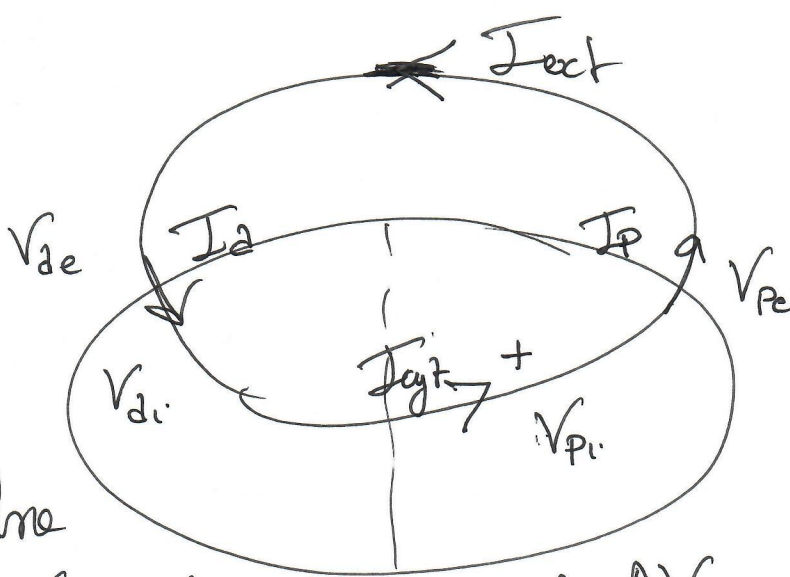


(1)



define

$$V_p = V_{pi} - V_{pe}$$

$$V_a = V_{di} - V_{de}$$

$$\text{and } \Delta V_{\text{cyt}} = V_{di} - V_{pi}$$

$$\Delta V_{\text{ext}} = V_{pe} - V_{de}$$

$$(V_{de} - V_{di}) + (V_{di} - V_{pi}) + (V_{pi} - V_{pe}) + (V_{pe} - V_{de}) = 0$$

$$-V_a + \Delta V_{\text{cyt}} + V_p + \Delta V_{\text{ext}} = 0$$

$$V_a - V_p = \Delta V_{\text{cyt}} + \Delta V_{\text{ext}}$$

By conservation of charge $I_a = I_{\text{cyt}} = I_p = I_{\text{ext}}$

How do we deal with the diffusion component between the two compartments?

Actually it is not an issue. The currents are not ohmic

We can however suppose that $I_{\text{ext}} = \frac{\Delta V_{\text{ext}}}{R_{\text{ext}}}$ is

ohmic in nature as we will assume that there is negligible diffusion. The concentrations are homogeneous on the outside. There is only drift.

We will need $\Delta V_{\text{cyt}} = V_a - V_p - \Delta V_{\text{ext}}$ to calculate

the intercompartment diffusion / drift currents (2)

$$\Delta V_{ext} = R_{ext} I_{ext}$$

R_{ext} can be calculated. It will be a function of the ion concentrations and the geometry of the outside space measured in terms of an effective drift coefficient. In a first step, we can just use an estimated value.

To understand the impact of R_{ext} , we could also simply treat $I_{cyt} = \frac{\Delta V_{cyt}}{R_{cyt}}$

and then ^{should} we have $V_a - V_p = \Delta V_{cyt} + \Delta V_{ext}$
 $= I (R_{cyt} + R_{ext})$

However, since the motion of impermeant anions is one issue that we are trying to understand

$$\Delta V_{cyt} = V_a - V_p - \Delta V_{ext}$$
$$= V_a - V_p - I_{ext} R_{ext}$$

But are these relations true if we are not in steady state?