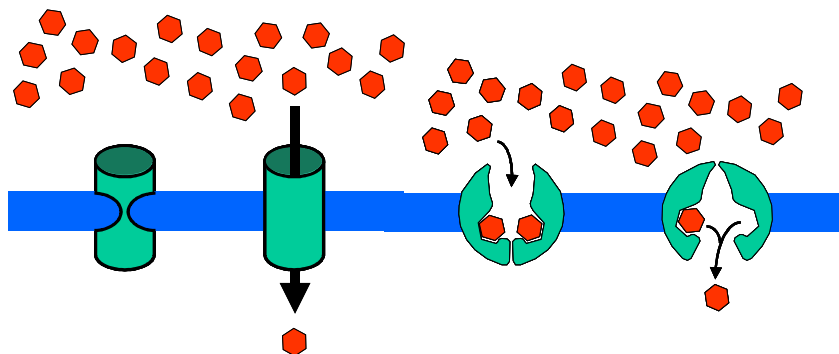
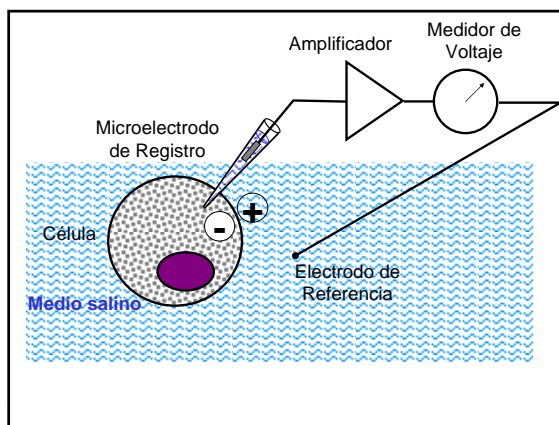
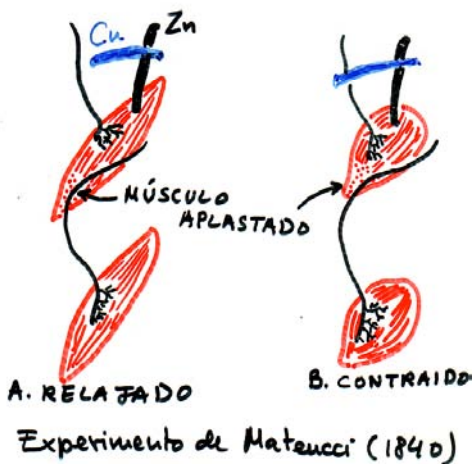
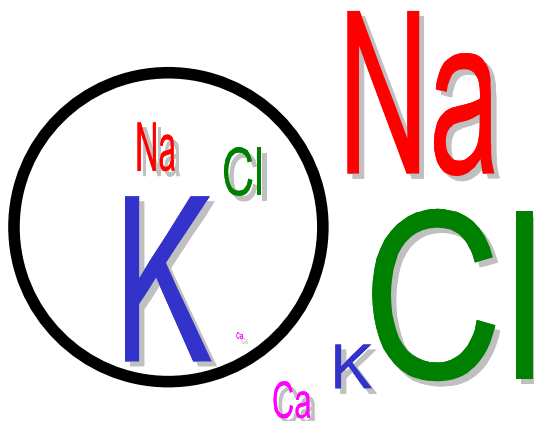


MECANISMO	SUBSTRATO	CINETICA	OBSERVACIONES
DIFUSION	Subs. Lipo-solubles (O₂ CO₂ EtOH)	$J_s = ? [S] \cdot P_s$	Tamaño Acidos y bases débiles
CANALES	Iones: Na⁺, K⁺, Cl⁻, Ca²⁺	$J_i = P_i (? [I], E_m)$	Proteínas Selectivos Regulables
DIFUSION FACILITADA	Azúcares, Aminoácidos, Metabolitos	$J_s = \frac{V_m \cdot [S]}{K_m + [S]}$	Transportadores Selectivos Regulables
BOMBAS	Na⁺/K⁺, Ca²⁺, H⁺	Saturación y Competición	Transportadores Transp. Activo 1º ? G = ATP
CO- y CONTRA-TRANSPORTE	Azúcares, Aminoácidos, Metabolitos, Iones	Saturación y Competición	Transportadores Transp. Activo 2º ? G = ? [ion] (Na⁺, K⁺, H⁺)

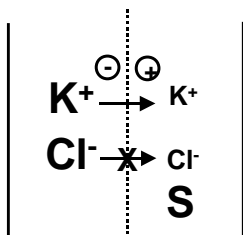


COMPOSICION CELULAR (mM)

ION	INTRA-CELULAR	EXTRA-CELULAR
Na ⁺	10	140
K ⁺	140	5
Cl ⁻	10	110
Ca ²⁺	0,0001	1



Potencial de Equilibrio. Ecuación de Nernst



$$\mu_A = \mu_0 + RT \cdot \ln(a_A) + z \cdot F \cdot V$$

$${}^1\mu_K = \mu_K^0 + RT \cdot \ln[K]_1 + z \cdot F \cdot V_1$$

$${}^2\mu_K = \mu_K^0 + RT \cdot \ln[K]_2 + z \cdot F \cdot V_2$$

En Equilibrio, ${}^1\mu_K = {}^2\mu_K$

$$RT \cdot \ln[K]_1 + z \cdot F \cdot V_1 = RT \cdot \ln[K]_2 + z \cdot F \cdot V_2$$

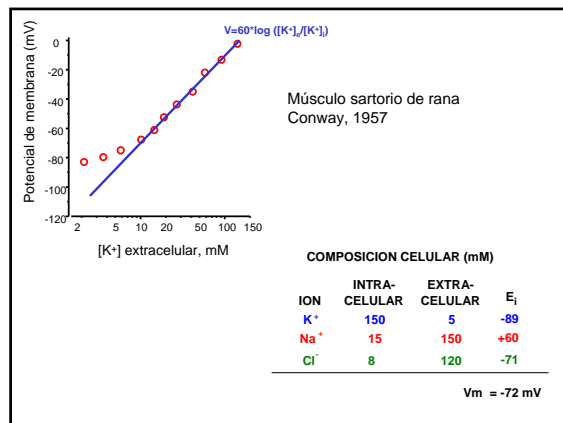
$$z \cdot F \cdot (V_1 - V_2) = RT \cdot \ln\left\{\frac{[K]_2}{[K]_1}\right\}$$

$$(V_1 - V_2) = \left(\frac{RT}{z \cdot F}\right) \cdot \ln\left\{\frac{[K]_2}{[K]_1}\right\}$$

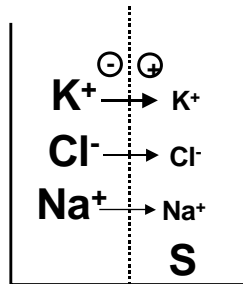
$$(V_1 - V_2) = 60 \cdot \log\left\{\frac{[K]_2}{[K]_1}\right\}$$

$$[K^+] / [K^+]_e = 10, \quad V_m = -60 \text{ mV};$$

$$[Cl^-] / [Cl^-]_e = 10, \quad V_m = +60 \text{ mV}$$



Potencial de Difusión. Ecuación de Goldman



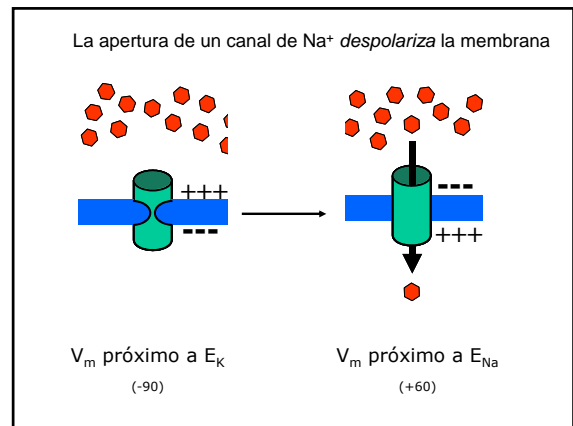
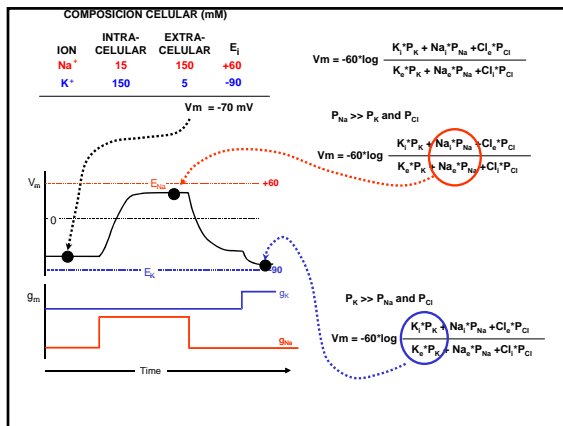
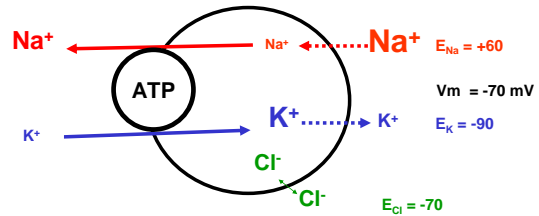
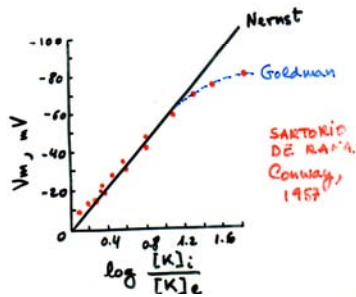
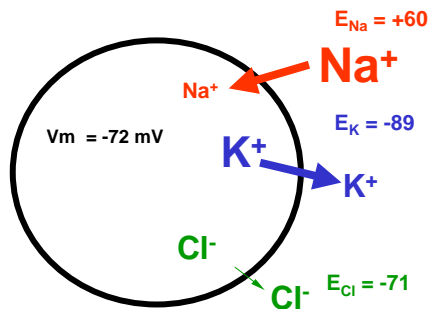
$$(V_1 - V_2) = (RT/F) \ln \frac{K_2 P_K + Na_2 P_{Na} + Cl_1 P_{Cl}}{K_1 P_K + Na_1 P_{Na} + Cl_2 P_{Cl}}$$

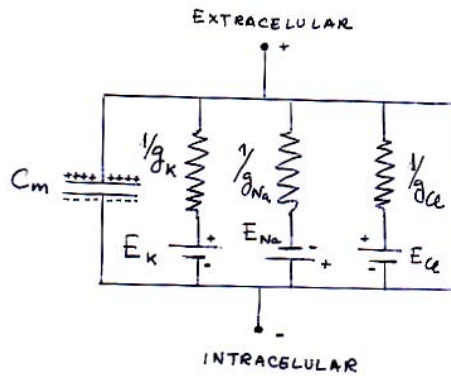
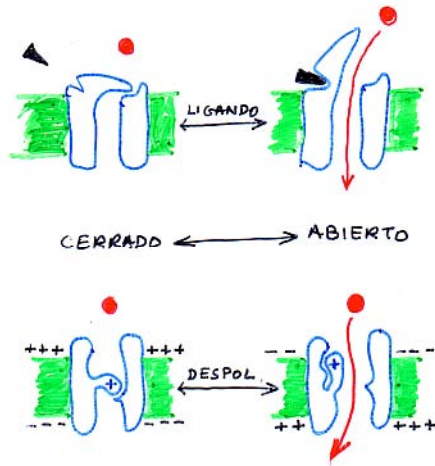
$$((V_1 - V_2) = -60 \log \frac{K_i P_K + Na_i P_{Na} + Cl_e P_{Cl}}{K_e P_K + Na_e P_{Na} + Cl_i P_{Cl}}$$

COMPOSICION CELULAR (mM)

ION	INTRA-CELULAR	EXTRA-CELULAR	E _i
K ⁺	150	5	-89
Na ⁺	15	150	+60
Cl ⁻	8	120	-71

Para P_K:P_{Na}:P_{Cl} = 1:0,03:0,05 V_m = -72 mV





Modelo de Hodgkin&Katz

- Condensador = 1 μF/cm² (C=Q/V)
- Resistencias + Baterías en paralelo
- Flujo = Corriente (EMF=E_i)

$$I = V/R = V \cdot g$$

$$I_x = (V_m - E_x) / R_x$$

$$E_m = \frac{g_K \cdot E_K + g_{Na} \cdot E_{Na} + g_{Cl} \cdot E_{Cl}}{g_K + g_{Na} + g_{Cl}}$$

$$I = V/R = V \cdot g$$

$$I_i = g_i \cdot (E_m - E_i)$$

$$I_{Na} = g_{Na} \cdot (E_m - E_{Na}); I_K = g_K \cdot (E_m - E_K); I_{Cl} = g_{Cl} \cdot (E_m - E_{Cl})$$

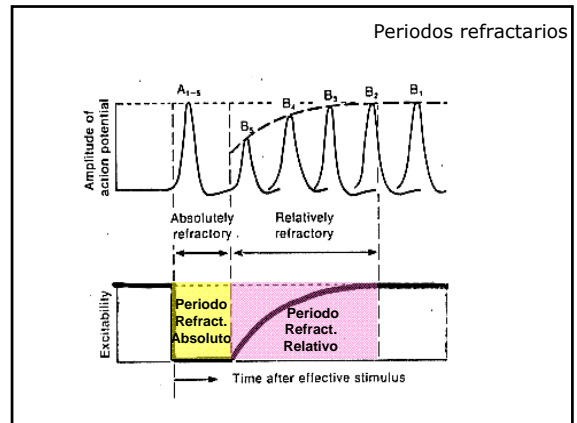
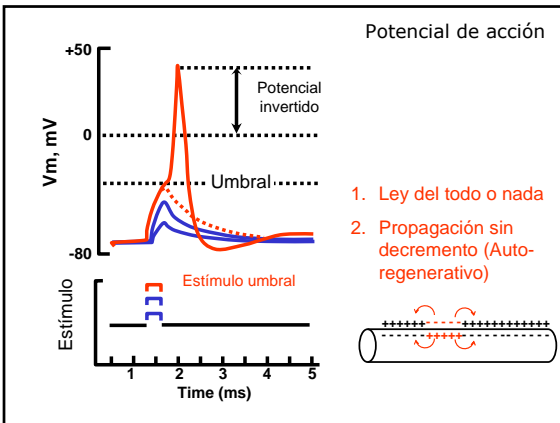
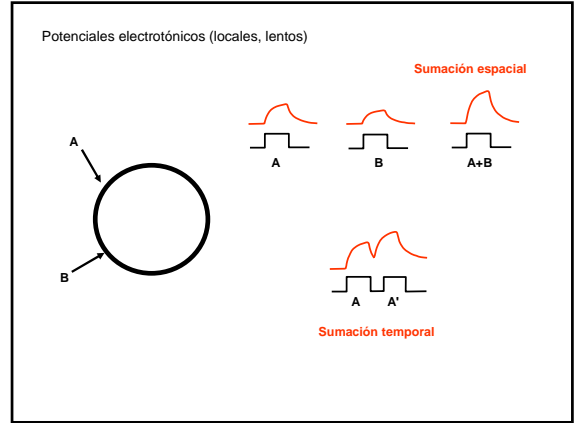
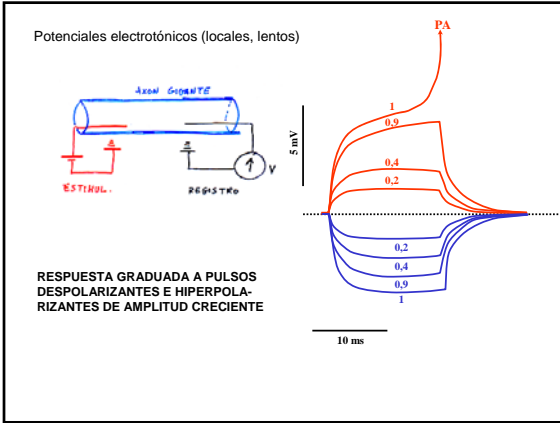
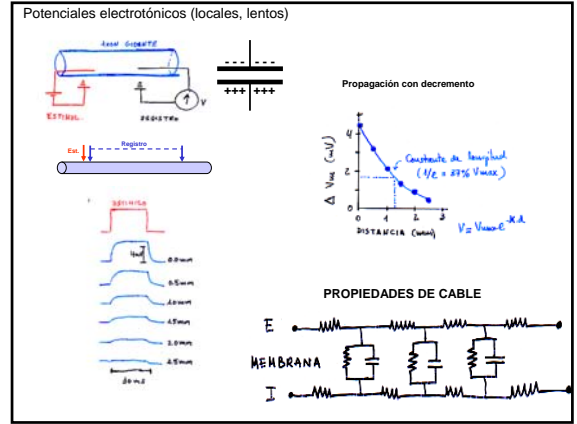
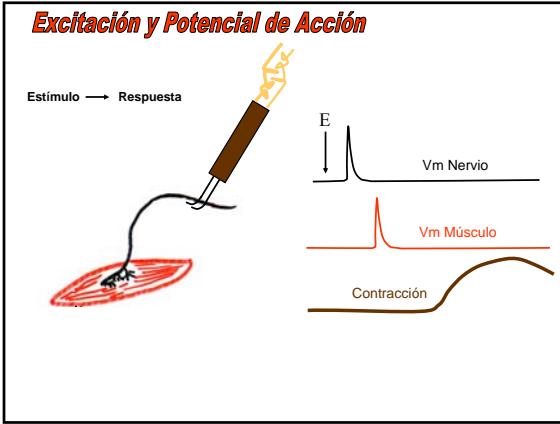
At equilibrium, $I_{Total} = I_{Na} + I_K + I_{Cl} = 0$

$$g_{Na} \cdot (E_m - E_{Na}) + g_K \cdot (E_m - E_K) + g_{Cl} \cdot (E_m - E_{Cl}) = 0$$

$$E_m \cdot (g_{Na} + g_K + g_{Cl}) = E_{Na} \cdot g_{Na} + E_K \cdot g_K + E_{Cl} \cdot g_{Cl}$$

$$E_m = (E_{Na} \cdot g_{Na} + E_K \cdot g_K + E_{Cl} \cdot g_{Cl}) / (g_{Na} + g_K + g_{Cl})$$

$$E_m = \Sigma(E_i \cdot g_i) / g_{Total} \text{ (Eq. Hodgkin \& Huxley)}$$



Bases iónicas del potencial de acción

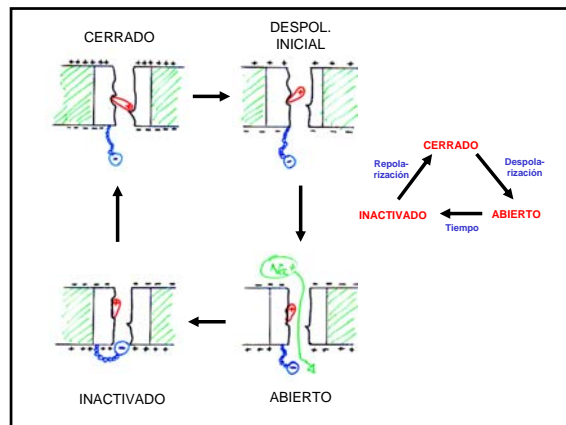
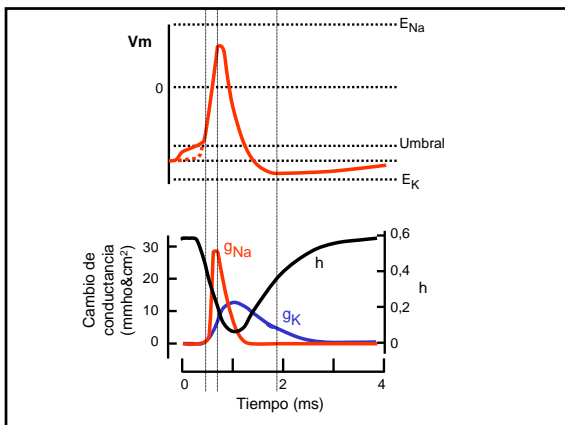
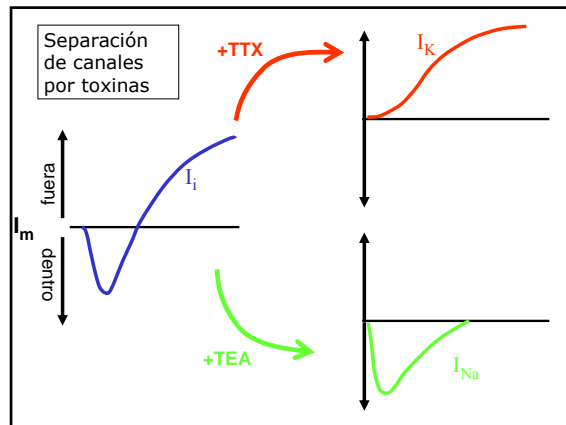
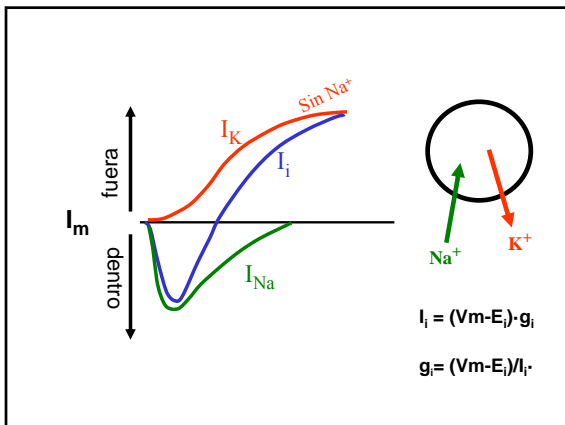
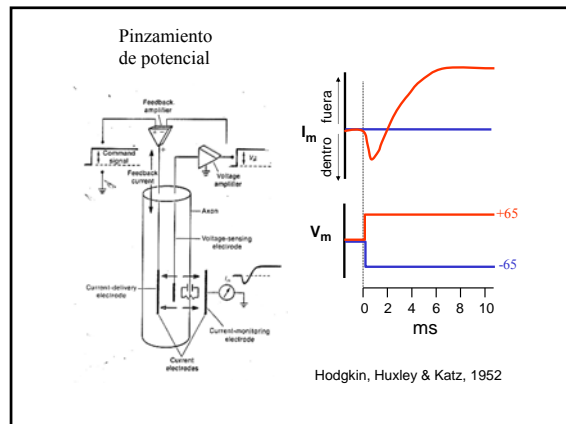
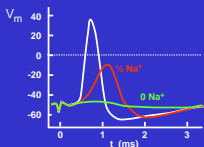
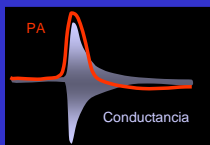
•1902, Bernstein: ↑ Permeabilidad inespecífica ⇒ Colapso de Vm

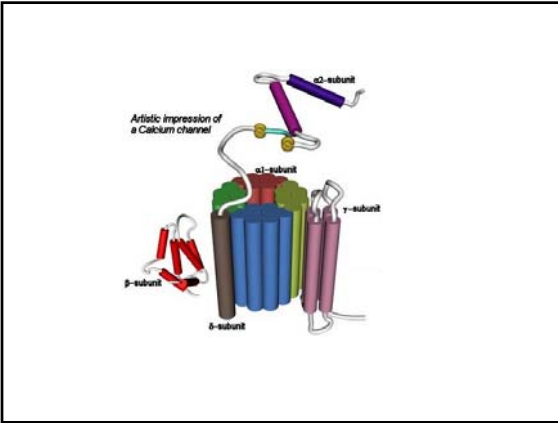
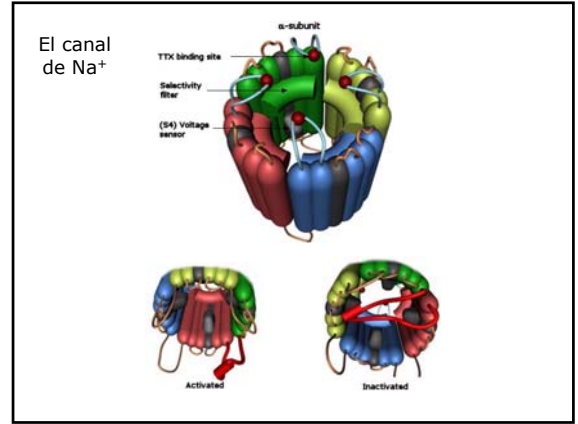
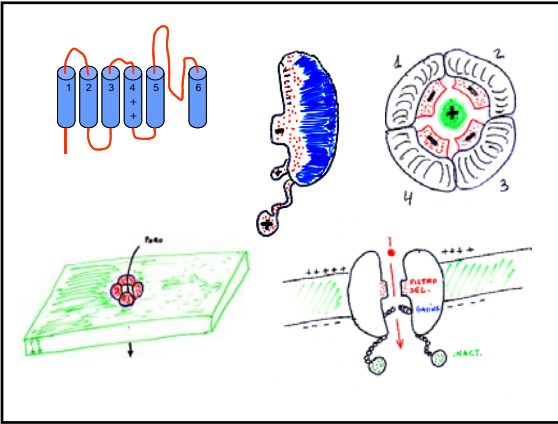
•1939, Curtis & Cole: ↑ g_{Na} durante PA ⇒ ↑ I_{Na} iónica tanto durante la despolarización como durante la repolarización

•1939, Hogkin & Huxley: Potencial positivo durante el pico: E_{Na} es el único potencial de equilibrio adecuado.

•1949, Hodgkin, Huxley & Katz: Efectos del Na^+ extracelular sobre el PA ⇒ Entrada de Na^+ durante el pico. Entrada de ^{22}Na durante el PA

•1952, Hodgkin & Huxley: Pinzamiento de potencial.

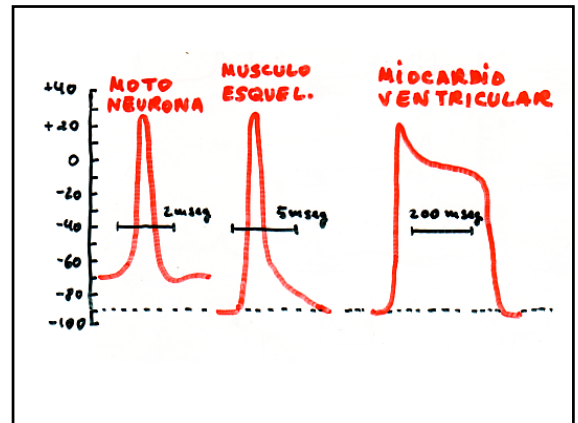
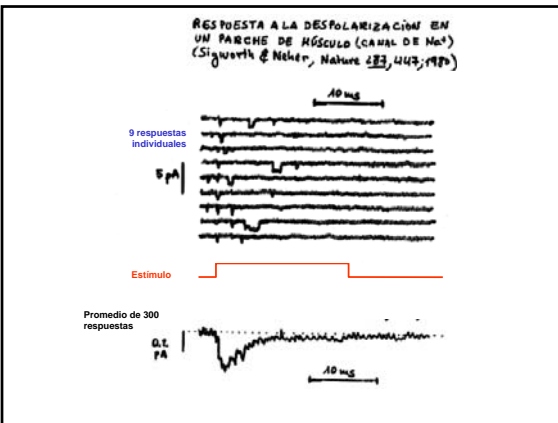




Patch clamp recording

Neher & Sakmann
Nobel Prize 1991

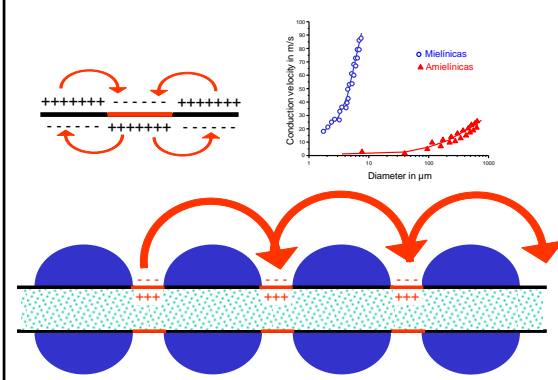
Single ion channel



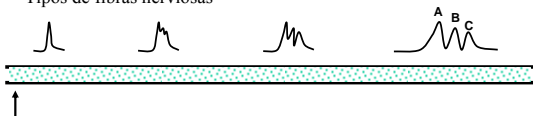
Channelopathies

Condition	Channel type
Bartrter syndrome (limb of Henle)	various by type
Brugada syndrome	various, by type
Congenital hyperinsulinism	Inward-rectifier potassium ion channel
Cystic fibrosis	Chloride channel
Dravet Syndrome	Voltage-gated sodium channel
Episodic Ataxia	Voltage-gated potassium channel
Erythromelalgia	Voltage-gated sodium channel
Generalized epilepsy with febrile seizures	Voltage-gated sodium channel
Familial hemiplegic migraine	Various
Fibromyalgia	Voltage-gated sodium channel
Hyperkalemic periodic paralysis	Voltage-gated sodium channel
Hypokalemic periodic paralysis	Voltage-gated sodium or calcium channel
Long QT syndrome	Various
Malignant hyperthermia	Ligand-gated calcium channel
Mucopolidosis type IV	Non-selective cation channel
Myasthenia Gravis	Ligand-gated sodium channel
Myotonia congenita	Voltage-dependent chloride channel
Neuromyotonia	Voltage-gated potassium channel
Nonsyndromic deafness	various
Paramyotonia congenita	Voltage-gated sodium channel
Retinitis pigmentosa (some forms)	Ligand-gated non-specific ion channels
Short QT syndrome	various potassium channels suspected
Timothy syndrome	Voltage-dependent calcium channel
Seizure	Voltage-dependent potassium channel

CONDUCCIÓN DEL POTENCIAL DE ACCIÓN



Tipos de fibras nerviosas



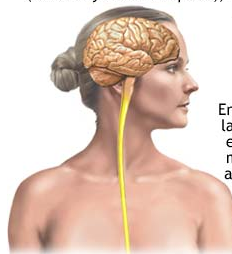
CLASIFICACION DE ERLANGER Y GASSER				LLOYD
TIPO	DIAMETRO (μm)	V. Conduccion (m/s)	Subtipo	Tipo
A	2 a 20	12 a 120	α	I
			β	II
			γ	III
			δ	IV
B	<3	3 a 15		--
C	0,4 a 1,2	0,2 a 2,5		

PRESION: A>B>C
 COCAINA : C>B>A
 HIPOXIA: B>A>C

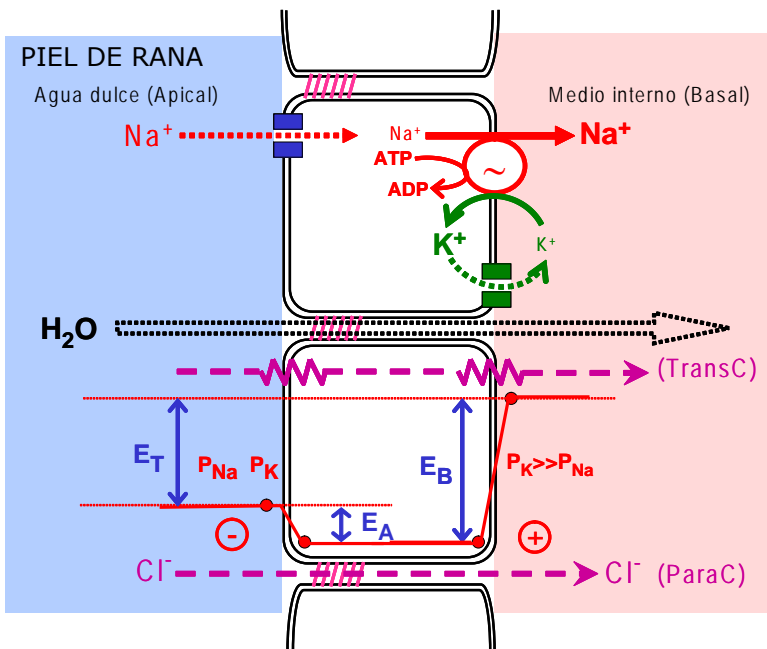
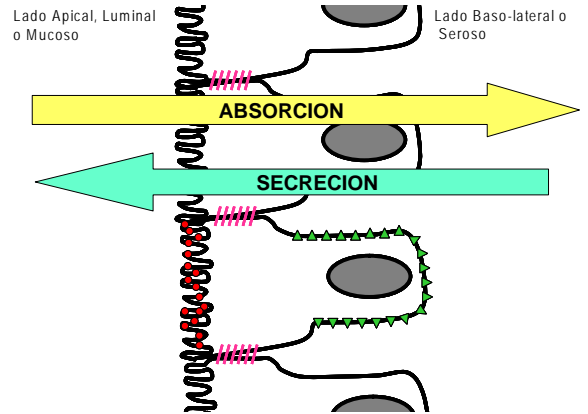
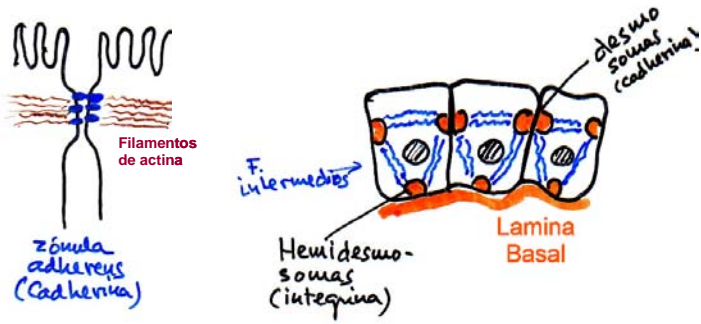
Sistema nervioso central (cerebro y médula espinal))



En la esclerosis múltiple, la vaina de mielina, que es una sola célula cuya membrana envuelve el axón, sufre destrucción por inflamación y cicatrización



EPITELIOS



Tipos de Epitelios

TIPO	ALTA RESISTENCIA (TIGHT)	BAJA RESISTENCIA (LEAKY)
RESISTENCIA	ALTA >10 ⁹ Ω/cm ²	BAJA <100 Ω/cm ²
POTENCIAL TRANSEPITELIAL	ALTO >40 mV	BAJO <5 mV
TRANSPORTE	Hipertónico Alto gradiente	Isotónico Bajo gradiente
TASA DE TRANSPORTE	BAJA	ALTA
EJEMPLOS	Túbulo distal Colon Piel de rana Vejiga de sapo	Túbulo proximal Intestino Vesícula biliar

