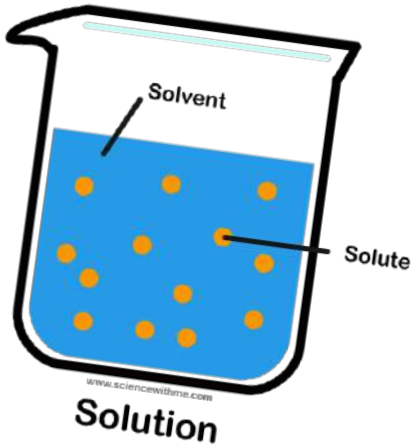
Dilution of Solutions

Solutions:

- Understanding how to prepare solutions and make dilutions is an essential skill for biochemists which is necessary knowledge needed for doing any experiment.



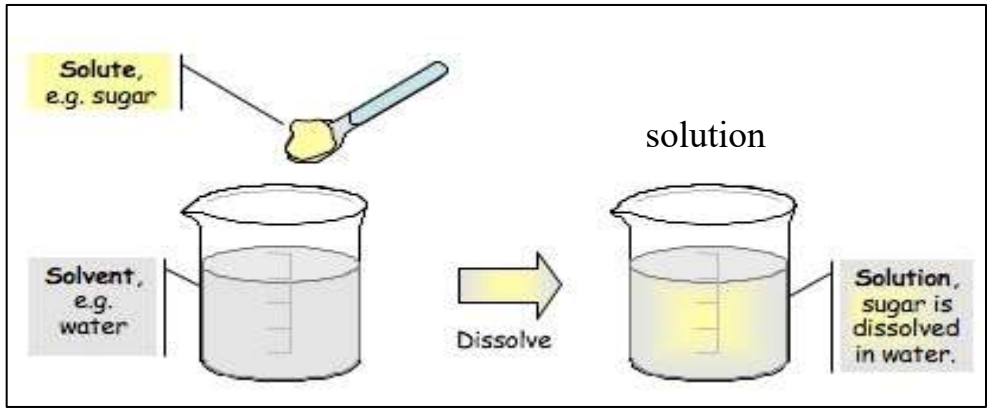
- **What is SOLUTIONS ?**

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

➔ One of them is called the **solute** and the other is the **solvent**.

➔ Solution can be composed from **one or more** solute dissolved in a solvent forming a homogenous mixture.

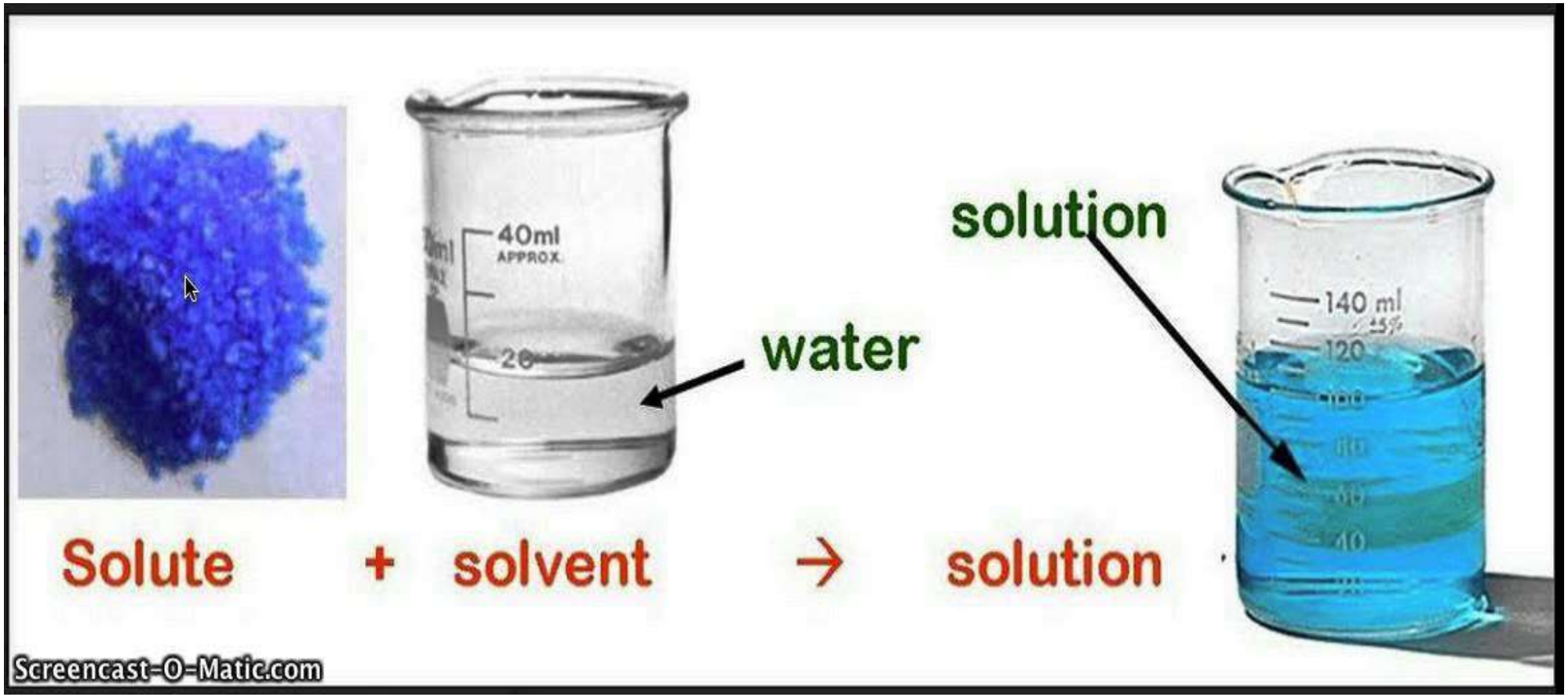
- **Example:**



Solute ➔ is the substance to be dissolved (sugar)

Solvent ➔ is the one doing the dissolving (water)

Solutions


40ml
APPROX.
20
water
solution
140 ml
120
Solute + solvent → solution
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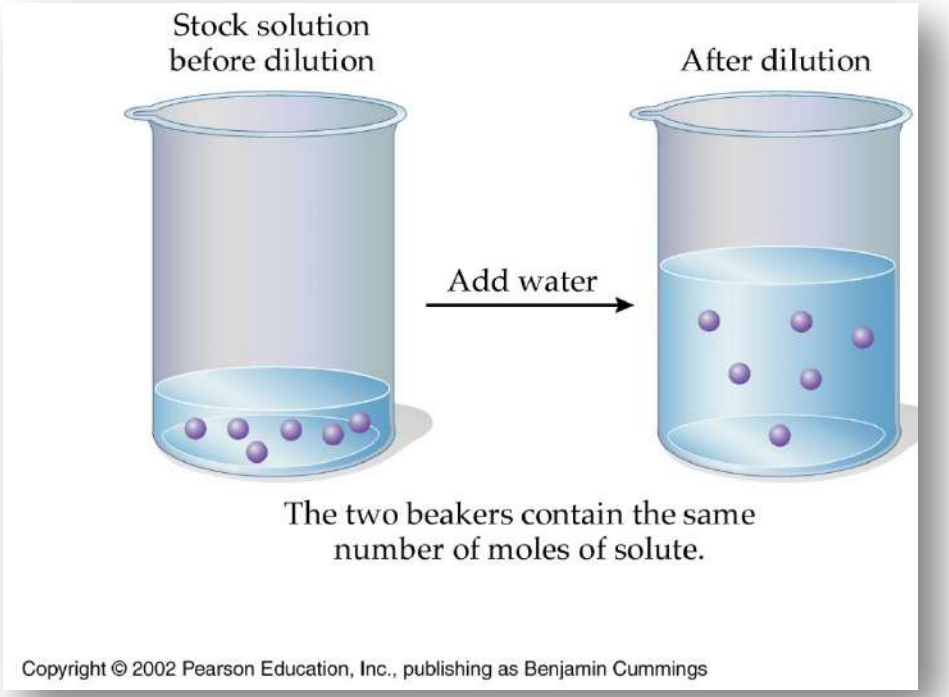
Dilution of Solution :

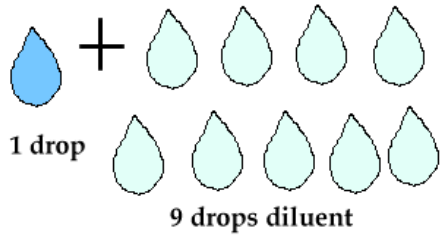
- **Dilution of solution:** means to add more solvent without the addition of more solute ➔ To make it less concentrated.

1. Volume to volume dilutions (ratio).
2. Preparing dilutions by using the $V_1XC_1=V_2XC_2$ formula.
3. Serial Dilutions.



(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 1M NaCl solution, one part of the **1M NaCl** solution, should be mixed with nine parts of **water**, for a total of ten parts.
- Therefore 1:10 dilution means ➔1 part of 1M NaCl + 9 parts of water.



- **Thus:**

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

➔ if 100 ml of 1:10 dilution was needed, then 10 ml of the 1M NaCl should be mixed with 90 ml of water. [The final concentration of NaCl in both cases will be 0.1 M (1/10) = 0.1]

- Example:

1:4 dilution

volume of solute

total volume

1 ml from solute + 3 ml from solvent = Total volume 4

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

how many ml of 7M solution A we need to make 20 ml of 2:10 A solution?

2 ml → 10 ml

? ml → 20 ml

= (2 X 20) / 10 = 4 ml

So,

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

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

How to Know the concentration of solution A after dilution?

First we will find the DILUTION FACTOR by the following :

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

=10/2 = 5

Then we will divide the stock concentration (before dilution) by the D.F:

7/5 = 1.4M

Note: To find out the stock concentration you will multiply the diluted concentration by the D.F

(2) Preparing dilutions by using the $V_1XC_1=V_2XC_2$ 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:**

$$V_1 \text{ X } C_1 = V_2 \text{ X } C_2$$

- Where:

- V_1= Volume of starting solution needed to make the new solution (volume of stock solution).
- C_1= Concentration of starting solution (stock solution).
- V_2= Final volume of new solution.
- C_2= Final concentration of new solution.

Example: Make 5ml of 0.25M solution from a 1.0M solution?

how many ml of 1M solution we need to make 5 ml of 0.25M solution?

➔ **$V_1XC_1=V_2XC_2$**

Where: V_1 = ? , C_1= 1M ,V_2= 5ml ,C_2 = 0.25M

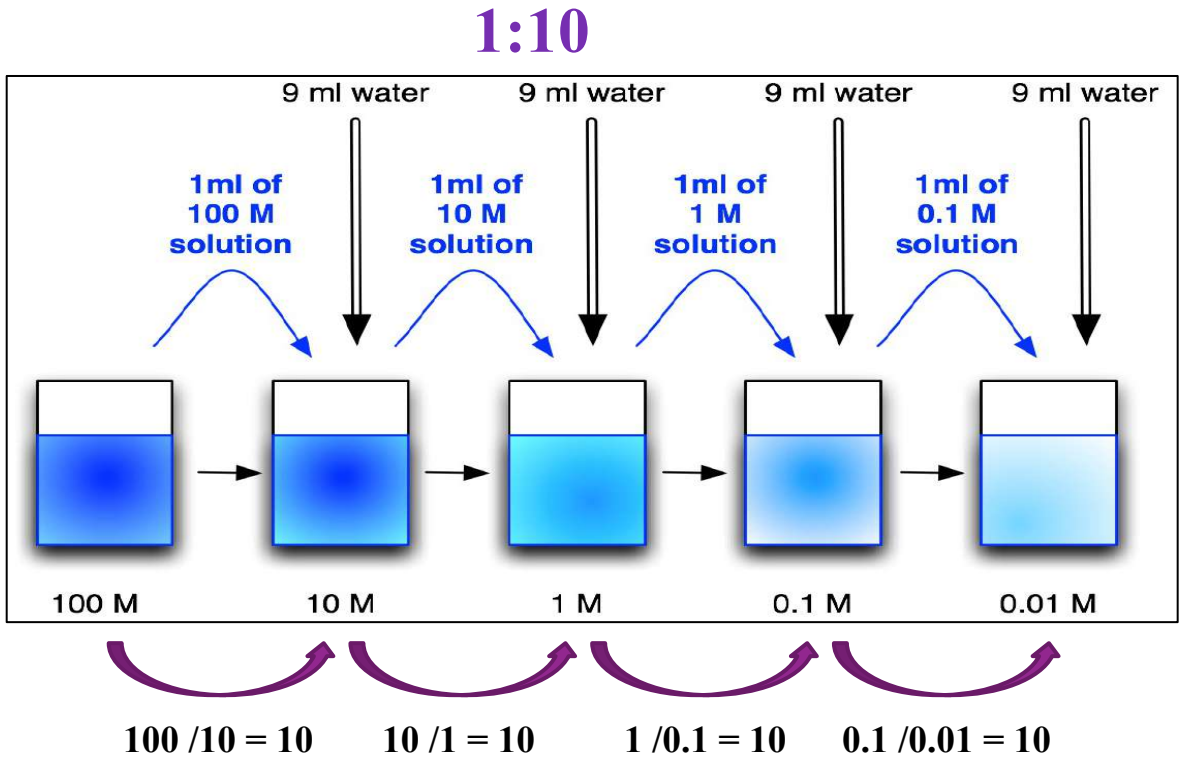
So: (V1) x (1M) = (5ml) x (0.25M)

➔ V1 = (5 x 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 by diluent (generally water).

(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.

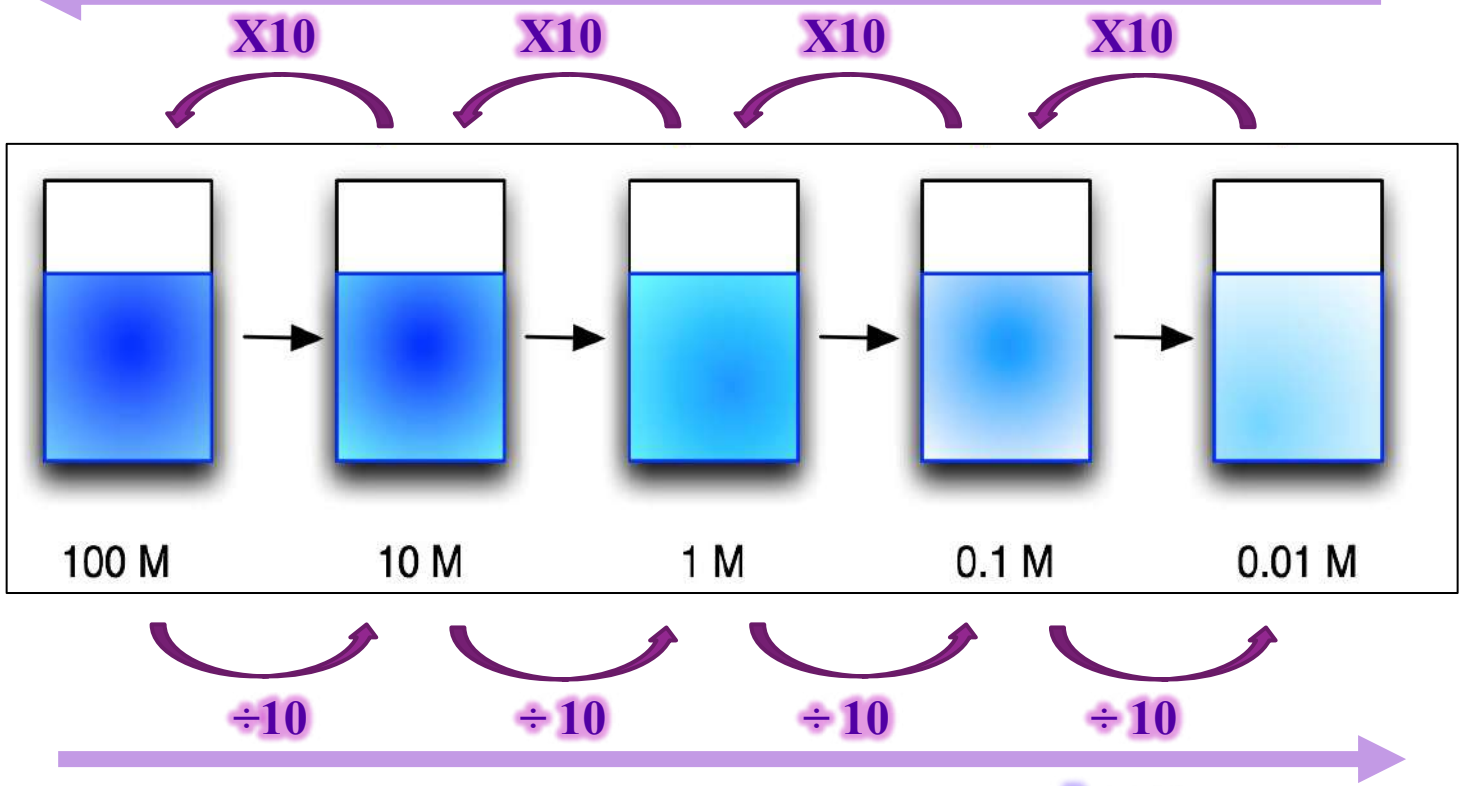


Dilution factor (D.F) = final volume / aliquot volume
= 10 /1 = 10 (for each step)

Find out the concentration of the diluted solutions:

Dilution factor (D.F) = final volume / aliquot volume = 10 /1 = 10 (for each step)

From the lower concentrated solution to the higher one



From the more concentrated solution to the lower one

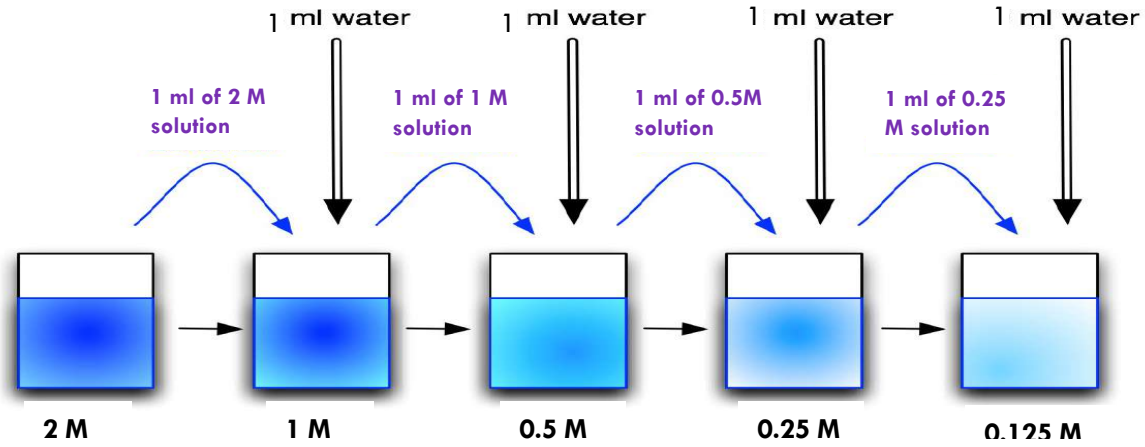
Example:

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** ➔ 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**

Practical Part

Objectives:

- To get familiar with solution dilutions by different methods.

Method:

Solution dilutions:

(1)……

- **Prepare 50ml with 1:20 dilution using the 0.08M NaOH solution you previously prepared.**

- Calculation:

……

……

➔To prepare the 1:20 dilution ……...ml of the starting solution (0.08M NaOH) is needed and volume made up to a final volume of …….ml.

Method:

(2)……

- **Prepare 100ml of 0.2M HCl from the previously 0.4M HCl solution you previously prepared.**

- Calculation:

……

……

➔ To prepare the 0.2M HCl ……..ml of the starting solution (0.4M HCl) is needed and volume made up to a total volume of ……..ml by adding water.

Method:

(3)……

- **Starting with a 3 M Copper Sulfate stock solution, prepare 8ml of four standard solutions (1 to 4) of the following Molarity respectively (dilution 2:8) :**
  (1) ……. M (2) ……. M (3) ……. M (4) ……. M .

- Calculation:

……

……

➔ To prepare standard solution 1: …… ml of the stock 2.0M solution is needed and volume made up to …….. ml with distilled water.

➔ To prepare standard solution 2-4: …… ml of the previously diluted solution (8.00×10-2 M) is taken and volume is made up to a final volume of …… ml by the addition of distilled water.