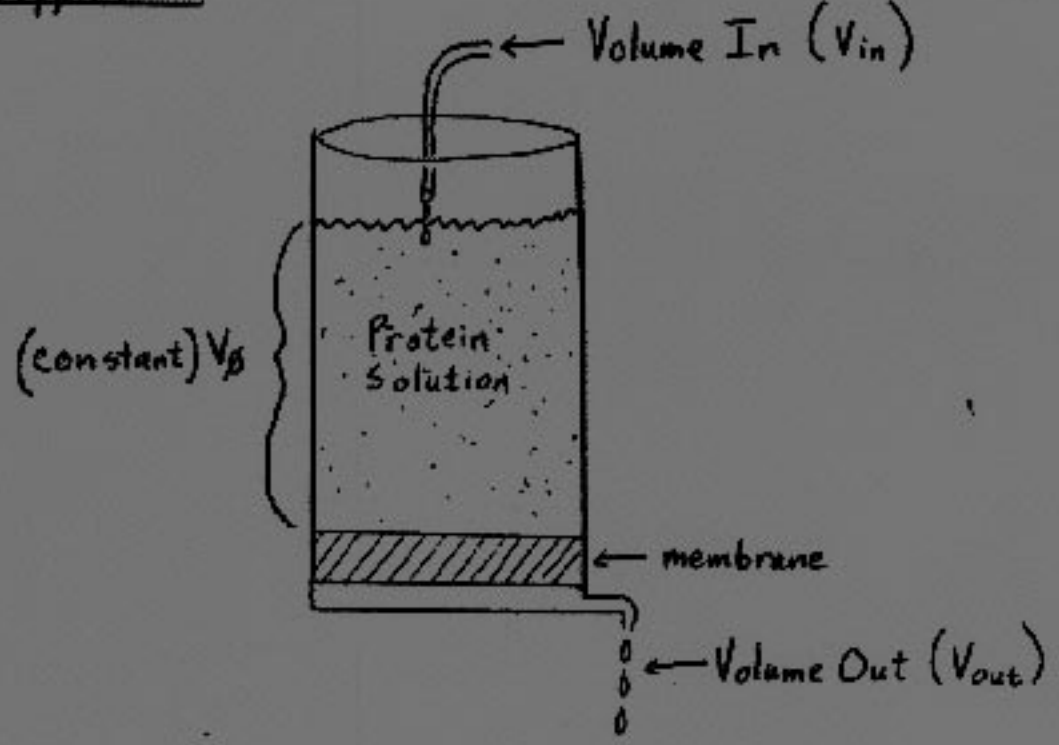
DIAFILTRATION

Apparatus



Function

A diafiltration apparatus allows one to dilute a protein solution selectively while maintaining a constant volume ($V_\emptyset$). This means that one can keep the concentration of protein constant while diluting any small molecular weight molecule/species that can pass through the semi-permeable membrane. (The protein is too big to pass through the membrane.)

Proof

$c = \frac{m}{V_\emptyset}$ where c = concentration of any small MW species (passes through membrane)

m = moles

$V_\emptyset$ = Volume

$$\frac{dV}{dt} = \frac{dV_{in}}{dt} - \frac{dV_{out}}{dt} = 0$$

so, $\frac{dV_{in}}{dt} = \frac{dV_{out}}{dt} = F$ (Flow)

$$\boxed{V_{in} = V_{out} = \Delta V = F \cdot \Delta t}$$

using $m = cV_\emptyset$

$$\frac{dm}{dt} = -c\left(\frac{dV}{dt}\right)$$

$$\frac{dcV_\emptyset}{dt} = -c\left(\frac{dV}{dt}\right)$$

[dt cancels out and you get...]

$$dcV_\emptyset = -c\,dV$$

[cross multiply...]

$$\frac{dc}{c} = -\frac{dV}{V_\emptyset}$$

$$\boxed{\ln \frac{c}{c_o} = \frac{-\Delta V}{V_\emptyset}} \quad \text{or} \quad \boxed{2.303 \log \frac{c}{c_o} = \frac{-\Delta V}{V_\emptyset}}$$

where c_o = original concentration

c = final concentration

Example

You are given a 10ml protein solution in 100 mM NaCl buffer. Your job is to dilute the NaCl concentration down to 1 mM while maintaining the protein concentration and volume of solution (V_ϕ).

Answer

1. For the V_{in}, the concentration of NaCl equals zero
2. Select a membrane permeable to NaCl but impermeable to the protein.

Remember, $\ln \frac{C}{C_o} = \frac{-\Delta V}{V_\phi}$

$$\therefore \ln \frac{1\,mM}{100\,mM} = \frac{-\Delta V}{10\,ml}$$

$$\boxed{\Delta V = -46\,ml}$$

$\therefore$ 46 ml will flow in/out in order to change the concentration from 100 mM NaCl to 1 mM NaCl.