BIOFISICA DELLE MEMBRANE E CELLULARE

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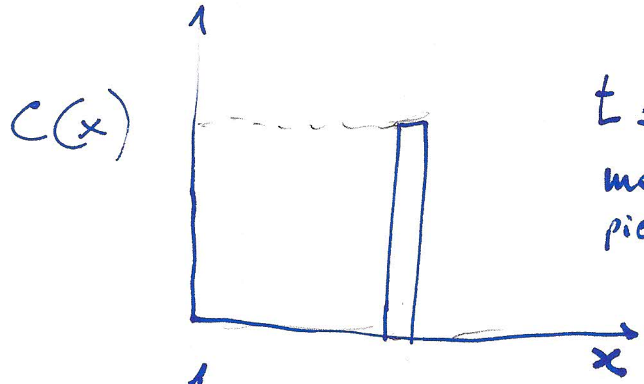
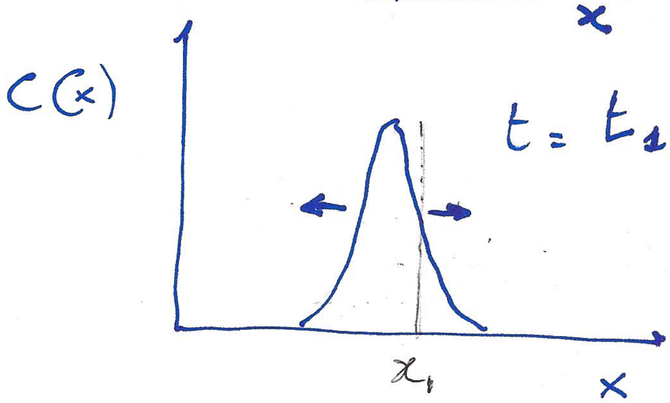


$t = 0$ (inizio)

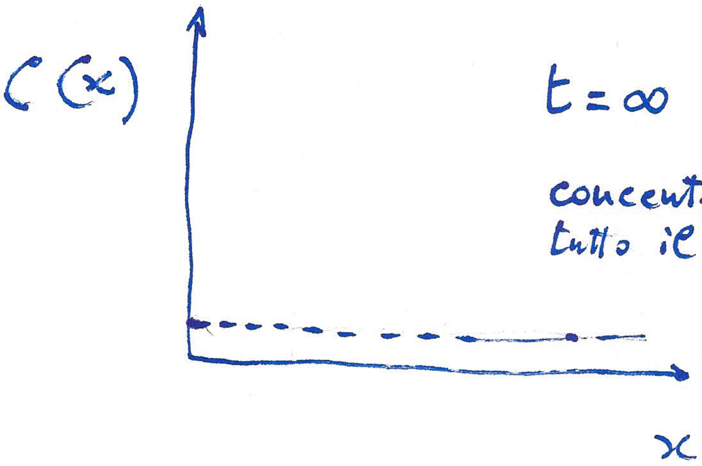
molecole localizzate in una piccola fetta centrale del contenitore



$t = t_1$

le molecole stanno occupando lo spazio disponibile

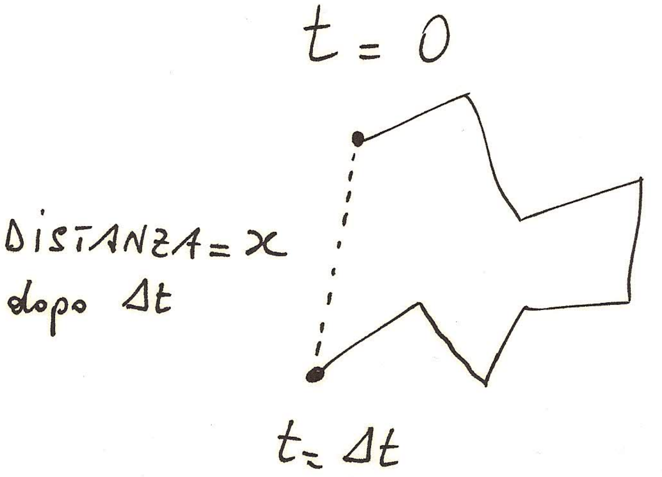
ecc.



$t = \infty$ (all'equilibrio)

o STATO STAZIONARIO

concentrazione uniforme in tutto il contenitore



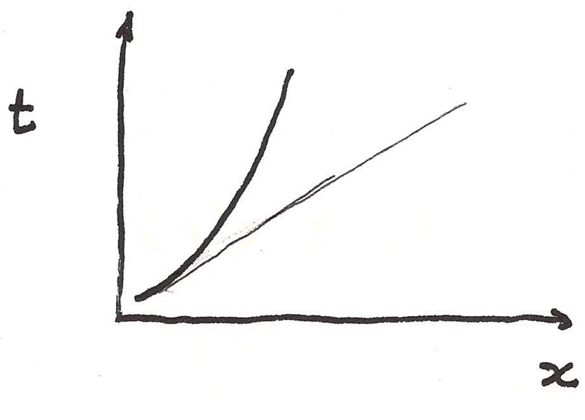
$$\langle x^2 \rangle \simeq \Delta t \quad (\text{VAR})$$

$$\langle x \rangle \simeq \sqrt{\Delta t} \quad (\text{STD DEV})$$

$2\Delta t \rightarrow$ 1 Dim

$4\Delta t \rightarrow$ 2 Dim

$6\Delta t \rightarrow$ 3 Dim



ALCUNI COEFFICIENTI DI DIFFUSIONE IN ACQUA.

Molecola	**D** (moltiplicato per 0.00001, cioè 10^{-5})
Acqua	2.2
O_2	2.0
Cl^-	2.0
K^+	2.0
Na^+	1.3
glicina	1.0
glucosio	0.6
lattosio	0.4
emoglobina	0.07

P. es. $D = 2.2 \times 10^{-5}\ cm^2/s$

$$t \simeq \frac{x^2}{D} \quad \left(\frac{cm^2}{cm^2/s} = s \right)$$

per $D = 2 \times 10^{-5}\ cm^2/s$

$x = 10\ \mu m = 10^{-3}\ cm$

$$t \simeq \frac{(10^{-3})^2\ cm^2}{2 \times 10^{-5}\ cm^2/s}$$

$$= \frac{10^{-6}}{2 \times 10^{-5}} = 0.5 \times 0.1\ s = 50\ ms$$

se $x = 1\ cm$ $\quad t \simeq 14\ h$

$x = 1\ m$ $\quad t \simeq$ ANNI

From: Weiss TF, Cellular Biophysics, MIT Press, 1996.

Table 3.4 Rough estimates of diffusion times for organelles, cells, and tissues of typical dimensions (Macey, 1980). The diffusion times were computed from the relation $t_{1/2} = x_{1/2}^2/D$ using a diffusion coefficient of $D = 10^{-5}$ cm^2/s.

$x_{1/2}$	$t_{1/2}$	Example
10 nm	100 ns	Thickness of cell membrane
1 μm	1 ms	"Size" of mitochondrion
10 μm	100 ms	Radius of a small mammalian cell
100 μm	10 s	Diameter of a large muscle fiber
250 μm	1 min	Radius of squid giant axon
1 mm	16.7 min	Half-thickness of frog sartorius muscle
2 mm	1.1 h	Half-thickness of lens in the eye
5 mm	6.9 h	Radius of mature ovarian follicle
2 cm	4.6 d	Thickness of ventricular myocardium
1 m	31.7 yrs	Length of a nerve or muscle cell

TRASPORTO ASSONICO CELLULIPETO O CELLULIFUGO

~100 ~400 mm/giorno

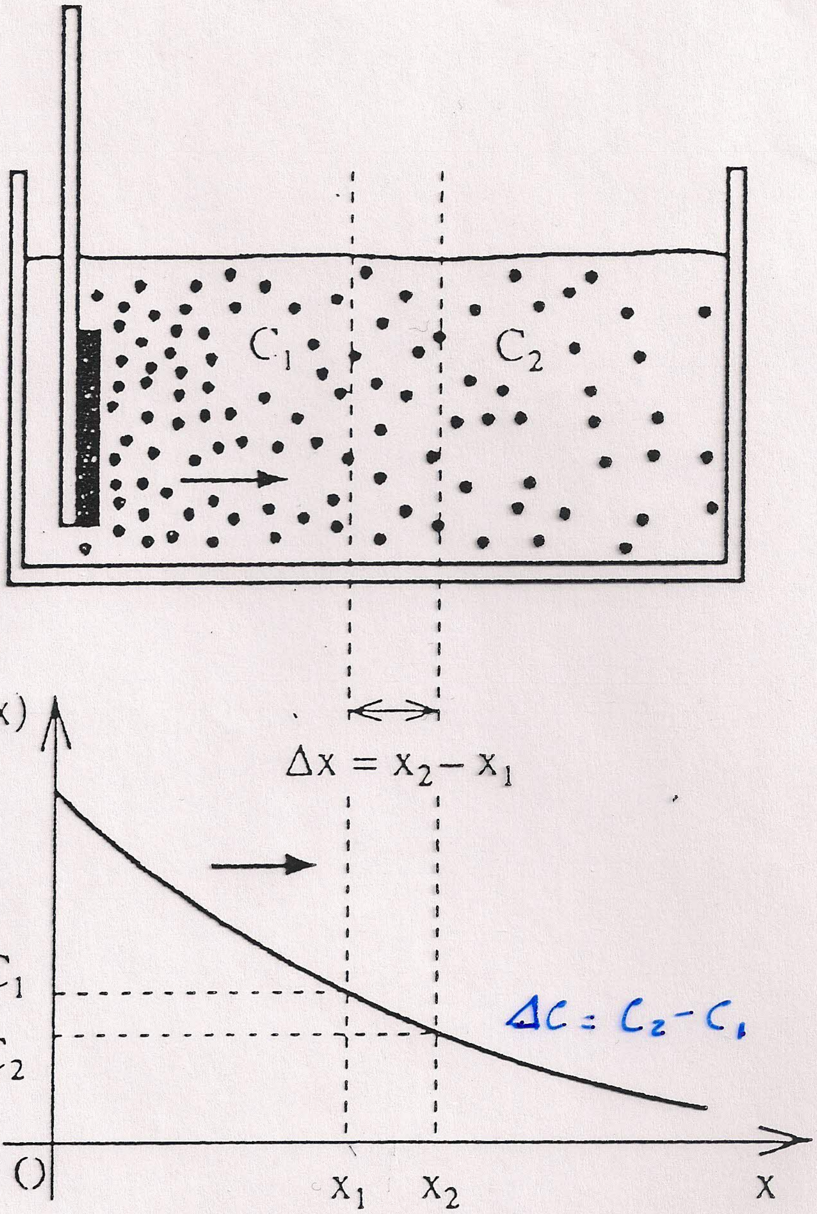
$$J = \frac{N}{A \cdot t} = \frac{moli}{cm^2 \cdot s} \text{ (o particelle)}$$

(DENSITÀ DI FLUSSO)

$$J_{TOT} = A J = \frac{moli}{s}$$

(FLUSSO o FLUSSO TOTALE, nel senso del flusso totale attraverso l'intera superficie che si sta considerando)

DIFFUSIONE SEMPLICE



$$J \propto \frac{\Delta c}{\Delta x}$$

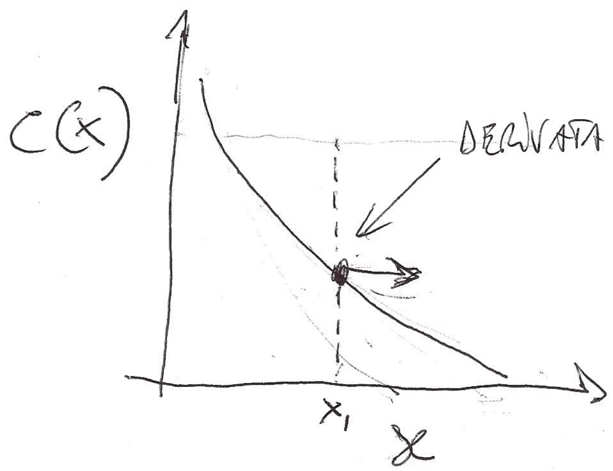
Maggiore è $\frac{\Delta c}{\Delta x}$, più rapida è la caduta di conc. e maggiore è il flusso.

I LEGGE DI FICK

$C(x,t) \longrightarrow C(x)$ STATO STAZION. ($t=\infty$)
o t piccolo

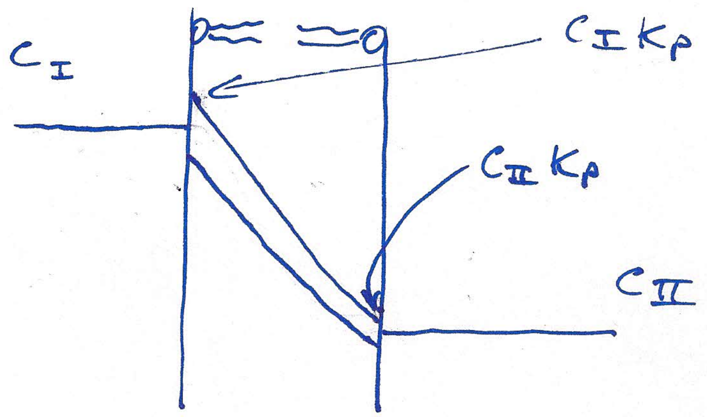
$$\vec{J} = -D \frac{dC(x)}{dx} \quad \text{se } \Delta x \to 0$$

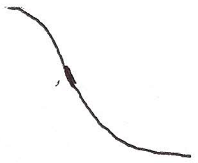
SEGNO e NOTAZIONE VETTORIALE



MODELLO "SOLUZIONE - DIFFUSIONE"

Per una membrana sottile ed omogenea:





COEFF. di PARTIZIONE $= K_p = \dfrac{\text{CONC. nella MEMB.}}{\text{CONC. nella SOLUZ.}}$ (all'equilibrio)

$$J = -\frac{D_m \Delta C}{\Delta x} = -D_m \frac{(K_p C_{II} - K_p C_I)}{\Delta x}$$

$$J = -\frac{D_m K_p}{\Delta x}(C_{II} - C_I)$$

$$= -P_m (C_{II} - C_I) = -P_m \Delta C$$

oppure $P_m (C_I - C_{II})$

$P_m = \dfrac{D_m K_p}{\Delta x}$ = PERMEABILITÀ (della membrana per un certo composto)

GRAFICO DI COLLANDER
(Collander-Bärlund, 1933)
chara (ALGA)

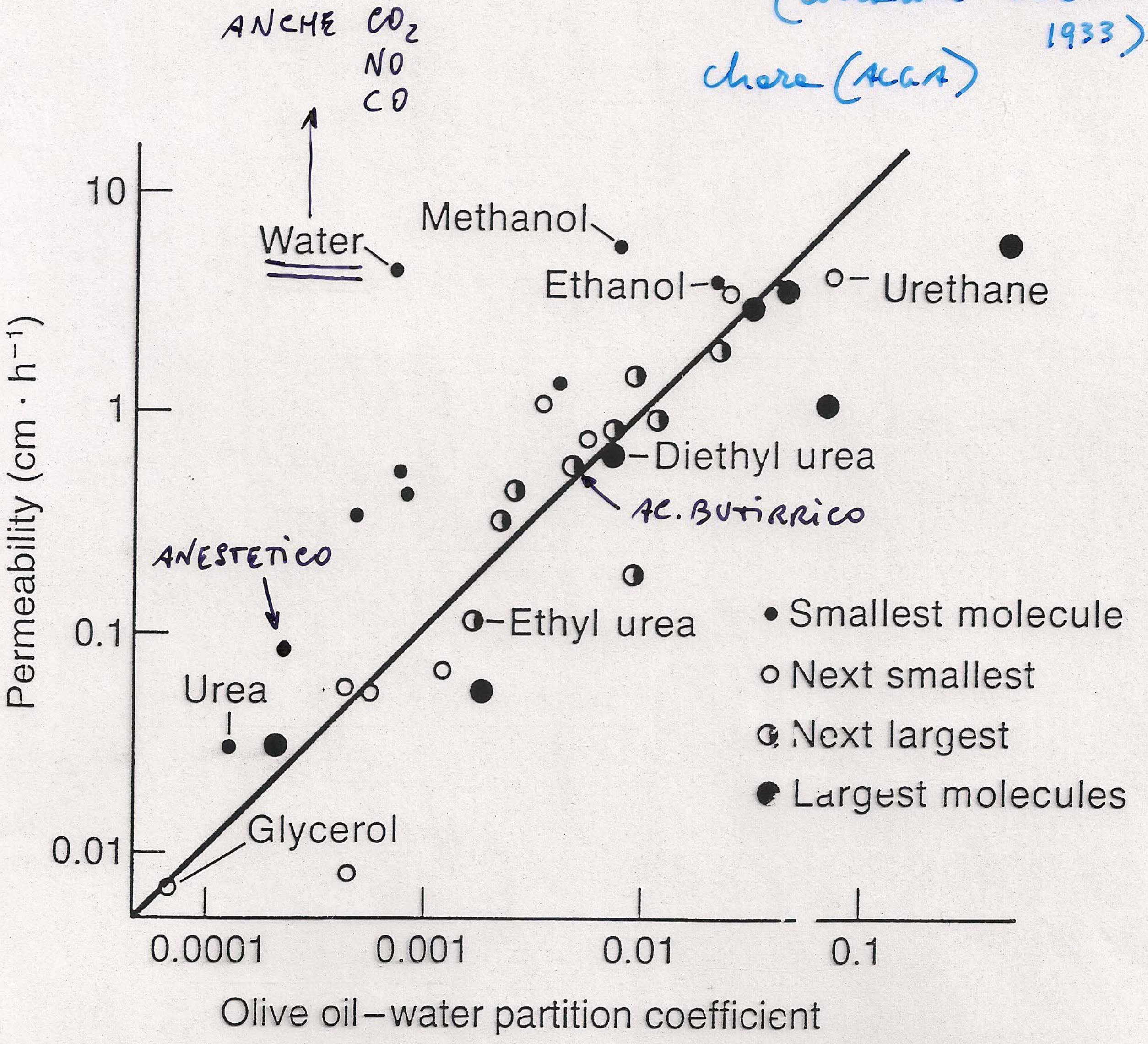


Figure 4-19 Membrane permeability of nonelectrolytes is linearly related to their respective oil-water partition coefficients. Note that the permeability of nonelectrolytes is independent of molecular size.

(FROM RANDALL ET AL. ANIMAL PHYSIOLOGY, 4th ED.)

COEFFICIENTE DI PARTIZIONE (nella figura)

$$K_p = \frac{\text{CONC. DEL SOLUTO NEL LIPIDE}}{\text{CONC. DEL SOLUTO IN ACQUA}}$$

↓

buona approssimazione del
Kp membrana/soluzioni organiche