

PHYSICAL PHARMACY

MORPHINE ACADEMY

MORPHINE
ACADEMY

Solutions of electrolytes

بجمع و مع كمية از 1000000 بار است

وعلى أن تفتقد الـ collective properties

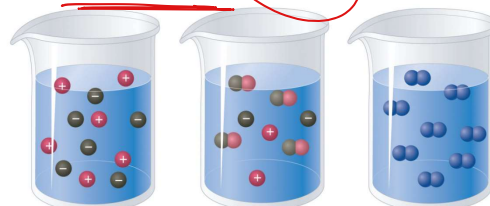
ما يسمى (electrolyte) بالـ near-electrolyte لأن
جزيئاته تتأين إذا ضاها لحد إلى قطب بالاضافة
أمثلة لها ما عا قنوف NaOH ما إلى قنوف NaCl
ولها إلى قنوف التي من بين.

لے مواد ۱۶ تھوچھا، ال solvent اے یقیناً ٹھنک کر $NaOH$ کی



Solutions of electrolytes

- An electrolyte is a substance that ionizes when dissolved in suitable ionizing solvents such as water.
 - $\rightarrow \text{NaCl} \rightarrow \text{Na}^+ + \text{Cl}^-$
 - $\rightarrow \text{H}_2\text{SO}_4 \rightarrow 2\text{H}^+ + \text{SO}_4^{2-}$
 - $\rightarrow \text{R-OH} \rightarrow \text{R}^+ + \text{OH}^-$
- This includes most soluble salts, acids, and bases.
- Electrolytes in solution have the capacity to conduct electricity through a process known as *electrolysis*.
- Electrolytes can be classified as *strong electrolytes* and *weak electrolytes*.
 - Strong electrolytes ionize completely (~100%), while weak electrolytes ionize only partially (1-10%).



Strong

Wea

No

poten

↓
paritally

→ no mobile ions.

high electrical conductivity.

ion + many un-ionized molecules
low conductivity.

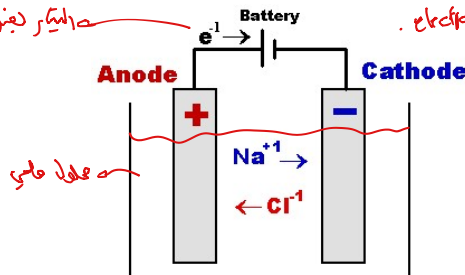
$\therefore \uparrow \text{mobility ions} \rightarrow \uparrow \text{electrical conductivity.}$

لنتی ار منہ بتائی الحلول یوصل الکھربا؟

Solutions of electrolytes

- Electrolytes in solution have the capability to conduct electricity through a process known as **electrolysis** → عملیۃ مرور البتار الکھربائی

صالحہ ہائیڈر الکھربائی (میزر سیکر مشین)



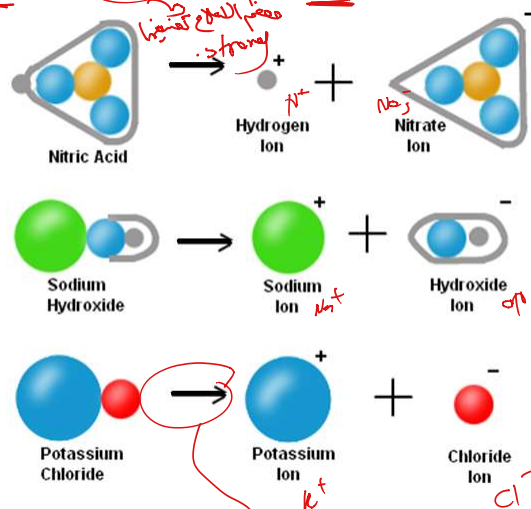
لے اذا بیت مٹالس و ذوبتہ ب مٹالس صلیب و قست القویۃ الکھربائی ب الحلول و قست اہ القویۃ الکھربائی زار مٹا

کام مٹالس کمال وقتا بکھر (مٹالس فز) + electrolyte مٹا

Solutions of electrolytes

صحتہ تا ۱۰۰%

- Strong electrolytes includes **strong acids** (e.g. HNO_3), **strong bases** (e.g. NaOH), and **most salts** (e.g. KCl).

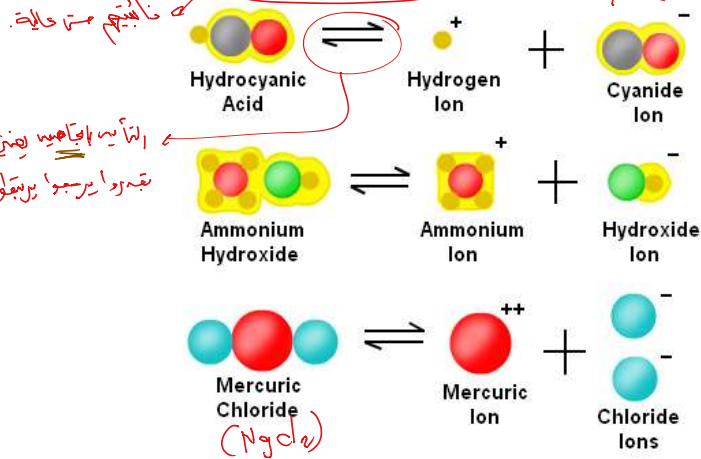


بل strong electrolytes : Dissociation بکھر ایتھ واسر البغی (HNO3) کوہ تفکک ائی H+ و NO3-

ماریج یوجھا رکھو ا HNO3 مٹا کایت، مٹالس باہما ر مٹا.

Solutions of electrolytes

- Weak electrolytes include weak acids (e.g. CH_3COOH), weak bases (e.g. NH_3), and slightly soluble salts (e.g. AgCl). HgCl_2



Colligative properties

- Van't Hoff observed that the osmotic pressure (π) of dilute solutions of nonelectrolytes such as sucrose and urea, can be expressed by the equation:

$$\pi = RTc$$

- R: Gas constant, T: absolute temperature, c: concentration in mole/L

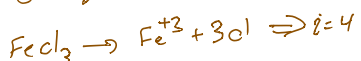
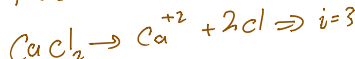
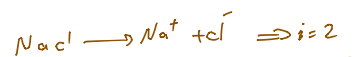
- However; he found that solutions of electrolytes gave osmotic pressures approximately two, three, and more times larger than expected from this equation.

- Van't Hoff Introduced a correction factor (i) to account for the irrational behavior of ionic solutions, he wrote:

$$\pi = iRTc$$

- The (i) factor approximately equals the number of ions formed upon dissociation (e.g. 2 for NaCl , 3 for CaCl_2 , and 4 for FeCl_3).

لكل مادة i من دالها فوجدتها صيغة عدد من كل الجزيئات التي تتفكك إليها (معدنات electrolyte weak)



- ① osmotic pressure (π).
- ② Freezing-point depression.
- ③ Boiling-point elevation.
- ④ vapor-pressure lowering.

$\pi = RTc$ يعني ما طبقنا قانونه electrolyte solutions على π أقل من المتوقع، لأنهم يتفككوا إلى 3 أو 4 جزيئات، أي أن π أكبر من المتوقع.

لأن π من colligative property (التي تعتمد على عدد الجزيئات فقط، وليس على طبيعة الجزيئات).

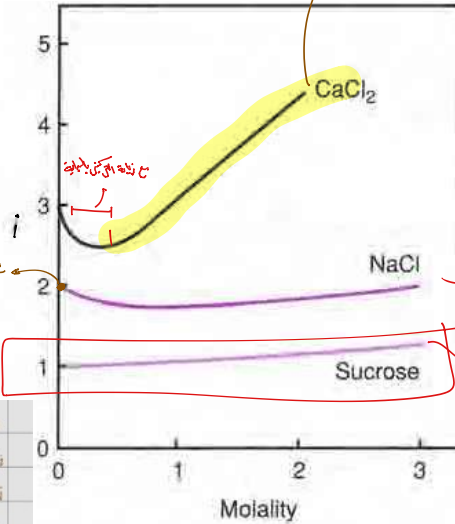
والجزيئات التي تتفكك إلى 3 أو 4 جزيئات، أي أن π أكبر من المتوقع.

اما بالدرجة الاولى لشيء من حيث الارتفاع الى حالة سائلة
 { ذرات اكبر من حيث الاثر في كثافة سائلة 4.5 ؟
 سائل ، لذا هاء ينفذ ها حالة سائلة .

تؤثر زيادة التركيز بغير المولود حصة او $non-ideal$.

اختلاف من حيث الذرات مع انكسار $molarity$.

Colligative properties



من حيث الذرات
 بتغير بتغير الارتفاع
 ذرات بتغير المسافات والتساوي
 بين الذرات .

كلما زادت شدة التفاعل $electrostatic$ interactions

لعل لشيء $CaCl_2$ باقي أكثر من $NaCl$ ؟
 لأنه لما ينقسم في محالته : Ca^{2+}/Cl^-
 سائل الارتفاع مع Na^+ ، دالة
 الارتفاع يعني تفاعل كيميائي أقوى .

.. High ionic charge $\Rightarrow$ stronger ionic interaction.

van't Hoff / factor of representative compounds.

Actual i may differ from the ideal value. $\approx$ approximately

The i factor approximately equals the number of ions formed upon dissociation e.g. 2 for $NaCl$, 3 for $CaCl_2$, and 4 for $FeCl_3$.

اعتماد : من زيادة التركيز تزداد $interionic$ interactions ويغير السلوك $non-ideal$.
 لذلك i experimental / effective van't Hoff factor يغير عن القيمة المثالية .

Colligative properties

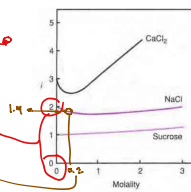
Example:

What's the osmotic pressure of a 2.0 m solution of sodium chloride at 20°C?

Answer: the i factor for a 2 m solution of sodium chloride as observed in the figure is about 1.9

$$\pi = iRTm$$

$$= 1.9 \cdot 0.082 \cdot 293 \cdot 2 = 91.3 \text{ atm}$$



Nad
 Nm

2 كذا ، كما صاب من حيث i في سائل
 صحيح يكونه 1.9

صالح التركيز لكل
 مع زيادة التركيز

Real solns aren't perfectly ideal.
 electrostatic interactions موجودة.
 يعني المولود ضيق جدا
 (Extremely Dilution)
 وهو نكته سائل المولود قريب
 من $ideal$ behavior .
 # At infinite dilution,
 i approaches its ideal value.

في تعلقة هذه الـ nonelectrolyte ، و conc. soln of electrolyte ، و conc. soln of nonelectrolyte

نفسا المبدأ ، وانهم معدل الأيونات يتراجع عنهم بالعبارات المذكورة بهذا السبيل ، لذا في هذه

يبين soln of nonelectrolyte ، nonelectrolyte soln

نفس المبدأ انه لا تتأثر بـ التوازن الهادي بيني الأيونات تتفاعل مع بعضها ومع الماء كالمسالمة ،
لذا فإنهم معدل الأيونات يتراجع عنهم بالعبارات المذكورة بهذا السبيل ، لذا في هذه

Colligative properties

The Van't Hoff factor can be used to express the four colligative properties for solutions of electrolytes and concentrated solutions of nonelectrolytes.

colligative properties $\propto$ effective no. of solute particles.

هذا القانون يستعمل بوجود تركيزه
① تركيز Aqueous soln
② نسبة المذابة في الماء (solute) في الماء

vapor pressure equation

$$\Delta p = 0.018 i p_1^{\circ} m$$

$\Delta p = 0.018 i p_1^{\circ} m$
of pure solvent

$$\Delta T_f = i K_f m$$

$$\Delta T_b = i K_b m$$

$$\pi = i R T m$$

مع زيادة
تأثيره

معدل التوازن
بـ تركيزه
في الماء

electrolytes
مع زيادة تأثيره

nonelectrolyte
لا يتأثر بـ تركيزه
في الماء

$CaCl_2 > NaCl > sucrose$

لذلك $CaCl_2$ أكبر تأثير

- ✓ vapor-pressure lowering
- ✓ freezing-point depression
- ✓ boiling-point elevation
- ✓ osmotic pressure

لأنه يتأثر بـ تركيزه في الماء
formula unit

- The first equation applies only to dilute aqueous solutions

$$X_2 = \frac{\Delta p}{p_1^{\circ}} \cong \frac{n_2}{n_1} = \frac{n_2}{\frac{1000}{18}} = \frac{m}{55.5} = 0.018 m$$

قليل جدًا
الدرجة المئوية

n_2
 n_1

$$\frac{m \times 55}{18} = \frac{1000}{18} \rightarrow 0.018 m$$

Electrolyte Dissociation

(Arrhenius theory)

Both strong and weak electrolytes are fully dissociated into ions at infinite dilution (extremely dilute solutions in which solute-solute interactions are negligible).

هذا يعني انهم في الماء
وهو في تركيزه ، solute-solute interactions
فإنهم في تركيزه ، قائمة بـ تفاعل بـ تركيزه (100%)
سواء كانت strong or weak electrolyte
ما يتراجع بـ تركيزه ، يعني انهم في تركيزه
أيونات $\propto$ مفعول بـ تركيزه

At moderately concentrated solutions, Arrhenius differentiated between strong and weak electrolytes by the fraction of the molecules ionized: the degree of dissociation (α).

A strong electrolyte was one that dissociated into ions to a high degree and a weak electrolyte was one that dissociated into ions to a low degree.

Arrhenius determined the degree of dissociation (α) directly from conductance measurements

اشياء التي كان
القياس

كما كانت α أكبر ، يعني المدة تزداد
بـ تركيزه أكبر ، يعني التأثير أكبر

strong elect. = α
weak elect. = α

تزداد α
بـ تركيزه

infinite dilution
 $\alpha \rightarrow 1$ (100%)

Dilution $\uparrow \rightarrow \alpha \uparrow \rightarrow$ strong electrolyte
 $\downarrow$
 $C \rightarrow 0$

Electrolyte Dissociation

Arrhenius theory

Example:

Calculate the degree of ionization of 0.1 m acetic acid providing that its freezing point is -0.188°C .

Answer: Acetic acid dissociates into two ions, so $v = 2$.

To calculate i :

$$i = \frac{\Delta T_f}{k_f m}$$

$$= 0.188 / (1.86 \cdot 0.1) = 1.011$$

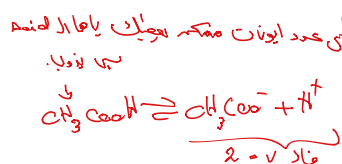
It is possible now to calculate the degree of ionization:

$$\alpha = \frac{i - 1}{v - 1}$$

$$= (1.011 - 1) / (2 - 1) = 0.011 \text{ or } 1.1\%$$

#

#



Handwritten notes in Arabic at the top right of the page, discussing concepts related to activity and concentration.

الأنشطة المعلى إلى active properties

effective conc.

Activity and Activity Coefficient

- The large number of oppositely charged ions in solutions of strong electrolytes influence one another through interionic attractive forces.
- For solution of nonelectrolytes, regardless of concentration, the number of ions is small and the interionic attractive forces are insignificant.
- As for strong electrolytes, ions can associate at high concentrations into groups known as ion pairs. Thus the values of the freezing point depression and the other colligative properties are less than expected for solutions of unhindered ions. Consequently, a strong electrolyte may be completely ionized, yet incompletely dissociated into free ions.
- One may think of the solution as having an "effective concentration" or, as it is called, an activity.

Actual < ideal

Activity and Activity Coefficient

- The activity (a), in general, is less than the actual or stoichiometric concentration of the solute (m), not because the strong electrolytes are partly ionized, but rather because some of the ions are effectively "taken out of play" by the electrostatic forces of interaction.
- At infinite dilution in which the ions are so widely separated that they do not interact with one another, the activity **a** of an ion is equal to its concentration:
- As the concentration of the solution is increased, the ratio becomes less than unity because the effective concentration or activity of ions becomes less than the molal concentration. This ratio is known as the practical activity coefficient (γ), thus:

$$a = \gamma m$$

$$\gamma = \frac{a}{m}$$

actual conc. is less than a

interaction factor.

ion-ion interactions $\rightarrow 0$ $\leftarrow$ infinite dilution

والتي: $a = \gamma m$

$$m = \gamma m$$

$$1 = \gamma$$

At infinite dilution $\gamma \rightarrow 1 \Rightarrow a \rightarrow m$

لا تملك السلوك المثالي

$\#$ high concentration + strong electrolytes: $\Rightarrow$ strong $\Rightarrow \alpha \uparrow$
 $\hookrightarrow$ ions close together $\Rightarrow$ interionic interactions $\uparrow \Rightarrow$ ion pairs $\Rightarrow$ $\gamma < 1 \Leftarrow \alpha < m$
 : infinite dilution is $\gamma = 1$
 $\alpha < m \Leftarrow \gamma = 1 \Leftarrow$ interactions $\rightarrow 0$
 $0 < \gamma \leq 1$

$\gamma = 1 \rightarrow$ Dilute conc.
 $\gamma < 1 \rightarrow$ at exist interionic interactions.

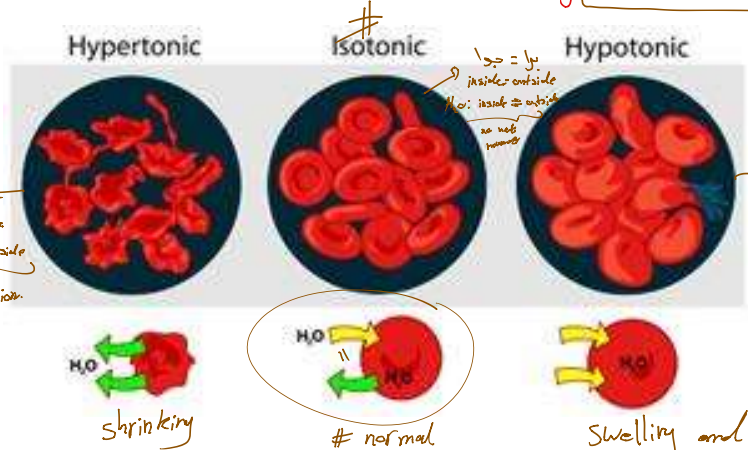
Isotonic Solutions

انتقال α solvents من منطقة هيا تر كين
 و solvents منخفض الى منطقة هيا تر كين
 مرتفع؟ كانه هيا كين لانه افضل بعينهم $\downarrow$ (semipermeable membrane)
 جاكى ان هيا الى بعينهم جاكى الى بعينهم
 بعينهم α solvents.

وهذا يعني ان هيا تر كين isotonic = equal π , not equal amounts of solute or solvent.
 non-perturbing solutes داخل خارج

Introduction

The need to achieve isotonic conditions with solutions to be applied to delicate membranes is dramatically illustrated by mixing a small quantity of blood with aqueous sodium chloride solutions of varying tonicity.



المني من انه يتوقف عن
 الحركة تمامًا ، عاري هو وحده
 ونشج الى المصل بالانفاسيه
 مناري لذلك ك هيا تر كين هيا
 في هيا تر كين.

amount of solute inside $\downarrow$
 $=$ amount of solute outside
 لا كاني كانه isotonic كانه هيا تر كين
 ان كاني α solute متساوية.

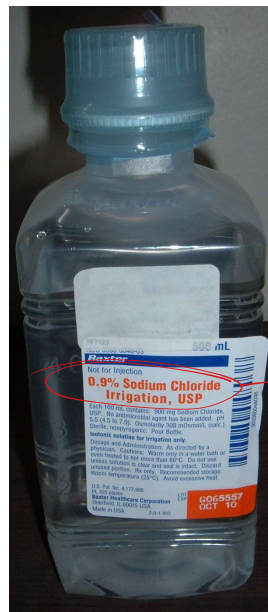
$\gamma > 1$ / lower solute conc. $\rightarrow$ high solute conc.
 $\gamma < 1$ / inside $>$ outside
 H_2O : outside $\rightarrow$ cell
 Hemolysis

$\uparrow$ effective conc. of osmotically active particles (non-perturbing solutes) $\rightarrow \pi$

- ① Hypertonic: $\pi_{outside} > \pi_{inside}$
- ② Hypotonic: $\pi_{outside} < \pi_{inside}$
- ③ Isotonic: $\pi_{outside} \approx \pi_{inside}$

Introduction

- The solutions that cause no swelling or contraction of the tissues and produce no discomfort when instilled in the eye, nasal tract, blood, or other body tissues is termed **isotonic**.
- Isotonic sodium chloride **NaCl (0.9%)** is a familiar pharmaceutical example of such a preparation.



normal saline.
ورق NaOH (0.9%)

فائدة متعلقة بـ NaCl isotonic
وإنما يفتح مع التركيز:

منخفض: Hypotonic
مرتفع: Hypertonic
متوسط: isotonic

100 mL → 0.9 g
#

عدد جزيئات (solute) لكل 1 kg من solvent

عدد الجزيئات من (solute) الموجودة في 1 liter من soln

Isosmotic Solutions

- Osmolality** and **osmolarity** are colligative properties that measure the concentration of the solutes independently of their ability to cross a cell membrane.

- The unit to express the amount of osmotically active particles in a solution is the osmole or milliosmole:

$$\text{Number of osmoles} = \text{Number of moles} \times (n)$$

- Where **n** is the number of species into which the solute is dissolved

$$\text{NaCl} = 3 \text{ mole} \times 2 \text{ } \rightarrow \text{ } = 6$$

$$1 \text{ Osmol} = 10^3 \text{ mOsmol}$$

- Osmolarity** is the number of osmoles of solute per L of solution

- Osmolality** is the number of osmoles of solute per kg of solvent

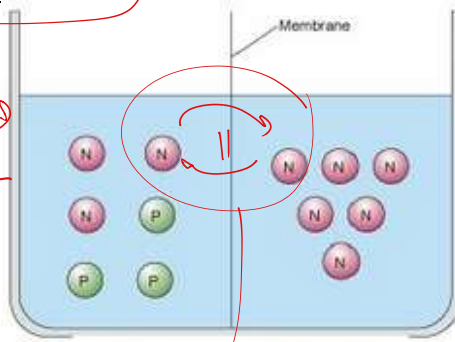
لعبارة عدد الجزيئات

عبرها عنها
بـ

#

Isosmotic Solutions

- When two solutions are separated by a perfect semipermeable membrane and there is no net movement of solvent molecules across the membrane, the solutions are isosmotic (i.e. have equal osmotic pressure or osmolarity).
- Perfect semipermeable membrane is permeable only to solvent molecules.



يسمى المحلول الذي لا يسمح بمرور الجزيئات solutes.

$$\pi_1 = \pi_2$$

Isosmotic: interests with TOTAL conc. of particles
Isotonic: interests with particles that can't cross the membrane.

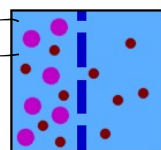
isotonic = isosmotic

① osmotic effect
② solutes غير نافذة الغشاء

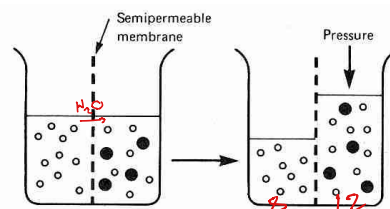
معدلة الانتقال = مقياس

Isosmotic Solutions

- When two isosmotic solutions contain solutes that cannot cross the biological membrane, they are described as isotonic with respect to that membrane.
- Tonicity is a measure of the effective osmotic pressure gradient of two solutions separated by a semipermeable membrane.
- Osmolarity takes into account the total concentration of penetrating solutes and non-penetrating solutes, whereas tonicity takes into account the total concentration of only non-penetrating solutes



10 = osmolarity
6 = Tonicity



10 10
6 12
Tonicity.
not. ← penetrating

كم particle في المحلول
فعلا ينفذ إلى جزء آخر
non-penetrating solutes

ما في انتقال للمواد بين الخليطين ، بالتالي ما في اختلاف بالتركيز بين الخليطين ، هذا يعني انه ما في انتقال للمواد ؟ لا ، على انتقال للمواد ، ما في انتقال للمواد في الخليطين

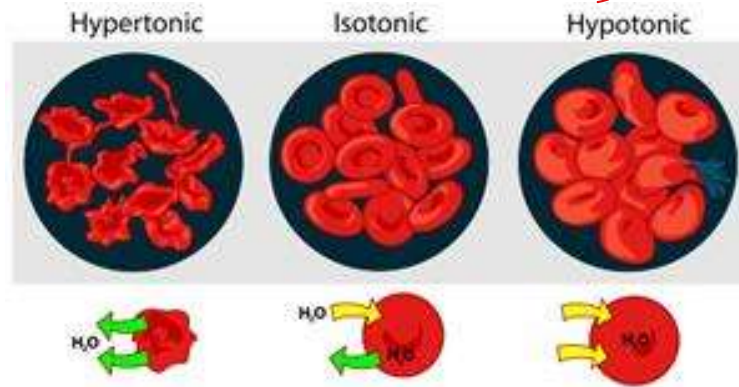
الفرق بين Osmolarity و Tonicity
Osmolarity: total concentration of all solutes
Tonicity: concentration of non-penetrating solutes
Osmolarity = Osmolarity of penetrating solutes + Osmolarity of non-penetrating solutes
Tonicity = Osmolarity of non-penetrating solutes
Osmotic pressure = Osmolarity x R x T

بعضی سوختن از انحلال عقابا
؟ RBC!

Measurement of Tonicity

① Hemolytic method

- The effect of various solutions of the drug is observed on the appearance of red blood cells suspended in the solutions. *shrik*



swell + burst.

② Measurement of Tonicity

Cryoscopic Method

- The tonicity is determined from ΔT_f of the solution, which is determined theoretically from the equation $\Delta T_f = K_f c$.
- For solutions of electrolytes, a new factor ($L = K_f$) is used:

$$\Delta T_f = L c$$

- The L value for solutions that is isotonic with body fluids is written as L_{iso}

$$L_{iso} = \Delta T_f / c$$

- For sodium chloride the concentration of isotonic solution is 0.9% w/v = 0.154 M:

$$L_{iso} = 0.52 \text{ } ^\circ\text{C} / 0.154 = 3.4$$

$$0.9\% \rightarrow 0.09g / 100ml \rightarrow n = \frac{0.9}{58.44} = 0.0154$$

$$\frac{0.0154}{0.1} = 0.154 M$$

			-10.24	← A+B solute
			-10.66	← A+B solute
Solute A:	$\Delta T_f = T_f - T_f$			
	$= (-10) - (-10.24)$			
	$= 0.24 \text{ } ^\circ\text{C}$			
Solute B:	$\Delta T_f = T_f - T_f$			
	$= (-10) - (-10.66)$			
	$= 0.66 \text{ } ^\circ\text{C}$			

دست نه Tonicity) ۱) *colligative properties*

Freezing point Depression.

$\uparrow$ solute $\rightarrow \uparrow \Delta T_f$ lowering
 $\uparrow$ Tonicity.

$\Delta T_f < 0.52 \Rightarrow$ hypotonic.

$\Delta T_f = 0.52 \Rightarrow$ isotonic.

$\Delta T_f > 0.52 \Rightarrow$ hypertonic.

#

Handwritten calculations and notes related to the cryoscopic method, including the formula $\Delta T_f = K_f \cdot m$ and the calculation of L_{iso} for sodium chloride.

من السهل بي لازم تفهم من خلال
 الى الـ L_{iso} انا يومه ΔT_f انا

Measurement of Tonicity

Cryoscopic Method

TABLE 8-3
 AVERAGE L_{iso} VALUES FOR VARIOUS IONIC TYPES*

Type	L_{iso}	Examples
Nonelectrolytes	1.9	Sucrose, glycerin, urea, camphor
Weak electrolytes <i>partially</i>	2.0	Boric acid, cocaine, phenobarbital
Di-divalent electrolytes <i>من اثنان الى اثنين</i>	2.0	Magnesium sulfate, zinc sulfate
Uni-univalent electrolytes <i>من واحد الى واحد</i>	3.4	Sodium chloride, cocaine hydrochloride, sodium phenobarbital
Uni-divalent electrolytes <i>من واحد الى اثنين</i>	4.3	Sodium sulfate, atropine sulfate
Di-univalent electrolytes <i>من اثنين الى واحد</i>	4.8	Zinc chloride, calcium bromide
Uni-trivalent electrolytes <i>من واحد الى ثلاثة</i>	5.2	Sodium citrate, sodium phosphate
Tri-univalent electrolytes <i>من ثلاثة الى واحد</i>	6.0	Aluminum chloride, ferric iodide
Tetraborate electrolytes <i>من اربعة الى واحد</i>	7.6	Sodium borate, potassium borate

*From J. M. Wells, J. Am. Pharm. Assoc. Pract. Ed. 5, 99, 1944.

من كانت القيمة بتعطيها من electrolytes انا من ملاحظة ان L_{iso} انا

ليس؟ لانه $L_{iso} = \frac{\Delta T_f}{c}$ مع c (conc) بتغيره انا L_{iso} انا
 من electrolytes من c (conc) انا

$$L_{iso} = \frac{i \cdot k_f}{T} \rightarrow L_{iso} \rightarrow i \rightarrow \uparrow$$

العوامل التي بتغير L_{iso} انا

- ① Van't Hoff factor (i) (directly)
- ② k_f (directly)
- ③ T (directly)
- ④ concentration (inversely) $\rightarrow L = \frac{\Delta T_f}{c}$

Methods of Adjusting Tonicity

Cryoscopic method

- In the cryoscopic method, sodium chloride or some other substance is added to the solution of the drug to lower the freezing point of the solution to -0.52°C and thus make it isotonic with body fluids.
- The freezing point depressions ΔT_f of drug solutions can be determined experimentally or theoretically.

$$0.52 = T_f$$

$$0.52 = \Delta T_f$$

7:00

الكلية هي اننا نستخدم ΔT_f لمعرفة كمية NaCl اللازمة لجعل المحلول isotonic مع الدم.

Methods of Adjusting Tonicity

Cryoscopic method

Example

المسحوق يحتاج ΔT_f بعدة 0.52°

How much NaCl is required to render 100 mL of a 1% solution of apomorphine hydrochloride isotonic with blood serum?

1% solution of the drug has a ΔT_f of 0.08°C .

1% solution of NaCl has a ΔT_f of 0.58°C .

To make this solution ($\Delta T_f = 0.08^\circ\text{C}$) isotonic with blood ($\Delta T_f = 0.52^\circ\text{C}$), sufficient NaCl must be added to reduce the freezing point by an additional 0.44°C ($0.52^\circ\text{C} - 0.08^\circ\text{C}$).

$$\frac{1\%}{X} = \frac{0.58^\circ\text{C}}{0.44^\circ\text{C}} \Rightarrow X = 0.76\%$$

Thus, 0.76% NaCl will lower the freezing point by 0.44°C and will render the solution isotonic.

نفس : كمية NaCl المطلوبة لجعل المحلول isotonic

1g / 100ml

1g / 100ml

الحل :

1% apomorphine HCl $\rightarrow \Delta T_f = 0.08^\circ\text{C}$
 وقيم ΔT_f بعدة 0.52°C يعني ΔT_f الدم
 مسحوق 1% $\rightarrow \Delta T_f = 0.08^\circ\text{C}$ وكمية NaCl المطلوبة لجعل المحلول isotonic هي 0.76%
 1% NaCl $\rightarrow \Delta T_f = 0.58^\circ\text{C}$
 ΔT_f الدم 0.52°C
 ΔT_f المسحوق 0.08°C
 ΔT_f NaCl 0.58°C
 $0.52 - 0.08 = 0.44^\circ\text{C}$
 $\frac{1\%}{X} = \frac{0.58}{0.44} \Rightarrow X = 0.76\%$
 يعني : كمية NaCl المطلوبة لجعل المحلول isotonic هي 0.76%
 1% NaCl $\rightarrow \Delta T_f = 0.58^\circ\text{C}$
 ΔT_f الدم 0.52°C
 ΔT_f المسحوق 0.08°C
 ΔT_f NaCl 0.58°C
 $0.52 - 0.08 = 0.44^\circ\text{C}$
 $\frac{1\%}{X} = \frac{0.58}{0.44} \Rightarrow X = 0.76\%$
 يعني : كمية NaCl المطلوبة لجعل المحلول isotonic هي 0.76%

1) احسب كم ΔT_f نأفها : $\Delta T_f \text{ drug} - \Delta T_f \text{ blood}$
 2) نستخدم ΔT_f NaCl 1% ونأخذ نتاج

Methods of Adjusting Tonicity

NaCl equivalent method

$E \text{ NaCl} = 1 \text{ g of drug}$

- The sodium chloride equivalent (E) of a drug is the amount of sodium chloride that has the same osmotic effect of 1 g of the drug.
- E value can be obtained theoretically from L_{iso} value and Molecular weight of the drug.

اهميتها : اذا عرفنا
 الخسائر في باقي اعمق
 مقبلة اعدنا L_{iso}

بما يعني المحلول في الدم يعني isotonic
 isotonic 0.9% NaCl

لو عندي 2g drug وال $E = 0.2$ ، فإشارة E ان 1g drug يعادل 0.2g NaCl
 $2 \times 0.2 = 0.4 \text{ g NaCl}$

0.9% NaCl
 0.9g NaCl / 100ml

ولو كان الجسم النهائي 100ml ، فنحتاج اجمالاً 0.9g NaCl equivalent

دفعنا 0.4 g $\leq 0.9 - 0.4 = 0.5 \text{ g}$ of NaCl

0.4 drug equivalent + 0.5 NaCl added = 0.9 isotonic

Osmotically Equivalent : $\Delta T_{f, \text{drug}} = \Delta T_{f, \text{NaCl}}$

Methods of Adjusting Tonicity

NaCl equivalent method

- For a solution of 1 g of drug in 1000 ml of solution

$$c = \frac{1 \text{ g}}{\text{MW}} \quad \rightarrow \quad \Delta T_f = \frac{L_{iso}}{\text{MW}} \quad \text{Body fluid is } \approx \text{isotonic sol} \text{ in water}$$

- For a solution of NaCl with the same freezing point depression as the drug solution

$\Delta T_f = 3.4 \frac{E}{58.45}$
 $\rightarrow \frac{L_{iso}}{MW} = 3.4 \frac{E}{58.45}$
 $E = 17 \frac{L_{iso}}{M.Wt}$

$DTF = \text{Liso} \cdot \frac{1}{m.m}$

$= \frac{\text{Liso}}{m.m}$

for a drug.

Methods of Adjusting Tonicity

NaCl equivalent method

Example 1

Calculate the approximate E value for a new amphetamine hydrochloride derivative (M.Wt =187). The drug is a univalent salt with a L_{iso} value of 3.4.

$$E = 17 \frac{L_{iso}}{M.Wt}$$

$$E = 17 \times \frac{3.4}{187} = 0.31$$

التي يعني انه ampheteric
 المجموعه او E القاعدي 0.31؟ يعني
 او لو من هذا المبدأ الح بعينك osmotic effect
 الـ 0.31 من NaCl. #

کے لئے عبادت میں تامل و حیرت۔

Methods of Adjusting Tonicity

NaCl equivalent method

Example 2

A solution contains 1.0 g of ephedrine sulfate in a volume of 100 mL. What quantity of sodium chloride must be added to make the solution isotonic? E value for the drug is 0.23

The quantity of the drug is multiplied by its NaCl equivalent, E :

Ephedrine sulfate: $1 \text{ g} \times 0.23 = 0.23 \text{ g}$

The ephedrine sulfate has contributed a weight of material osmotically equivalent to 0.23 g of NaCl.

Because a total of 0.9 g of NaCl is required for isotonicity, 0.67 g (0.90 - 0.23 g) of NaCl must be added.

$$\frac{0.9 \text{ g NaCl}}{100 \text{ mL}}$$

* drug $\rightarrow$ 0.23 g of NaCl

$$0.9 - 0.23 = 0.67 \text{ g NaCl}$$

حاصل نهضت هالته
isotonic

Methods of Adjusting Tonicity

NaCl equivalent method

Example 3

How much dextrose would be required to make the solution in example 2 isotonic instead of NaCl?

Because the sodium chloride equivalent of dextrose is 0.16, then:

$$\frac{1 \text{ g dextrose}}{0.16 \text{ g NaCl}} = \frac{X}{0.67 \text{ g NaCl}}$$

$X = 4.2 \text{ g}$ of dextrose

$$E_{\text{dext}} = 0.16$$

$$1 \text{ g dext} = 0.16 \text{ g NaCl}$$

$$x = 0.67 \text{ g}$$

$$\frac{0.16x}{0.16} = 0.67$$

$$x = 4.2 \text{ g}$$

#

اندا حتمنا مادة تانيه لازم نولها مكافئ NaCl بتميزه

Methods of Adjusting Tonicity

White-Vincent Method

- White and Vincent developed a simplified equation for calculating the volume V (mls) of isotonic solution prepared by mixing the drug with water.

$$V = w \times E \times 111.1$$

w : weight (g) of the drug.

E : NaCl equivalent

V = final volume (المطلوب)

حجم الماء الذي يضاف

بنسبتها إلى الماء الذي تأتى
تدريجياً بعد كل كمية معينة من NaCl

يعني
الماء 0.21 g drug 1

$$2 \text{ g of NaCl} \rightarrow \frac{100}{0.9} = 111.1 \text{ ml}$$

2 g NaCl can make
111.1 ml isotonic soln.

يعني انه اذا بنوع 0.3 بنوع بنوعها بالاسماء
of the

الحجم المطلوب هو 7 ml
الاسماء بنوعها بالاسماء

isotonic soln جاهز
30 ml

Methods of Adjusting Tonicity

White-Vincent Method

Example

How to make 30 mL of a 1% solution of procaine HCl isotonic with body fluid? NaCl equivalent for procaine HCl is 0.21

Weight of the drug = $30 \times 1\% = 0.3 \text{ g}$

$$V = w \times E \times 111.1$$

$$V = 0.3 \times 0.21 \times 111.1 = 7 \text{ ml}$$

7 ml of water is added to the drug to make it isotonic, then enough isotonic diluting solution is added to make 30 mL of the finished product.

يعني انه اذا بنوع 0.3 بنوع بنوعها بالاسماء
7 ml of H₂O

الحجم المطلوب هو 7 ml
الاسماء بنوعها بالاسماء

7 ml بنوعها بالاسماء isotonic جاهز

يعني لنضيف 23 ml حتى نحصل 30 ml