Preparation of Biological Solutions and Serial Dilutions

- Objective:

1- To learn how to prepare solutions.

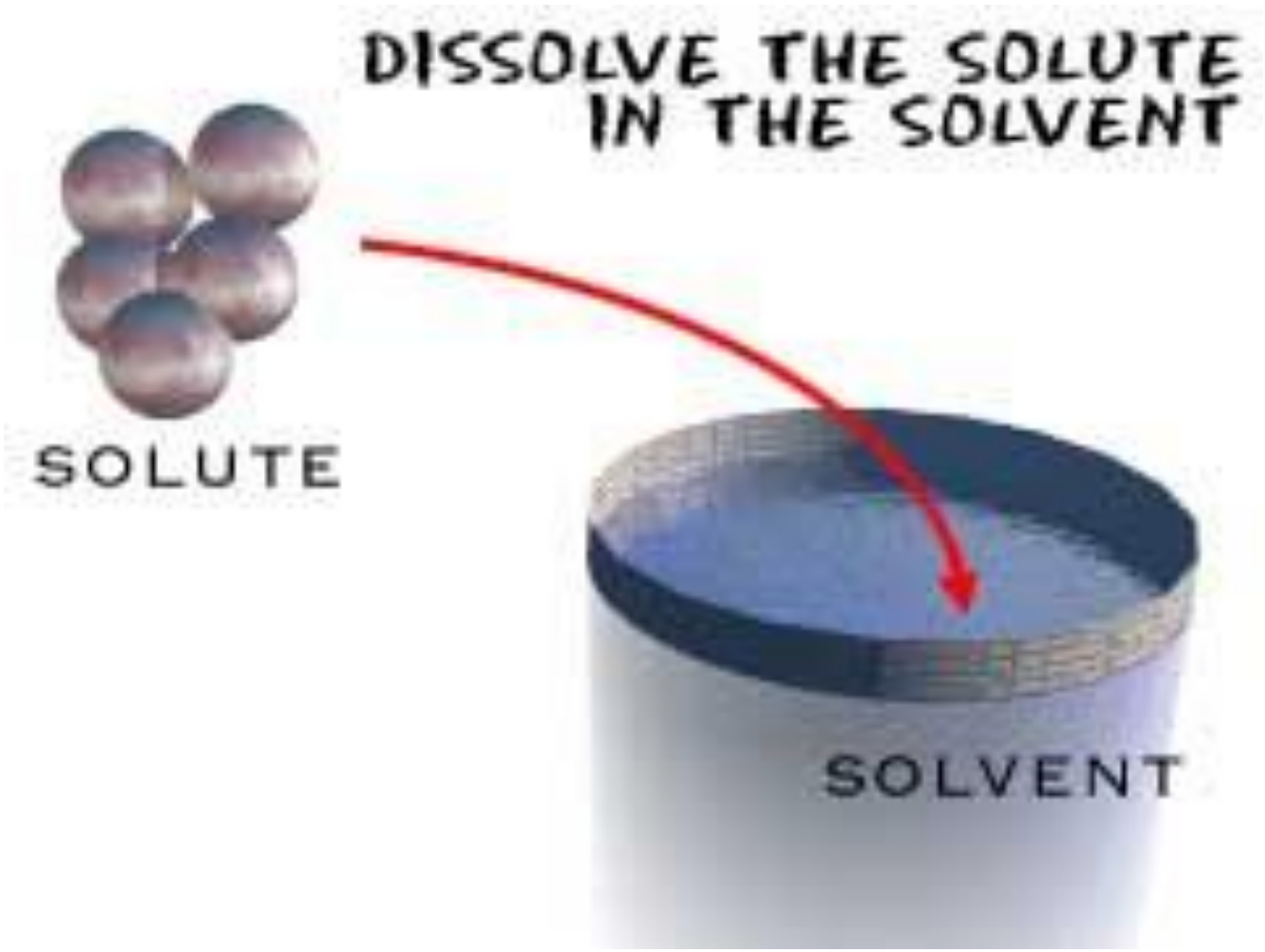
2-To get familiar with solution dilutions.

- Introduction:

- It is very important to understand how to prepare solutions and make dilutions and it is an essential skill for biochemists which is necessary knowledge needed for doing any experiment.

- A simple solution is basically two substances that are mixed together.

- One of them is called **the solute** and the other is **the solvent**. A **solute** is the substance to be dissolved (sugar). A **solvent** is the one doing the dissolving (water) forming a homogenous mixture.


DISSOLVE THE SOLUTE
IN THE SOLVENT
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A. Preparation of biological solutions:

- **There are many units for concentration:**

1. Molarity.
2. W/V %.
3. W/W %.

1.Molarity:

- It is the number of moles of solute dissolved in one liter of solution.

Molar = no. of mole/vol. in L.

- Remember that:

- No of mole = weight (g) / molecular weight

- Example: 0.5 Molar (M) solution:

- That mean there are 0.5 mole dissolved in 1000ml (1L).

Note: Number of mole (No of mole).

Example:

- **How many gram to Prepare 2 M of NaCL in 100 ?**

- 2 mole of NaCl present in 1000 ml [or 1Liter] of solvent (dis.H2O)

- And we know that

No of mole = weight (g) / molecular weight.

So, [2 mole= weight (g) / 58.5] ⟶ weight (g) = 2 x 58.5 = 117 g.

- This weight needed if 1000 ml is required to be prepared. Since we need to prepare only 100 ml.

117 g ====> 1000 ml.

? g ====> 100 ml.

[(100 x 117)/1000] = 11.7 g

- **11.7 g of NaCl** dissolved in small volume of dis.H2O, then complete the volume up to 100 ml.

Note: The MW of NaCl is 58.44 =(35.5+23)

- Practically how to prepare 2M NaCl:

1. Place a beaker in a balance and zero the balance.

2. Weight 11.7 grams of NaCl , in the beaker and dissolve in little water (less than 100 ml).

3. Once the solid is dissolved the volume is transferred to 100 ml volumetric flask.

4. Brought up to a final volume 100 ml.

2. W/V %:Weight/Volume Percentage Concentration:

- The number of grams of solute dissolved in 100 mL of solution.

For example:

- Prepare 3% of NaOH:

It means **3 grams of NaOH** is dissolved in **100 ml of the solution**.

- Example:

Prepare 50 ml of 4% NaOH

4g------> 100 ml

?-------->50 ml

- The weight in grams of NaOH needed to prepare 4% NaOH is = (4 x 50)/100 = 2 g.

So,

- **2 grams of NaOH** is dissolved in little water and the volume made up to 50 ml

3. W/W %:

- The number of grams of solute dissolved in 100 gram of solution.

- The concentrations of many commercial acids are giving in terms of w/w%.

- In order to calculate the volume of the stock solution required for a given preparation the density **(specific gravity)** of stock solution should be provided.

- **Weight (wt) =** volume (ml) x SG x w/w% (as decimal).

- To calculate w/w% as decimal = (w/w)/100.

- For example: w/w%= 20% ⟶ 20 / 100 = 0.20

- **Prepare 100 ml with 0.4 M HCl solutions starting with the concentrated HCl solution you are provided with. (w/w% = 36% , S.Gr = 1.15).**

- **Weight= volume(ml) x SGr x w/w% (as decimal)**

- **Important Note!!!**: the volume in this formula is not the required volume in the question, it is the volume of the concentrated HCl that you must add.

- *First we must calculate the weight by the following:*

Mole= Molarity x volume in liter = 0.4 x 0.1= 0.04 mole

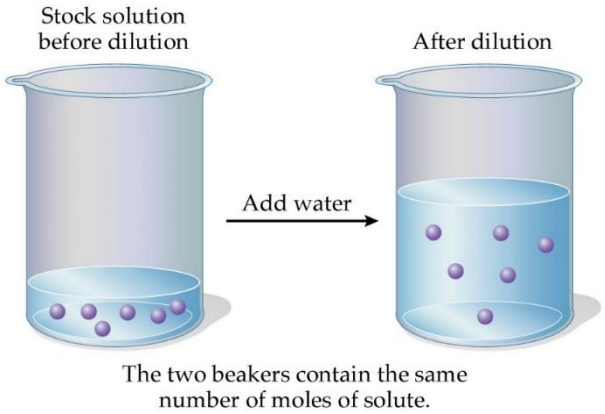
Weight= mole x MWt → 0.04 x 36.5= 1.46 g

1.46 = volume x 1.15 x 0.36 → Volume= **3.53 ml**

- **So, 3.53 ml of stock** (i.e. concentrated HCl) solution is needed and the volume made up to **100 ml by the addition of water**.

B .Dilution of Solution :

- It means to add more solvent without the addition of more solute →
To make it less concentrated.



1. Volume to volume dilutions (ratio).
2. Preparing dilutions by using the V1XC1=V2XC2 formula.
3. Serial Dilutions

1:4 dilution ?

vol. Of solute **Total vol.**

1 ml from solute + 3 ml from solute = total volume 4

1) Volume to volume dilutions (ratio):

- This type of dilutions describes the ratio of the solute to the final volume of the dilute solution.

- **For example,** to make 1:10 dilution of a 1.0 M NaCl solution: one part of the 1.0 M NaCl solution, should be mixed with nine parts of water, for a total of ten parts,

- Therefore 1 :10 dilution means 1 part + 9 parts of water .

-**Thus if 10 ml of the 1:10 dilution was needed**, then 1ml of 1.0 M NaCl should be mixed with 9 ml of water.

- If 100 ml of 1:10 dilution was needed, then 10 ml of the 1.0 M NaCl should be mixed with 90 ml of water. The final concentration of NaCl in both cases will be 0.1 M.

Example:

- Prepare 2:10 dilution of solution (A) with 7M , but the total volume is 20ml not 10 ml?

- Dilution factor (D.F) = 10/2 = 5

2 ml → 10 ml

?? → 20 ml

= (2 X 20) / 10 = 4 ml

So,

- **4 ml from solution(A)** of 7M is needed and complete volume up to 20 ml (adding 16 ml water).

Note: [16 ml water= 4 ml -20 ml].

(2) Preparing dilutions by using the $V_{1X}C_1=V_{2X}C_2$ formula:

- Sometimes it is necessary to use one solution to make a specific amount of a more dilute solution .
- To do this the following formula can be used: **V_1 X C_1= V_2 X C_2.**

Where:

V_1= Volume of starting solution needed to make the new solution.

C_1= Concentration of starting solution.

V_2= Final volume of new solution.

C_2= Final concentration of new solution.

- For example:

- Make 5ml of 0.25M solution from a 1.0M solution:

- Since: $V_1 \times C_1 = V_2 \times C_2$.

Where: V1 = ? , C1= 1M , V2= 5ml , C2 = 0.25M

$(V_1) \times (1M) = (5ml) \times (0.25M)$.

$V_1 = [(5 \times 0.25)/1] = 1.25$ ml

- So, 1.25ml of the 1M solution is needed (starting solution) then complete the volume up to 5 ml.

- Note:

(since the diluted solution should have a final volume of 5ml)

- $(V_1 - V_2) = 5ml - 1.25ml = 3.75ml$).
- 3.75ml of diluent (generally water) should be added to the 1.25ml of starting solution.

3) Serial Dilutions:

- It is a stepwise dilution of a solution, where the **dilution factor is constant at each step.**

- The source of dilution material for each step comes from the diluted material of the previous step.

- Example:

- Starting with a 2.0 *M* stock solution of hydrochloric acid, prepare four standard solutions by serial dilution of the following Molarity respectively 1 M, 0.5 M, 0.25 M, 0.125 M. [with 1:2 dilution]

- Dilution factor (D.F) = final volume / aliquot volume = 2/1 = 2

-To prepare standard solution 1,

- 1 ml of the stock 2.0M solution is needed and volume made up to 2 ml with distilled water (never forget to mix properly).

-To prepare standard solutions 2-4, 1 ml of the previously diluted solution is taken and volume is made up to a final volume of 2 ml by the addition of distilled water.

- How to calculate the concentration of the diluted solutions if they unknown ?

- **First:** find the D.F:

- Dilution factor (D.F) = final volume / aliquot volume = 2/1 = 2

- Second: divide the previous solution concentration by the D.F:

- Concentration of solution 1 = 2.0 M stock solution /2 =1 M

- Concentration of solution 2 = 1M/2 = 0.5 M

- Concentration of solution 3 = 0.5M/2 =0.25 M

- Concentration of solution 4 = 0.25/2 =0.125 M

Thank you