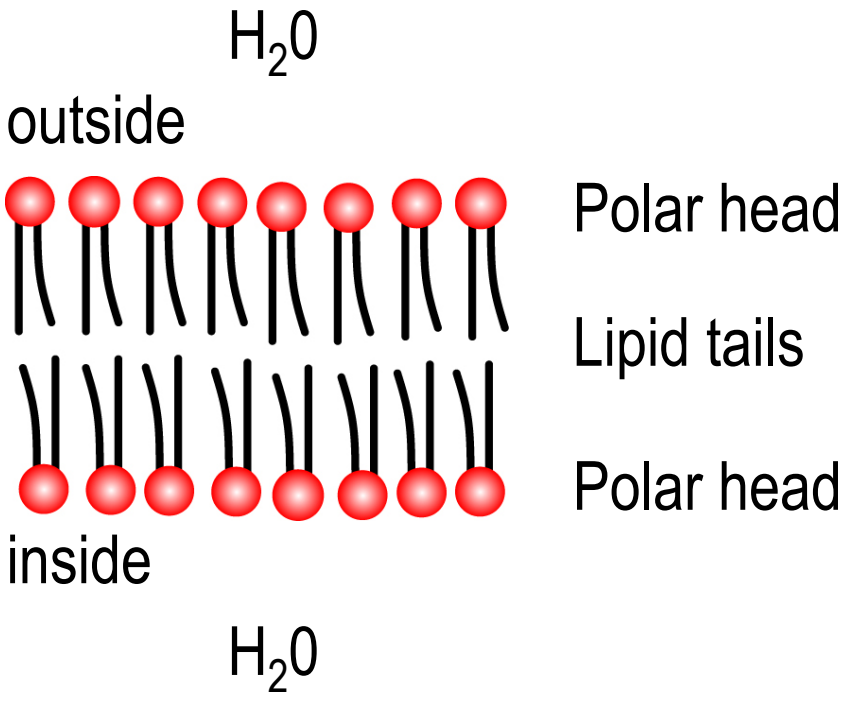
Phospholipid bilayers





The cell membrane is a phospholipid bilayer

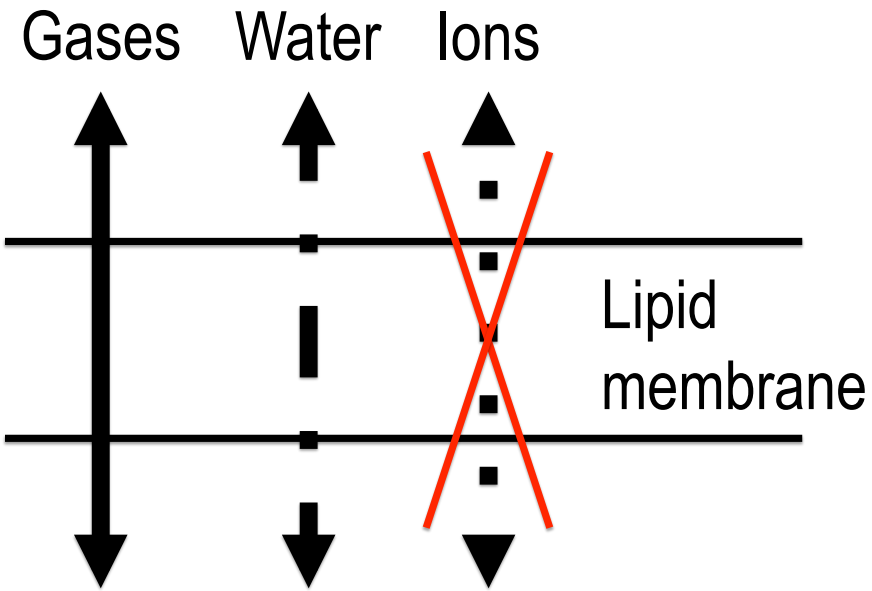




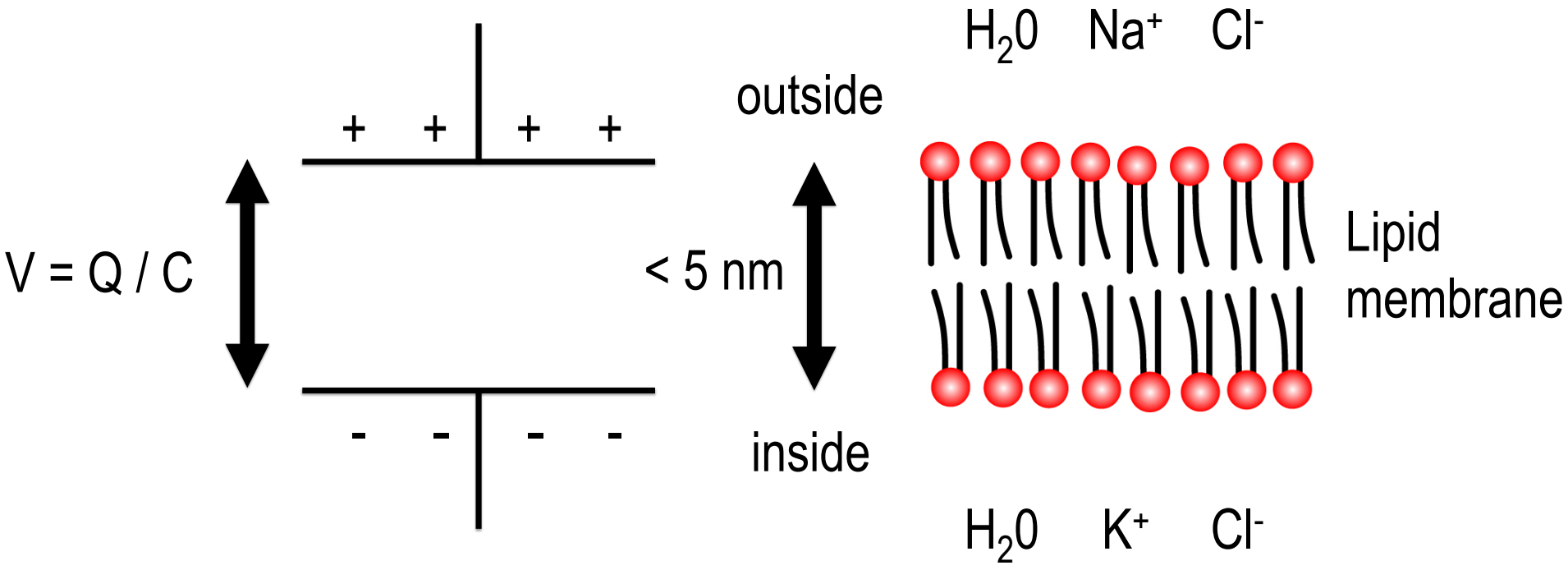
Membrane permeability

The lipid cell membrane is:

- highly permeable to gases and small uncharged molecules
- limited permeability to water
- impermeable to ions and charged molecules

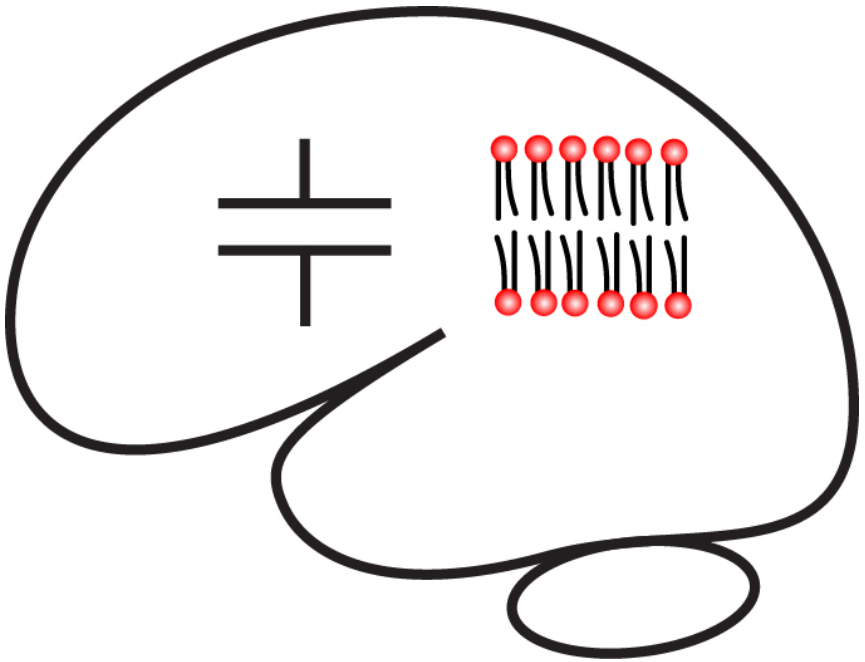


Membrane capacitance



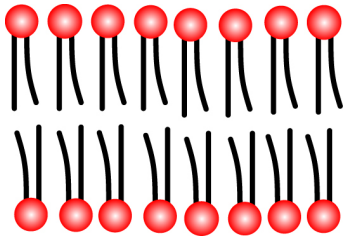
V, voltage; Q, charge; C, capacitance

The cell membrane is a capacitor

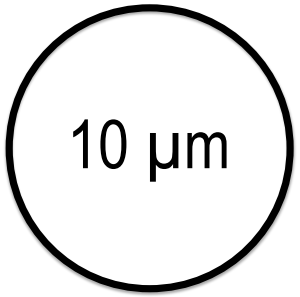


Some numbers - typical cell capacitance

Lipid membranes have a specific capacitance of ~ 1 µF / cm^2.



The capacitance of a typical cell is ~ **10 pF** = 10 x 10^{-12} F.



Some numbers - charge

- How much positive charge would need to move from the inside to the outside of a cell in order to give a membrane potential of -100 mV?

$$Q = C \cdot V$$

Some numbers – number of ions

- How many K^+ ions are in 1 pC ?

$e = 1.6 \times 10^{-19}$ C
Elementary charge

Some numbers – total number of ions in a cell

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- Is 6 million ions a lot?
- How many ions are in a cell?
- Total number of ions in a cell =
  Concentration x Volume x N_A

  $N_A = 6 \times 10^{23}$ mol^{-1}
  Avogadro constant

Electrical signals in cells

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- Only a small fraction of the total number of intracellular ions need to redistribute to generate biologically relevant membrane potentials.

- The membrane potential can change dramatically without substantially changing ionic concentrations.