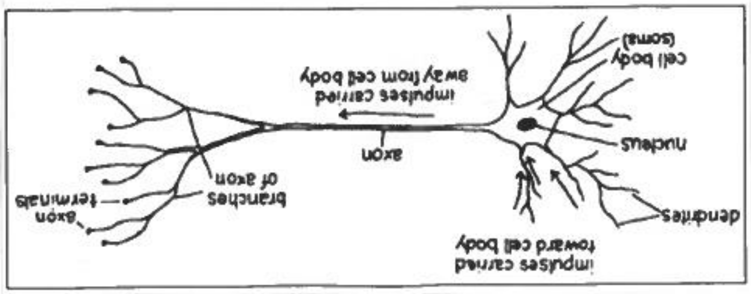
1-



Electrical potential exist across the membranes of various kinds of cells. Some cells, such as nerve cells and muscle cells, are said to be excitable because they are capable ~~to~~of transmitting a change of potential along their membrane.

A human nerve cell consists of a cell body and a single long fiber extension approximately 10^{-5} to 10^{-3} cm in diameter, Called the axone, which transmits impluses from the cell body to the adjacent nerve cell.

The electrical potential established by the difference in ionic concentrations across the membrane is known as the membrane potential.

The membrane potential changes from -70 mV to about 35 mV and then rapidly returns to its original values. The sudden spike in the membrane potential is called the action potential.

The depolarizing influx of Na^+ ions at the immediate site of the action potential causes the membrane potential in adjacent regions to depolarize slowly. when this slow depolarization has pushed the potential of the adjacent membrane beyond a certain value, called the threshold potential.

The action potential travels along the axon until it reaches either a synaptic junction which is the connection between nerve cells or a neuromuscular junction which is the connection between a nerve cell and a muscle cell.

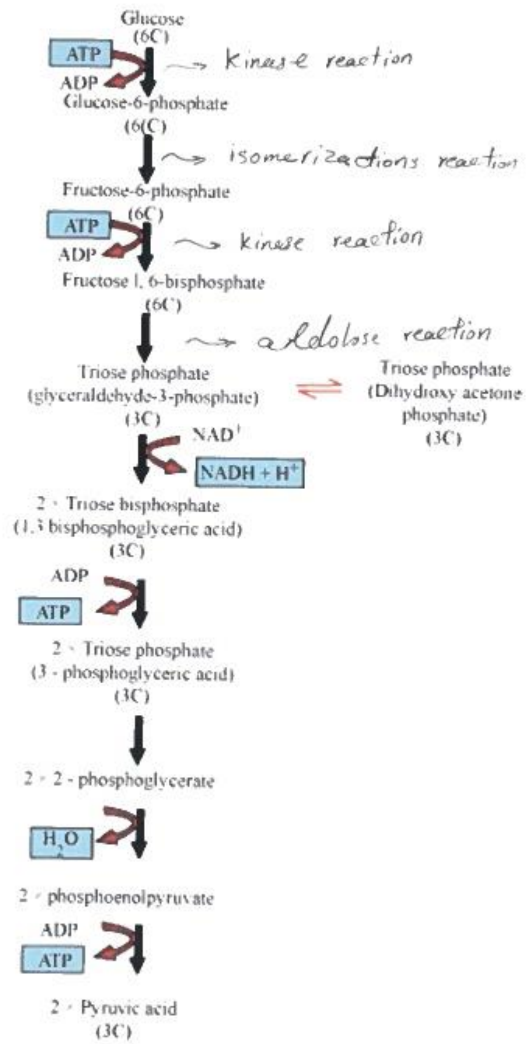
The arrival of an action potential at a synapse triggers the release of neurotransmitter which is a small, diffusible molecular such as acetylcholine present in the synaptic vesicles.

2- First, resonance stabilization in ADP,
Second, electron repulsion in the phosphate group
Last, stric crowding from phosphate groups.

3-

aerobic → 38 moles of ATP

anaerobic → 2 moles of ATP



4_

$$C_6H_{12}O_{6(s)} + 6O_{2(g)} \longrightarrow 6CO_{2(g)} + 6H_2O_{(l)} \quad \Delta G = -2879\ kJ$$

$$ADP^{-3} + H^+ + HPO_4^{2-} \longrightarrow ATP^{-4} + H_2O \quad \Delta G = 31.4\ kJ$$

$$\text{efficiency} = \frac{\text{Gibbs energy store in ATP}}{\text{Total Gibbs energy released}} \times 100$$

$$\text{efficiency} = \frac{38 \times 31.4\ kJ}{2879\ kJ} \times 100 = 41.4$$

if body behaved as an internal combustion engine:

$$\text{efficiency} = \frac{T_H - T_C}{T_H} \times 100\%$$

$$= \frac{310 - 298}{310} \times 100 = 3.9\%$$

5_ Thermodynamics are only valid for closed systems at equilibrium while living systems are open systems and they are at a steady state not equilibrium.

As well as this, Gibbs free energy is only valid for standards states and not for actual conditions in biological processes. In fact, in the living organisms, reactions do not take place at standard states.

6. $H_2|HCl|AgCl|Ag$ $\quad E^\circ = 0.222\,V$

, $E = 0.385\,V$

$$E = E^\circ - \frac{0.257\,V}{\upsilon}\,pH$$

$$\Rightarrow PH = \frac{\upsilon(E-E^\circ)}{0.257} = \frac{2(0.385-0.222)}{0.257} = 1.27$$

7- $Pt|F_2|F^- \Rightarrow F_{2(g)} + 2e^- \longrightarrow 2F'$ ⇝ Cathode

$E^\circ/V = +2.87$

$Ag|Ag^+ \Rightarrow Ag^+ + e^- \longrightarrow Ag$ ⇝ Anode

$E^\circ/V = +0.80$

$$E^\circ = E^\circ_{Cathode} - E^\circ_{Anode} = 2.87 - 0.8 = 2.07\,V$$

8- $2\,Ag \longrightarrow 2\,Ag^+ + 2e^-$

$F_2 + 2e^- \longrightarrow 2F^-$

$F_2 + 2\,Ag \longrightarrow 2\,Ag^+ + 2F^-$

$K = \exp(\upsilon F E^\circ/RT)$

$$K = \exp\left[\frac{(2)(96500\,C.mol^{-1})(2.07V)}{(8.314\,J.K^{-1}mol^{-1})(298\,K)}\right] = 1.07\times 10^{70}$$

9- $T = 298\,K$ $E^\circ = 0.67533\,V$

$Cd(s) | CdCl_2 . H_2O(s) || AgCl(s) | Ag(s)$

Temperature cofficient $= \left(\frac{\partial E^\circ}{\partial T}\right)_P = -6.5 \times 10^{-4}\ V/K^{-1}$

$\Delta_r G^\circ = -\nu F E^\circ = -2(96500\,c.\,mol^{-1})(0.67533\,V) = 13 \times 10^4$

$\Delta_r S^\circ = \nu F \left(\frac{\partial E^\circ}{\partial T}\right)_P = 2 \times (96500\,c.\,mol^{-1})(6.5 \times 10^{-4}\ V/K^{-1}) = 1.25 \times 10^2$

$\Delta_r H^\circ = \Delta_r G^\circ - T\Delta_r S^\circ$

$\Delta_r H^\circ = 13 \times 10^4 - 298(1.25 \times 10^2) = 9.28 \times 10^4$

10- $E' = E^\circ - \frac{0.257\,V}{\nu} \ln \frac{[NADH]}{[NAD](H^+/10^{-7})}$

$= 0.320 - \frac{0.257}{2} \ln \frac{1}{1 \times (10^{-9}/10^{-7})}$

$= 0.912\,V$

11- Anode: malate $\longrightarrow$ oxaloacetate $+ 2H^+ + 2e^-$

Cathode: $NAD^+ + H^+ + 2e^- \longrightarrow NADH$

$$E^\circ = -0.320\,V - (-0.166\,V) = -0.154\,V$$

$$\Delta_r G^{\circ'} = -\nu F E^\circ = -2(965000\,C.mol^{-1})(-0.154\,V) = 2.97\times10^{-4}\,J.mol^{-1}$$

$$K' = \exp\left(-\frac{\Delta_r G^{\circ'}}{RT}\right) = \exp\left[-\frac{2.972\times10^{4}\,J.mol^{-1}}{8.314\,J.K^{-1}.mol^{-1}(298\,K)}\right]$$

$$= \boxed{6.17\times10^{-6}}$$

12- $aA + bB \longrightarrow cC + dD$

$$\Delta_r G = -\nu F E \longrightarrow E = -\frac{\Delta_r G}{\nu F} \quad *$$

$$E^\circ = -\frac{\Delta_r G^\circ}{\nu F} \quad 0$$

we have $\longrightarrow$ $\Delta_r G = \Delta_r G^\circ + RT \ln \dfrac{a_C^c\, a_D^d}{a_A^a\, a_B^b}$

$$\xRightarrow{*\&0} \quad -\nu F E = -\nu F E^\circ + RT \ln \frac{a_C^c\, a_D^d}{a_A^a\, a_B^b}$$

$$\Rightarrow \quad E = E^\circ - \frac{RT}{\nu F} \ln \frac{a_C^c\, a_D^d}{a_A^a\, a_B^b}$$

$$\frac{RT}{F} = \frac{8.314\times 298}{96{,}500} = 0.257\,J.C^{-1} = 0.257\,V$$

$$\Rightarrow \quad E = E^\circ - \frac{0.257\,V}{\nu} \ln \frac{a_C^c\, a_D^d}{a_A^a\, a_B^b}$$