# Physical Pharmacy
# Lab - 4 -

## *Surface Tension*

***Done by:***

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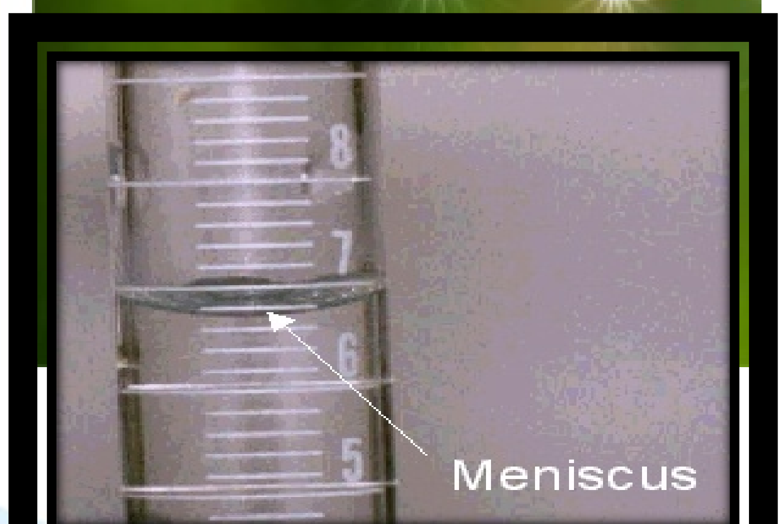
# WHAT IS SURFACE TENSION?

- Surface Tension is defined as the tension of the surface film of a liquid caused by the attraction of the particles in the surface layer by the bulk of the liquid, which tends to minimize surface area.

- It is due to the phenomena of surface tension that the drops of water tend to assume a spherical shape attain minimum surface area.



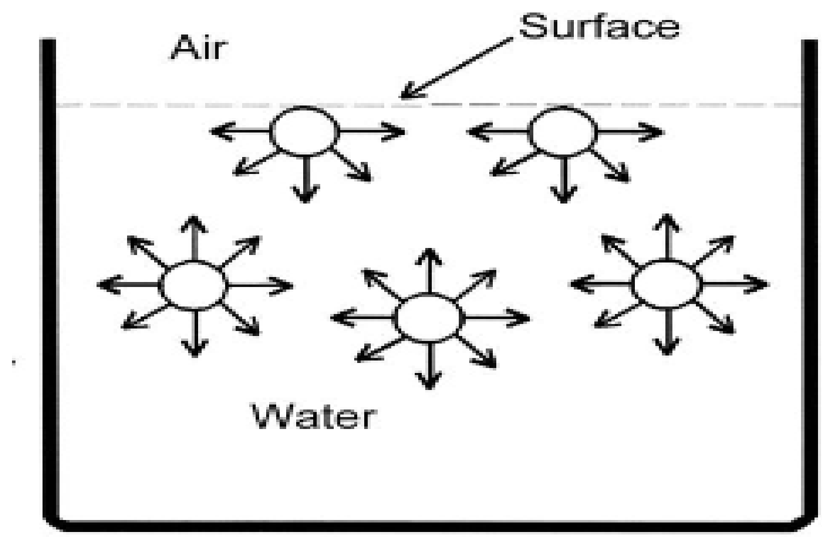
# Examples of Surface Tension

**Walking on water:** Small insects such as the water strider can walk on water because their weight is not enough to penetrate the surface.

**Floating a needle:** A carefully placed small needle can be made to float on the surface of water even though it is several times as dense as water. If the surface is agitated to break up the surface tension, then needle will quickly sink.

**Surface Tension and Droplets:** Surface tension is responsible for the shape of liquid droplets. Although easily deformed, droplets of water tend to be pulled into a spherical shape by the cohesive forces of the surface layer.

- **Surface:** is used when referring to either a gas-solid or a gas-liquid interface.
- **The tension in the surface**: is the force per unit length that must be applied to the surface so as to counterbalance the net inward pull. It has the units of dyne/cm. as shown in Figure 1.



# Interface

- ***Interface*** is the boundary between two or more phases exist together
- The properties of the molecules forming the interface are different from those in the bulk that these molecules are forming an ***interfacial phase.***
- Several types of interface can exist depending on whether the two adjacent phases are in solid, liquid or gaseous state.
- Important of Interfacial phenomena in pharmacy:
  - Adsorption of drugs onto solid adjuncts in dosage forms
  - Penetration of molecules through biological membranes
  - Emulsion formation and stability
  - The dispersion of insoluble particles in liquid media to form suspensions.

**Furthermore, there are two important terms related to forces.**

**First, Cohesive forces** are the intermolecular forces which cause a tendency in liquids to resist separation. These attractive forces exist between molecules of the same substance. While,

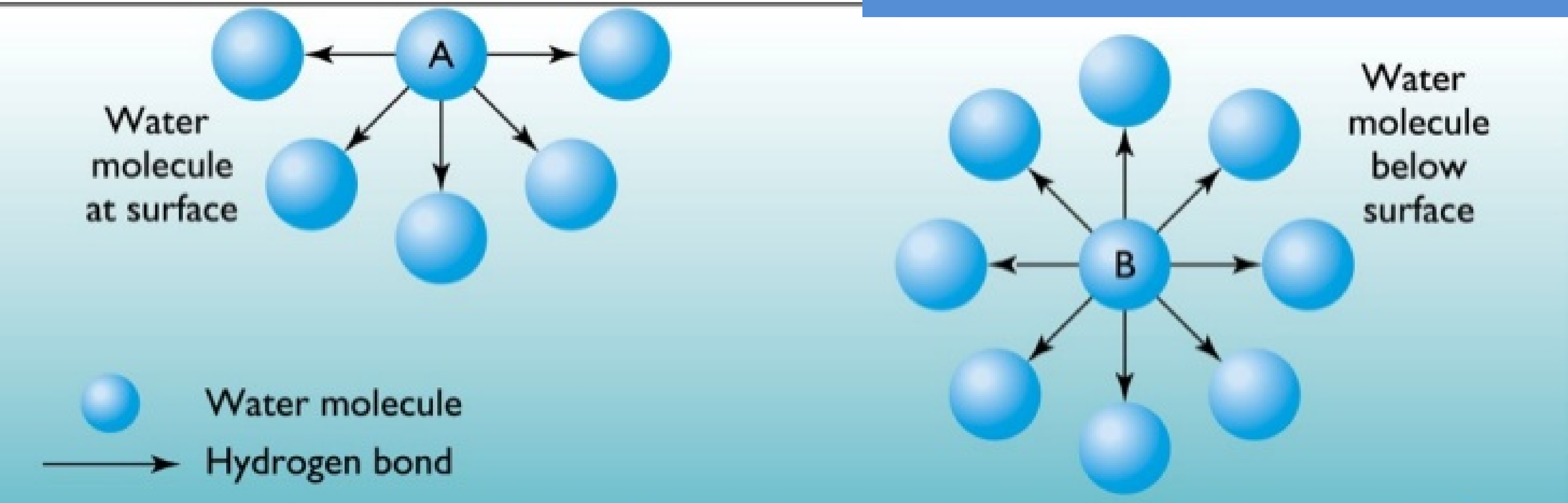
**Second, adhesive forces** are the attractive forces between unlike molecules. They are caused by forces acting between two substances, such as mechanical forces (sticking together) and electrostatic forces (attraction due to opposing charges)

# Surface tension

- The **cohesive** forces among the liquid molecules are responsible for this phenomenon

(A) A molecule in the surface experiences a net attractive force pointing toward the liquid interior, because there are no molecules of the liquid above the surface.

(B) A molecule within the bulk liquid is surrounded on all sides by other molecules, which attract it equally in all directions, leading to a zero net force.



- **Interfacial tension**: is the force per unit length existing at the interface between two immiscible liquid phases and has the unit of dynes/cm.
- ordinarily; it is less than surface tension because the adhesive forces between liquid phases forming an interface are greater than when a liquid and a gas phase exist together.
- It follows that if two liquids are completely miscible; no interfacial tension exists between them.

Surface tension or Interfacial tension =(cohesive forces- adhesive forces)

# Factors affecting surface tension

**1. Temperature**

**2. Surface active agents(S.A.A)**: addition of surfactants to water decreases the surface tension. Because surfactants in water orient themselves at interface in such away to remove hydrophobic tail away from aqueous phase, as a result some of water molecules at the interface replaced by non-polar part of surfactant and since attractive force between surfactant molecules (cohesive force) & between S.A.A and water (adhesive force) less than cohesive force between water molecules a lone (i.e. decrease cohesive force leads to decrease net effect (cohesive- adhesive) leads to decrease surface tension).

# *Methods to measure surface tension*

There are several methods of surface tension measurements:

**<u>1. Drop weight method:</u>** The surface tension of the liquid is related to the weight of a drop of that liquid which falls freely from the end of the tube by the expression

$$\gamma = \frac{MG * F}{R}$$

**y= surface tension (gm.cm/sec$^2$ = dyne /cm)**
**M=mass of one drop,**
**R= radius,**
**F= correction factor**
**G= 980 cm/sec$^2$ or 9.8 m/sec$^2$**

## 2. Modification of drop weight method (drop number method):-

It may be performed by counting the numbers of drop (n) by certain volume (0.5 ml) under conditions similar to that prescribed previously. A comparison with liquid of known surface tension must be similarly treated by using the same tube under the same condition.

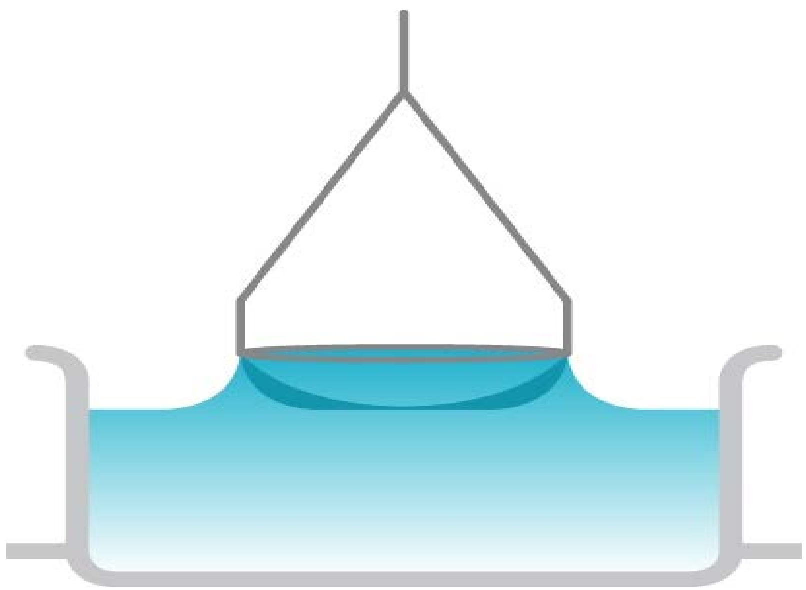
$$\frac{y1(water)}{y2(tween)} = \frac{m1}{m2} \qquad (\text{ m= density * volume}).$$

$$\frac{y1}{y2} = \frac{d1^{*}(0.5/n1)}{d2^{*}(0.5/n2)}$$

$$\frac{y1}{y2} = \frac{d1^{*}\,n2}{d2^{*}\,n1}$$

**Surface tension of water =72.8 at 25 $c^{o}$& d=1**

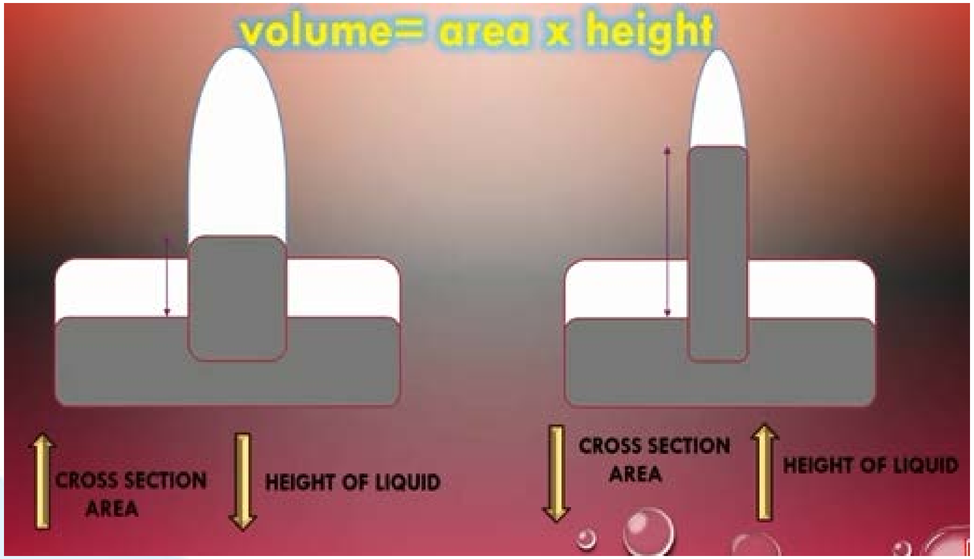
**3. Ring detachment method** (Du Noüy Ring Tensiometer):
The principle of the instrument depend on the fact that the force necessary to detach a platinum ring immersed at the surface or interface is proportional to the surface or interfacial tension.



## 4- Capillary rise method:-

In this method when inversed tube (capillary tube) in a liquid, the tube will be risen up to a certain distance by a liquid , it depends on:

- surface tension of liquid ( increasing surface tension leading to increase height of liquid) and
- on the cross section area of that tube ( increase area leads to decrease height).



# Experimental work

**The aim of the experiment** is to determine the surface tension of liquids in addition to the C.M.C. of surfactant such as tween.

**Materials and equipment:-**

-Distilled water, solution 2% tween60

-graduated pipette, beaker , conical and volumetric flask( 50 cc).

**Procedure:**

1. Use modified drop weight method to measure the surface tension of the concentrations of tween60 (0.01%, 0.03 %, 0.05%, 0.075%, 0.1%, 0.2%), then prepare 50 ml of each solution by dilution method using 2% stock solution.
2. Plot surface tension versus concentration.
3. Determine C.M.C. of tween60 from the plot (n water=16) (δ water =72.8).

**The densities of the concentration used are as follows:-**

| density | Concentration |
|---|---|
| 1.01 | 0.01 |
| 1.02 | 0.03 |
| 1.04 | 0.05 |
| 1.05 | 0.075 |
| 1.1 | 0.1 |
| 1.2 | 0.2 |

**Use water as a standard liquid (surface tension =72.8 & its density = 1).**

# How to prepare our solution for the experiment

For example: to prepare 50 mL of 0.01% tween60 from 2%stock solution by using dilution

C1V1 = C2 V2

2 %*V1 =0.01%* 50

V1= 0.25mL take from stock solution 2%tween 60 (using pipette ) put it in the volumetric flask then complete the volume to 50 mL by adding D.W

*The same procedure and calculation for preparation of the other concentration

# Steps of the experiment

Prepare diluted solution for example 0.01% in volumetric flask

Take 0.5 mL of the prepared solution by using 1mL pipette and dropped the liquid in the beaker and count the no. of drops

Now use the equation to find the surface tension

# calculate the surface tension of 0.01% tween 60 if the number of drops of this solution =18

$$\frac{y1(water)}{y2(tween)} = \frac{m1}{m2}$$

( m= density * volume)

$$\frac{y1}{y2} = \frac{d1*(0.5/n1)}{d2*(0.5/n2)}$$

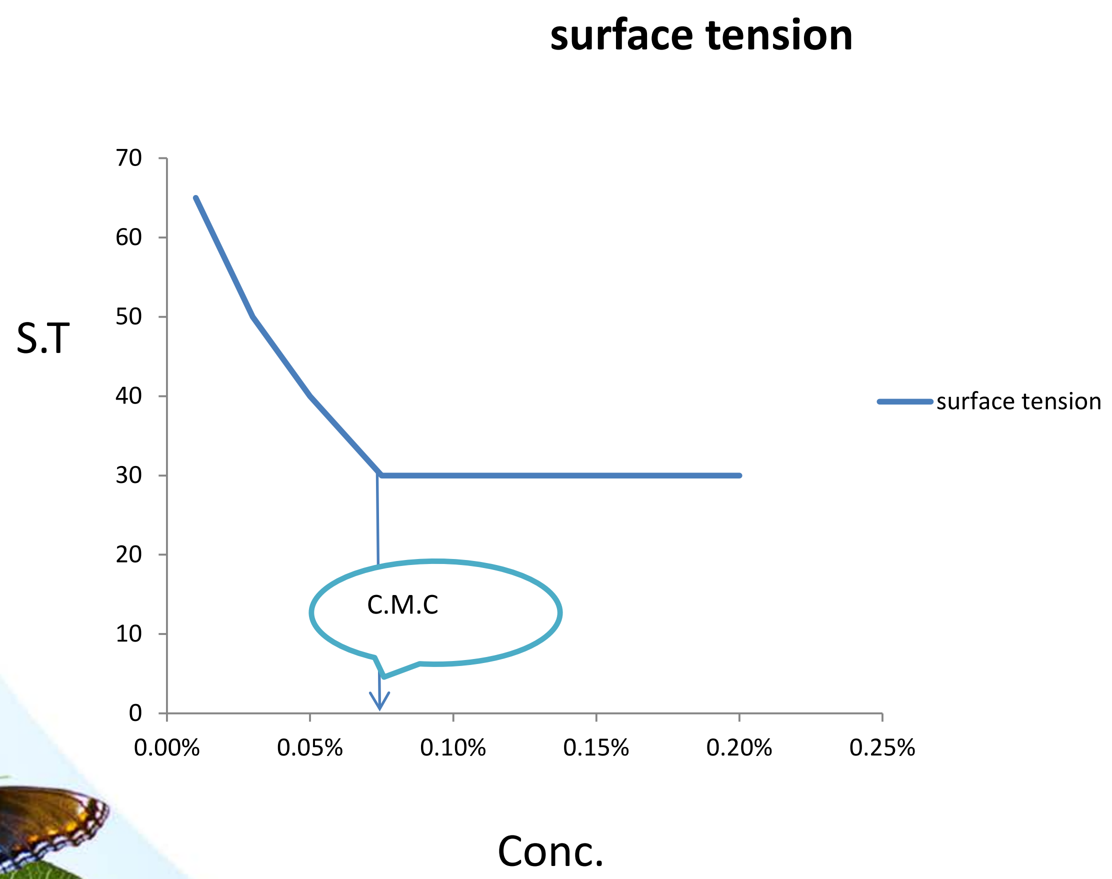
$$\frac{y1}{y2} = \frac{d1*n2}{d2*n1}$$

$$\frac{72.8}{y2} = \frac{1*18\ (no.of\ 0.01\%tween60\ drops)}{1.01*16(no.of\ water\ drops)}$$

**y2= 65.53 dyne/ cm**

**Surface tension of 0.01%tween60 solution**

# To find C.M.C


surface tension
S.T
70
60
50
40
30
20
10
0
C.M.C
0.00%
0.05%
0.10%
0.15%
0.20%
0.25%
surface tension
Conc.

# Thank You For Listening

**It's time for question???**