论电鳗的发电机制

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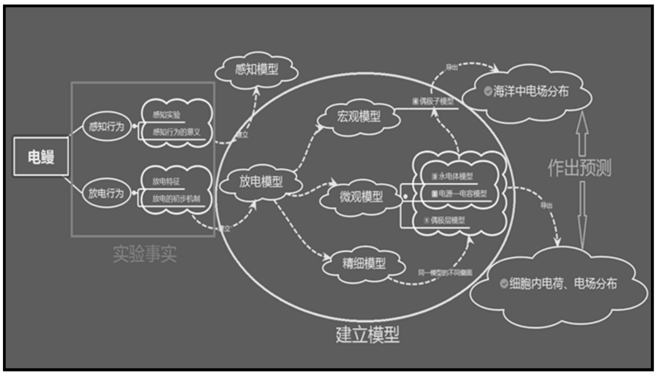
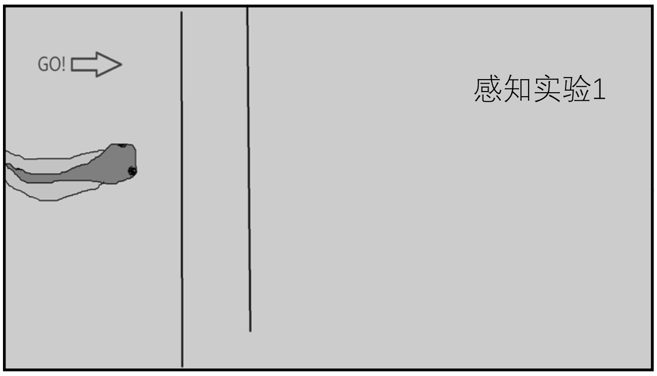
电鳗简介

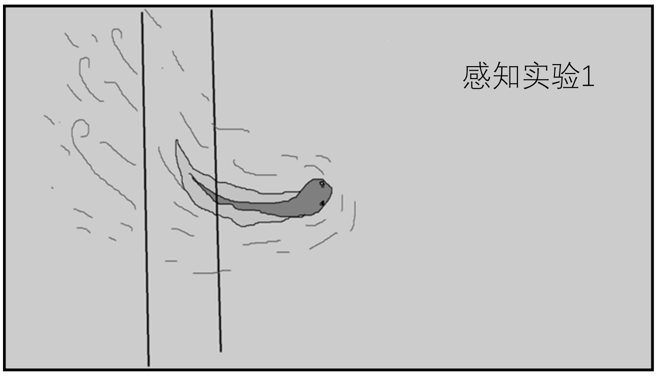


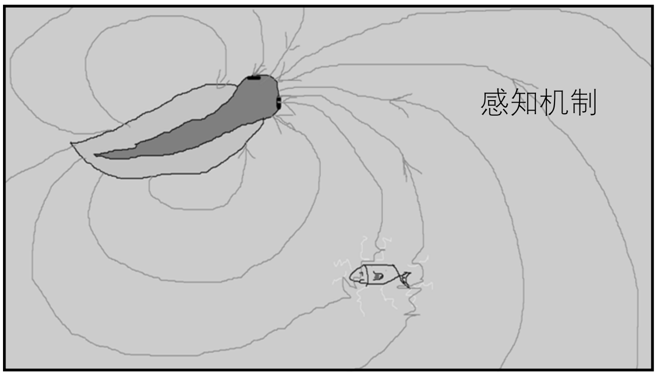
电鳗的感知行为

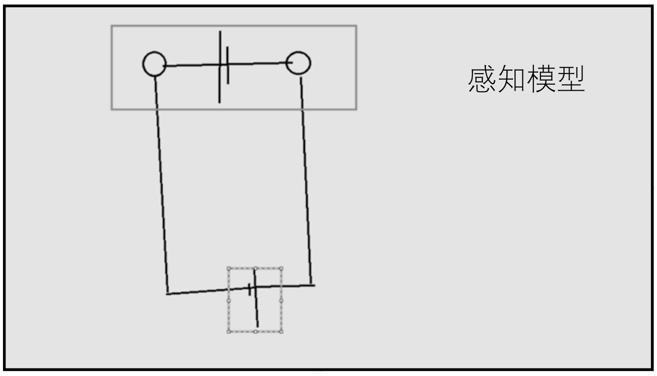
- 1.1感知实验
- 1.2感知行为的意义

- 2.1.感知模型&机制



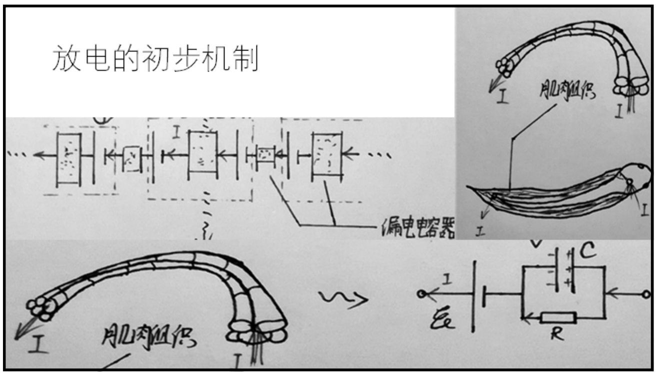






电鳗的放电行为

- 3.1放电特征
- 3.2放电的初步机制

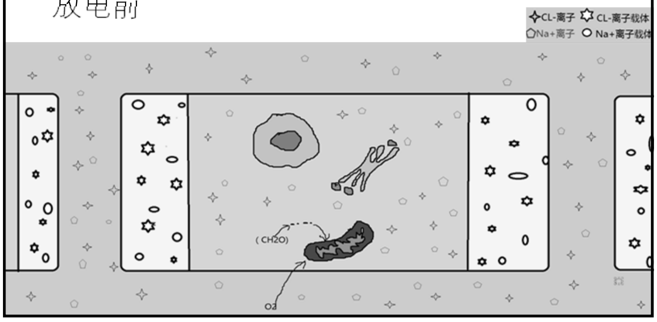


电鳗放电的精细微观模型

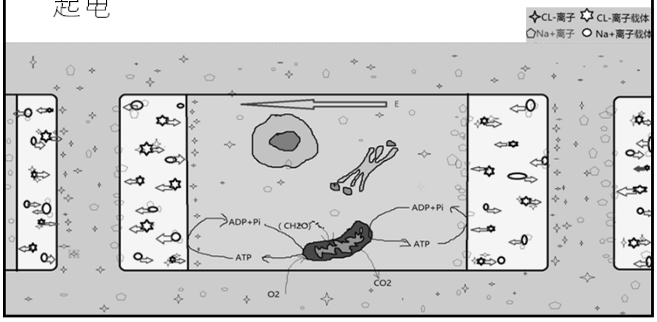
- 4.1精细微观模型

- 5.2细胞内的电场分布
- 5.3细胞内的净电荷分布

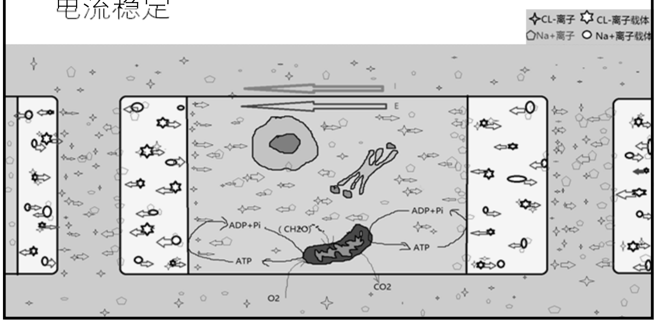
放电前



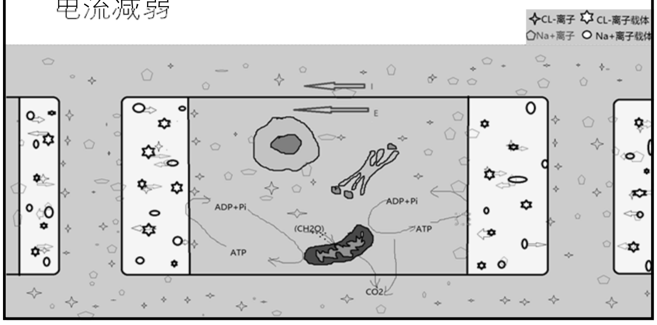
起电



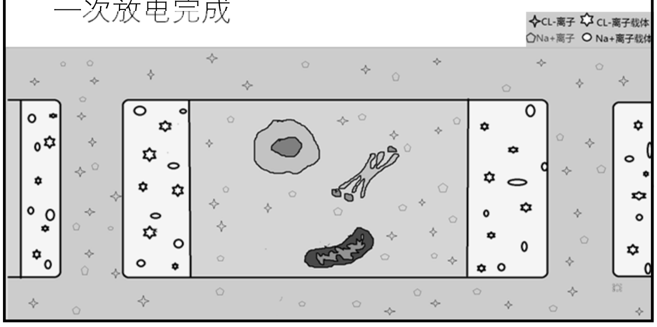
电流稳定

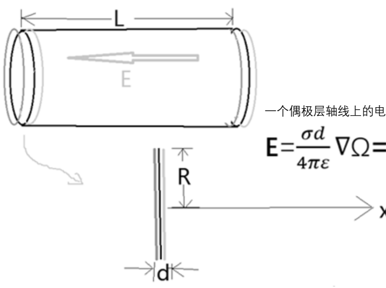


电流减弱



一次放电完成



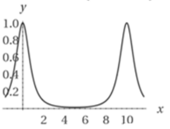


一个偶极层轴线上的电场

$$E=\frac{\sigma d}{4\pi\varepsilon}\nabla\Omega=\frac{\sigma d}{2\varepsilon}\frac{R^2}{(x^2+R^2)^{\frac{3}{2}}}\quad (x>>d)$$

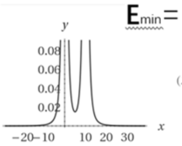
细胞内的电场分布 $E=\frac{\sigma d}{2\varepsilon}\left[\frac{R^2}{(x^2+R^2)^{\frac{3}{2}}}+\frac{R^2}{((L-x)^2+R^2)^{\frac{3}{2}}}\right]$ (x>>d 且（L-x）>>d)

$$E=\frac{\sigma d}{2\varepsilon}\left[\frac{R^2}{(x^2+R^2)^{\frac{3}{2}}}+\frac{R^2}{((L-x)^2+R^2)^{\frac{3}{2}}}\right]$$

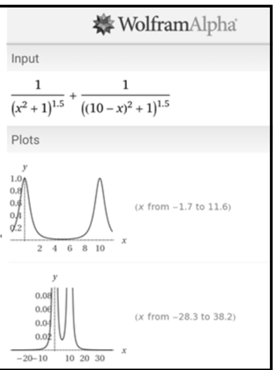


(x from −1.7 to 11.6)

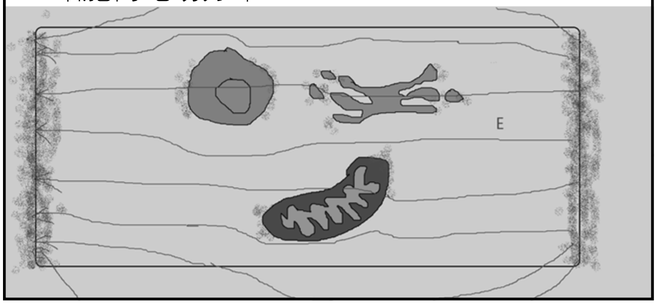
$$E_{min}=E\left(\frac{L}{2}\right)=\frac{\sigma d}{\varepsilon}\frac{R^2}{\left(\frac{L^2}{4}+R^2\right)^{\frac{3}{2}}}$$



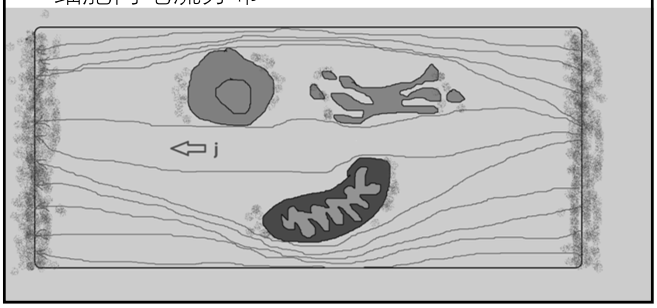
(x from −28.3 to 38.2)



细胞内电场分布（由细胞膜上的电荷激发）

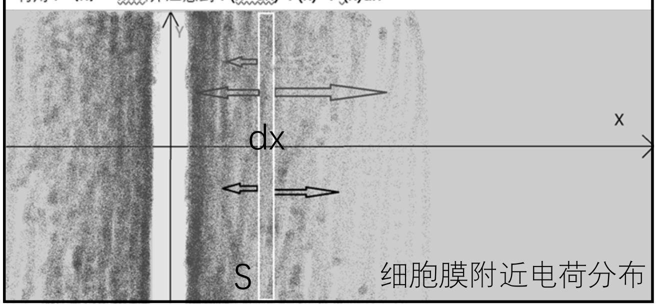


细胞内电流分布



$$\left(\int_{\frac{l}{2}}^{x}\frac{\rho(x)dx}{2\varepsilon}\right)\rho(x)Sdx+\rho(x)S=\left(\int_{-\infty}^{-\frac{l}{2}}\frac{\rho(x)dx}{2\varepsilon}\right)\rho(x)Sdx+\left(\int_{x}^{+\infty}\frac{\rho(x)dx}{2\varepsilon}\right)\rho(x)Sdx+\rho(x+dx)S$$

利用 P（x）=nkT,并注意到 P(x+dx)-P(x)=P'(x)dx



$$\left(\int_{\frac{l}{2}}^{x}\frac{\rho(x)dx}{2\varepsilon}\right)\rho(x)Sdx+\rho(x)S=\left(\int_{-\infty}^{-\frac{l}{2}}\frac{\rho(x)dx}{2\varepsilon}\right)\rho(x)Sdx+\left(\int_{x}^{+\infty}\frac{\rho(x)dx}{2\varepsilon}\right)\rho(x)Sdx+\rho(x+dx)S$$

利用 P（x）=nkT,并注意到 P(x+dx)-P(x)=P'(x)dx

⇨ $$\rho''\rho'-\rho'^2-\frac{q}{\varepsilon kT}\rho^3=0$$

初始条件：

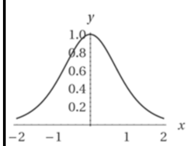
$$\rho'\left(\frac{l}{2}\right)=0$$

$$\int_{\frac{l}{2}}^{+\infty}\rho(x)dx=-\sigma$$

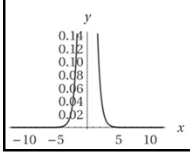
⇨ $$\rho(x)=-\frac{q\sigma^2}{2\varepsilon kT}\frac{1}{Ch^2\left[\frac{q\sigma}{2\varepsilon kT}\left(x-\frac{l}{2}\right)\right]}$$

Plots

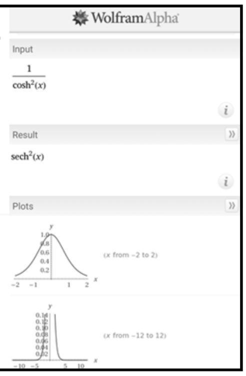
$$\rho(x)=-\frac{q\sigma^2}{2\varepsilon kT}\frac{1}{Ch^2\left[\frac{q\sigma}{2\varepsilon kT}\left(x-\frac{l}{2}\right)\right]}$$



(x from −2 to 2)



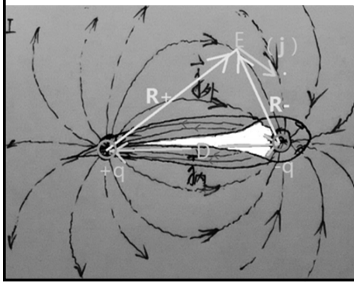
(x from −12 to 12)



电鳗放电的宏观模型

- 6.宏观模型
- 7.海洋中的电场分布

海洋中电流分布



$$E=\frac{q}{4\pi\varepsilon}\left(\frac{\boldsymbol{R+}}{R+^3}-\frac{\boldsymbol{R-}}{R-^3}\right)$$

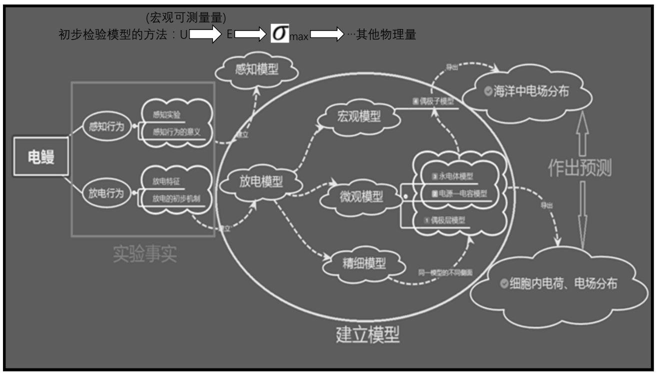
$$U=\frac{\boldsymbol{q^2}}{4\pi\varepsilon D}$$

$$j=\sigma E$$

$$\Rightarrow\quad j=\sigma\sqrt{\frac{DU}{4\pi\varepsilon}}\left(\frac{\boldsymbol{R+}}{R+^3}-\frac{\boldsymbol{R-}}{R-^3}\right)$$

远处近似为偶极子场

$$j_{远}=\sigma\sqrt{\frac{DU}{4\pi\varepsilon}}\frac{D}{r^3}(2cos\theta\boldsymbol{ro}+sin\theta\boldsymbol{\theta o})$$



谢谢！