Dialysis
&
Adsorption

Dialysis

The purpose of activity:

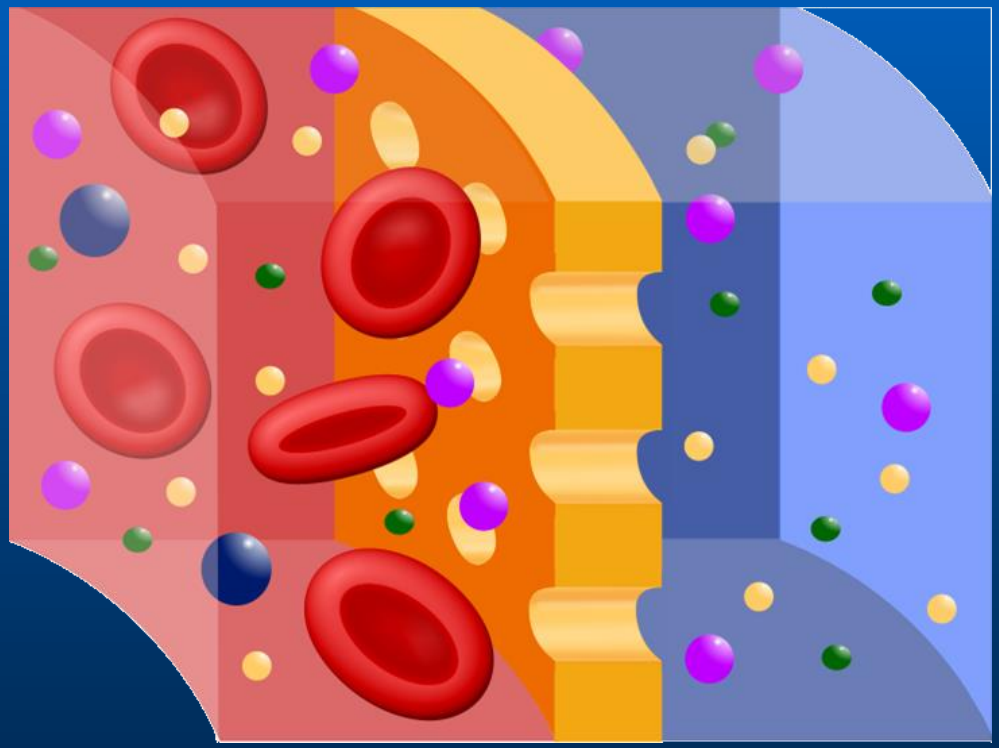
- The familiarization with the mechanism of dialysis process.

- The evaluation the effects of dialysis process by the determination of selected ions, lactose and proteins in the dialysis solution.

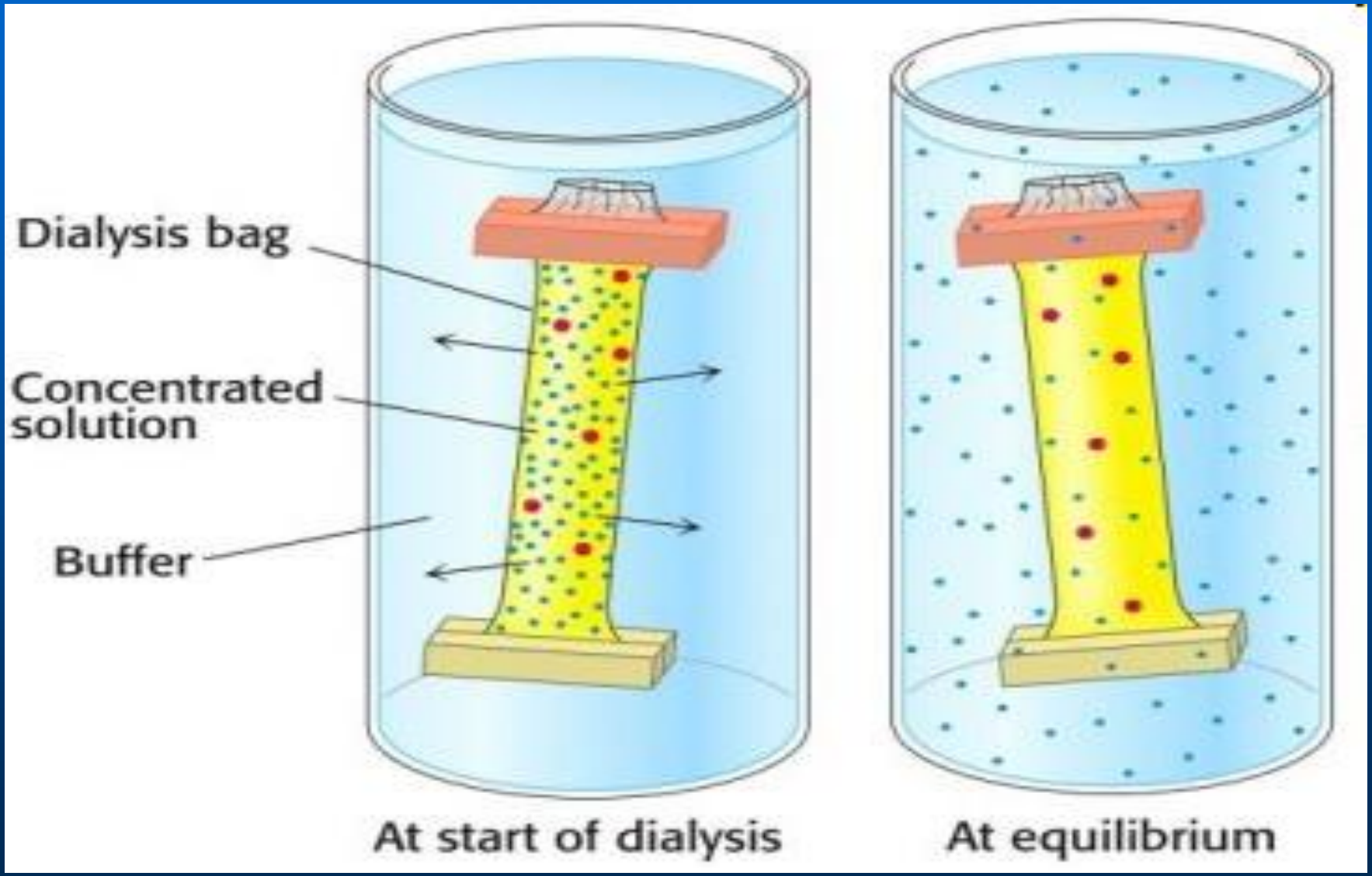
Dialysis

This is the method used for purification of colloidal solutions from electrolites based on the diffusion through a semi-permeable membrane.

Macromolecules such as proteins remain in the dialysis bag, while the ions and small particles can escape to the outside.

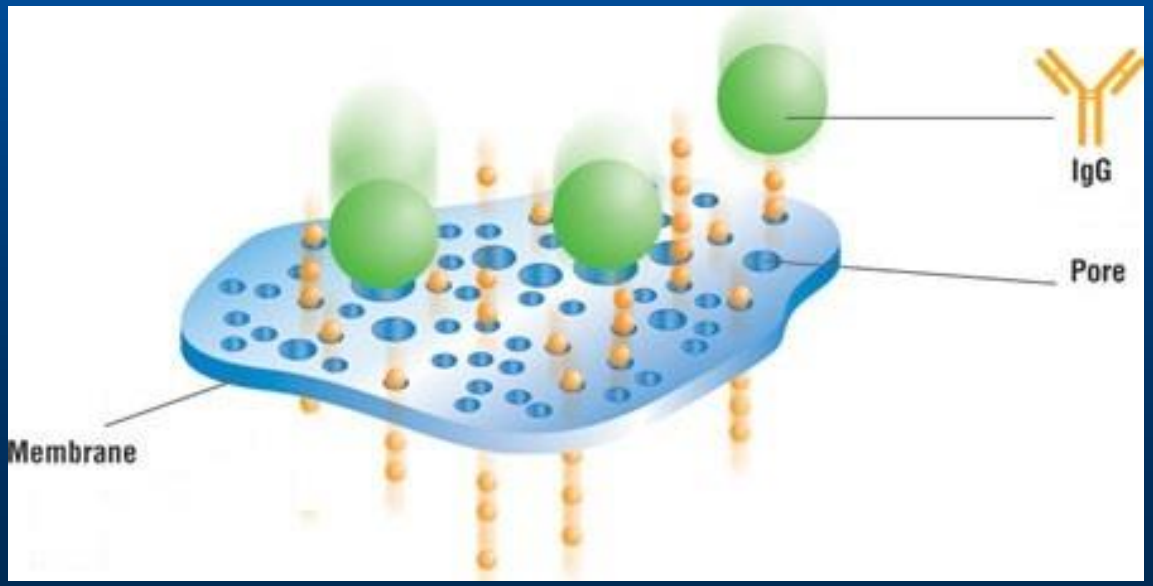


Dialysis procedure



Use of dialysis

- In laboratories for removal of unwanted small molecules (salts, dyes) from macromolecules (proteins, DNA)
- In medicine practice for treating poisonings or kidney failure

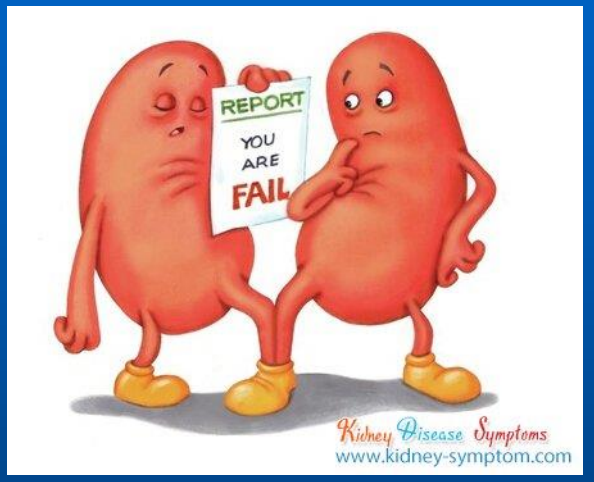


Dialysis in medical practice

In nephrology:

- for patients with renal failure who are not eligible for renal transplantation or waiting for this treatment.

Dialysis treatment can remove most of the harmful products of metabolism, such as urea.



Treatment of poisonings:

- the goal of intervention is to remove toxic substances from blood.

An example would be hemodialysis to treat ethylene glycol poisoning.

Hemodialysis

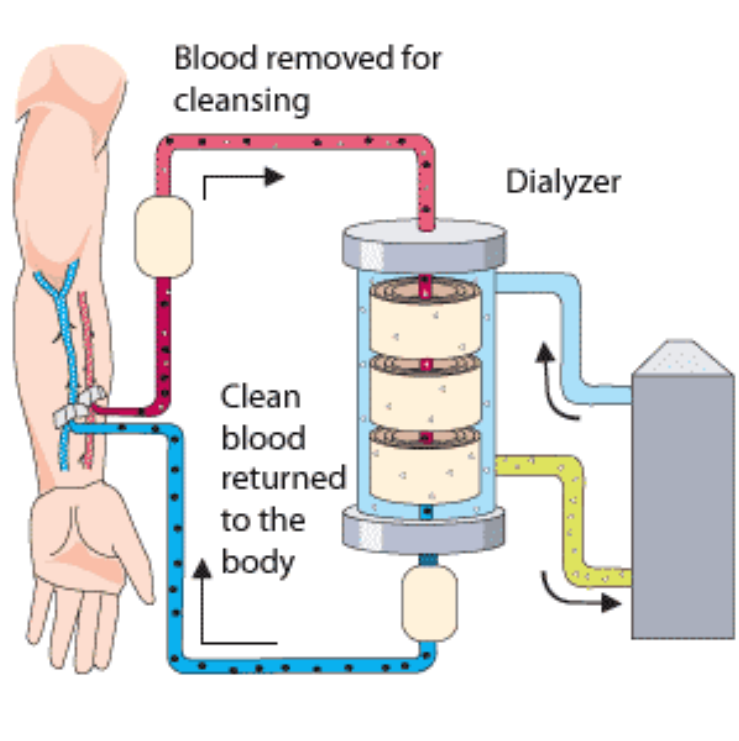
This process is based on the removal of waste products and water, or drugs and toxins from patient's blood through the artificial semi-permeable membrane (outside the body).

The treatment also allows to correct metabolic acidosis and electrolyte abnormalities.

Hemodialysis

During hemodialysis, blood is repeatedly pumped outside the body to the dialyzer, which acts as an artificial kidney.

1. Blood is removed from vein.
2. The dialyzer removes waste products from blood by filtration.
3. Clean blood returns to the bloodstream.



Peritoneal dialysis (PD)

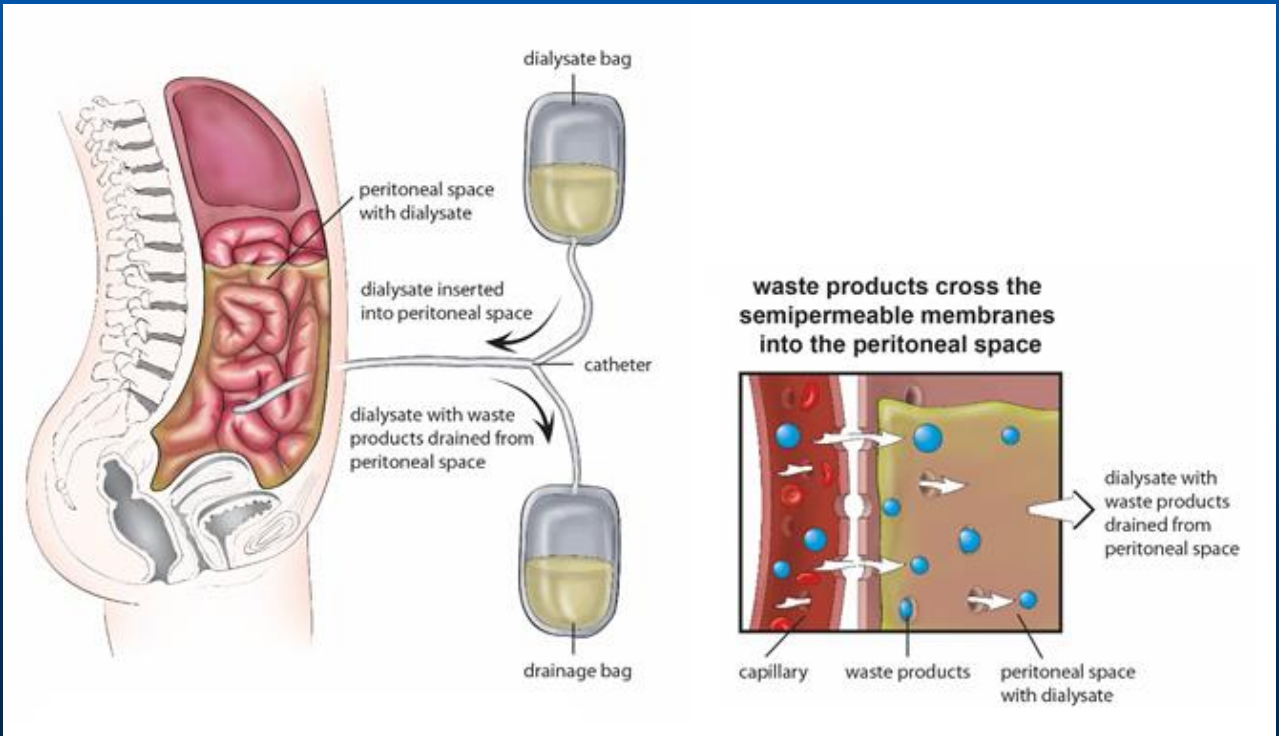
It is used for the purification of blood from toxic metabolic waste and leads to maintain an adequate fluid balance.

A semi-permeable dialysis membrane is peritoneum that lines the abdominal cavity and covers contained organs.

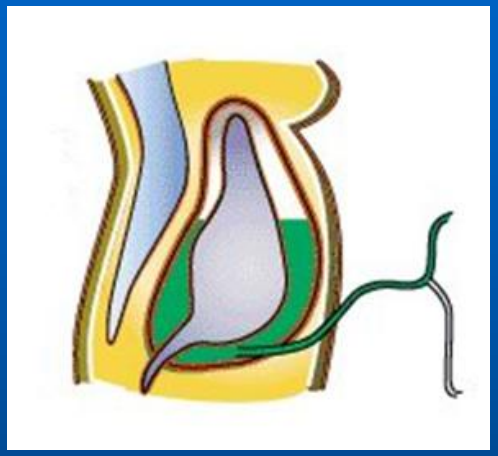
PD is a treatment for patients with severe chronic kidney disease.

Peritoneal dialysis (PD)

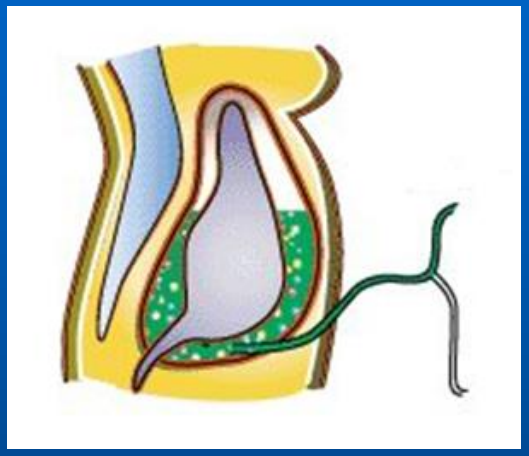
Before dialysis, a soft plastic tube (catheter) is placed in the abdomen at the bottom of the peritoneal cavity by surgery.



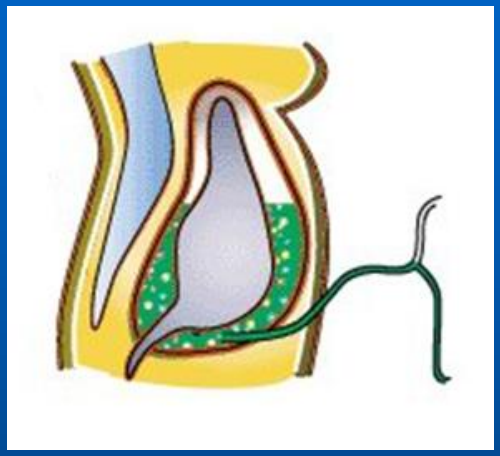
Peritoneal dialysis (PD)



Dialysate fluid is introduced to the abdomen via a dialysis catheter inserted in the peritoneal cavity.



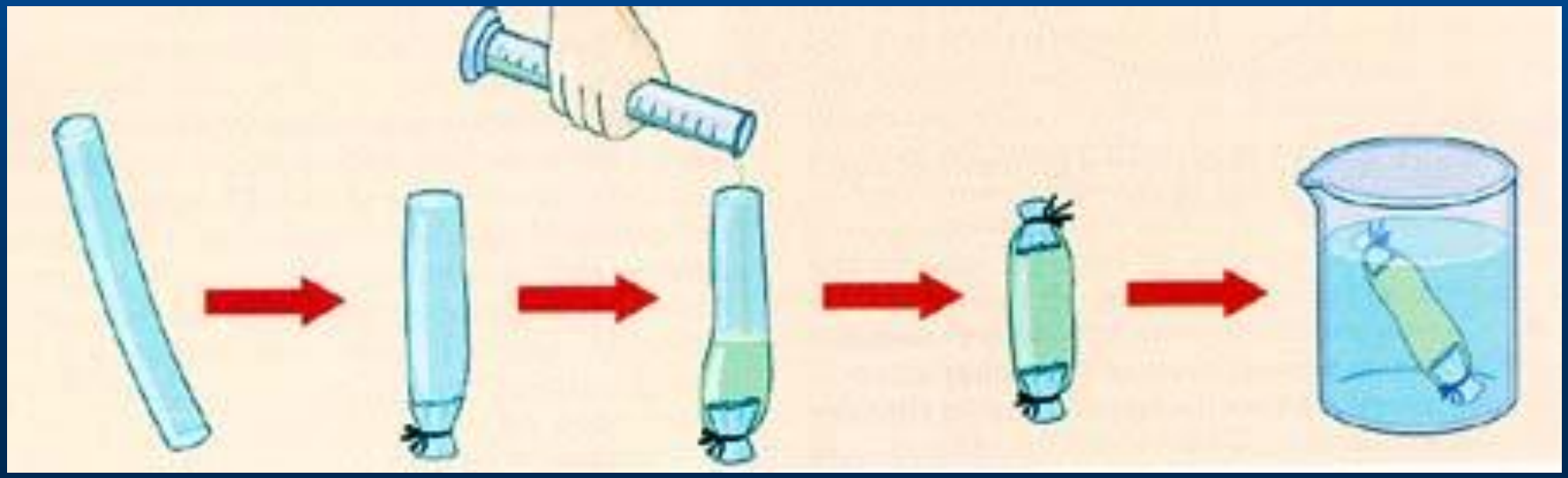
Toxins and water flow through the peritoneal membrane into the dialysate fluid.



Contaminated dialysate is drained out of the abdomen into an empty bag and it is replaced by a clean liquid.

Task 1: dialysis

1. Wet the dialysis tube section (length 25 cm) with distilled water.
2. Close one of the ends of the tube with a seal clip.
3. Pour the 50 cm^3 of milk (accurately measured volume) to the prepared dialysis bag.
4. Close the second end of a tube filled with milk using a clip, leaving some space over the layer.
5. Rinse the outer part of a bag (which could be contaminated by milk) with distilled water from a wash bottle.
6. Wipe the bag to dry using the scrap of paper or lignin.



Task 1: dialysis

7. Use the graduated cylinder to measure 200 cm^3 of distilled water and pour it to the beaker.

8. Insert dialysis bag filled with milk into beaker containing water.

9. Perform dialysis for 30 min at RT, gently moving the bag from time to time.

10. After that, remove the dialysis bag from the beaker and then measure the volume of solution in a beaker.

Task 1: Activities after dialysis

Perform qualitative analysis in the tested fluid after dialysis to detect the presence of ions, lactose and protein:

Detection of Cl^-

Add by drops 0,5 cm^3 of 0,1 mol/dm^3 $AgNO_3$ to 1 cm^3 of tested dialysis solution.

In the presence of Cl^- ions, white iridescent precipitate of AgCl appears.

Detection of Ca^{2+}

Add 0,5 cm^3 of 0,2 mol/dm^3 ammonium oxalate to 1 cm^3 of tested dialysis solution.

A crystalline calcium oxalate is precipitated.

Task 1: Activities after dialysis

Perform qualitative analysis in the tested fluid after dialysis to detect the presence of ions, lactose and protein:

Detection of PO_4^{3-}

Add 5 drops of concentrated HNO_3 and 0,5 cm^3 of 0.1 mol/dm^3 ammonium molybdate to 1 cm^3 of tested dialysis solution.

Warm the solution gently over the burner until the appearance of yellow precipitate, which indicates the presence of ammonium phosphomolybdate $(NH_4)_3PMo_{12}O_{40}$

Detection of lactose

Add 0,5 cm^3 of Fehling's reagent I and 0,5 cm^3 of Fehling's reagent II to 1 cm^3 of tested dialysis solution.

Heat the solution gently over the burner until the appearance of yellow, orange or red precipitate of copper oxide (I) Cu_2O.

Task 1: Activities after dialysis

Detection of protein – BIURET METHOD

Perform the test on the presence of protein in tested dialysis solution and in milk before dialysis:

Add 2 cm^3 of copper reagent to 0,5 cm^3 of:
1) tested dialysis solution
2) milk derived from dialysis tube.

Compare the colors appeared in both samples.

Protein is present, if the solution turns violet.

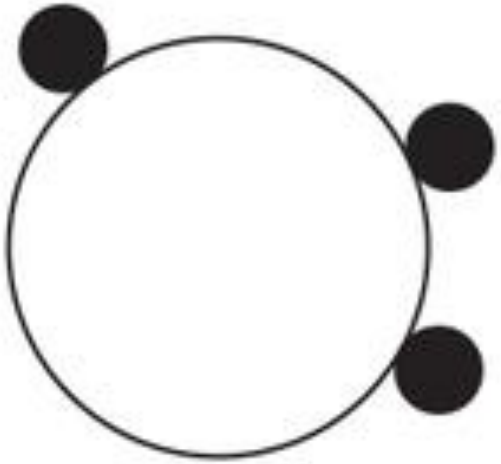
Adsorption

The aim:

to evaluate the adsorption properties of medical carbon by titration with standard solution of NaOH.

Sorption

absorption

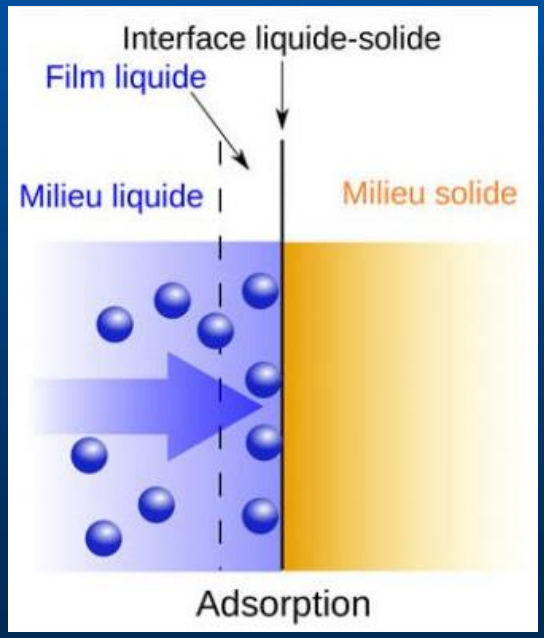


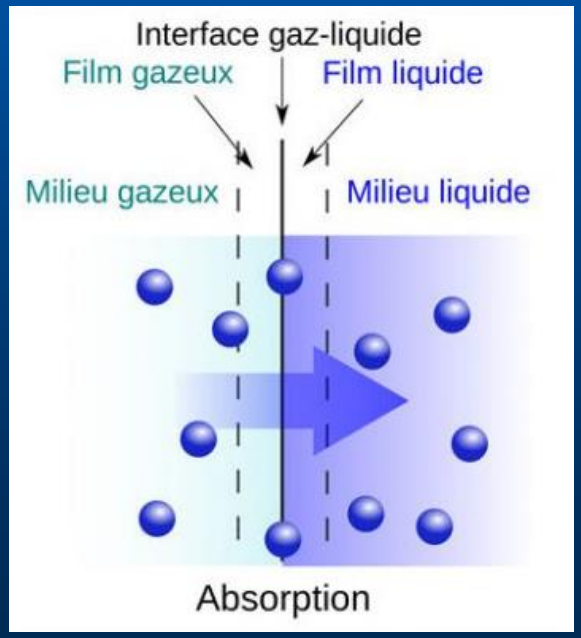
adsorption

Sorption

Adsorption – the process in which the molecules, atomes or ions adhere to the surface of the phase (adsorption of toxins through the activated carbon).

Absorption – the process in which the molecules, atomes or ions permeate into the interior phase (dissolving CO_2 in the water).





Adsorption capacity

This is the mass of the adsorbate that can be adsorbed by the adsorbent mass.

Adsorption capacity is experimentally determined and depends on many variables, such as:

- temperature
- contact time of the adsorbent and adsorbate
- contact surface of the adsorbent and adsorbate
- pressure

Types of adsorption

Physical adsorption – molecules bind to the surface via weak van der Waals forces.

Physical adsorption phenomenon is reversible process. Desorption of substance from the adsorbent surface may occur under the influence of elevated temperature. Desorption of substance from solution may occur due to the changes in pH and ionic strength of the environment.

Chemical adsorption - particles fuse with the surface via covalent bonds. It is irreversible process.

Medical carbon

Medical carbon (***Carbo medicinalis***) is a natural powdered activated carbon.

Thanks to the strong adsorption ability, after oral administration binds substances found in digestive tract, which increases peristalsis, increases the penetration of water into the intestinal lumen and cause diarrhea. These substances may be: bacterial toxins, bacteria, drugs, flatus or other toxic substances.

Medical carbon

Carbo medicinalis is recommended to treat both diarrhea and food poisoning as well as the prevention and treatment of indigestion and bloating.

It is a drug that does not hinder the intestinal peristalsis and does not stop the toxins in the body.

It binds harmful substances facilitating their elimination, whereby does not cause further damage.

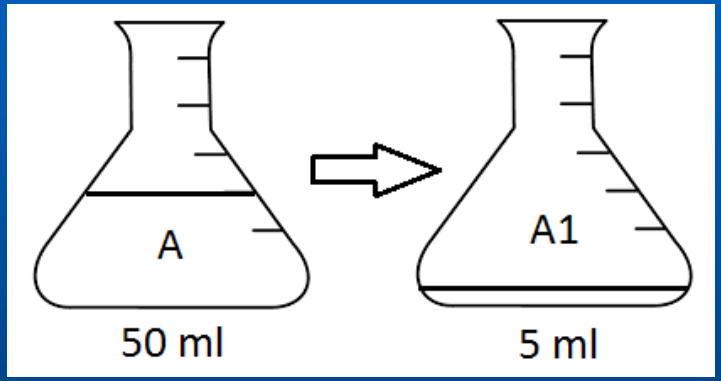
Task 2:
Adsorption on activated carbon

1. Dilute 0,5 mol/dm³ of acetic acid with distilled water in the conical flasks (marked as A and B) to obtain the acid solutions of concentrations 0.12 mol/dm^3 and 0.03 mol/dm^3 in accordance with the following table:

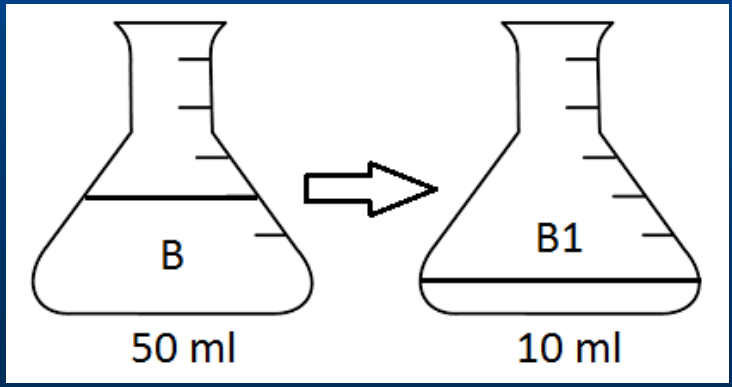
flask	CH_3COOH	H_2O	concentration	dilution	pH
A	12 cm^3	38 cm^3	0.12 mol/dm^3	approx. 4 x	2.8
B	3 cm^3	47 cm^3	0.03 mol/dm^3	approx. 16 x	3.2

Task 2:
Adsorption on activated carbon

2. Transfer 5 cm^3 of acetic acid solution from flask A to the new flask marked as A1.



3. Similarly, at the same time, transfer 10 cm^3 of acetic acid solution from flask B to the new flask marked as B1.



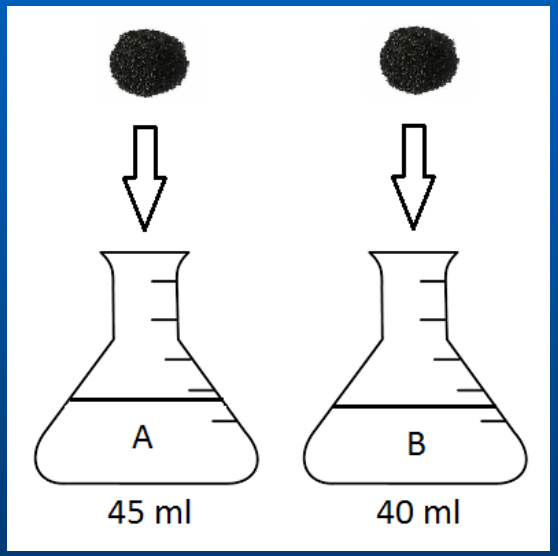
Task 2:
Adsorption on activated carbon

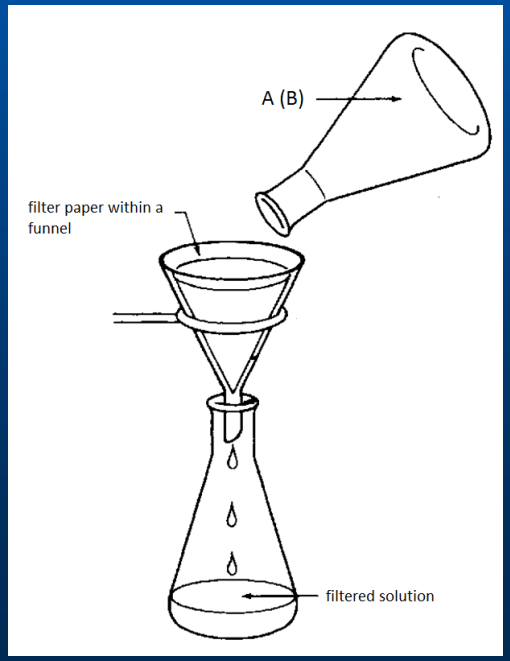
4. Add a few drops of phenolphtaleine to flasks A1 and B1 and then titrate each of them with standard solution of NaOH (0,1 mol/dm^3).

Calculate the real concentrations of obtained acetic acid solutions and compare them with calculated results (in the table).

Task 2:
Adsorption on activated carbon

5. Add 1 g of activated carbon to the flasks A and B and then gently shake them for 30 minutes.





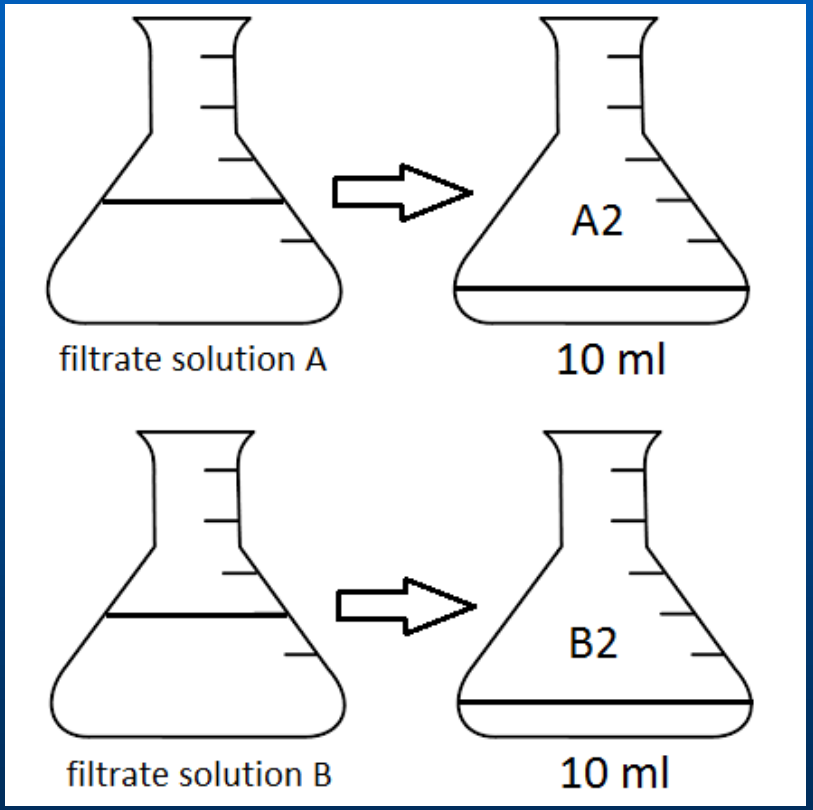
6. Filtrate the contents of the flasks using a filter paper.

Task 2:
Adsorption on activated carbon

7. Take 10 cm^3 of filtered solution from each flask and put in the new conical flasks marked as A2 and B2.

8. Add phenolphtalein and titrate with standard solution of NaOH.

Calculate the concentration of acetic acid in the flasks after adsorption.



Task 2:
Adsorption on activated carbon

Knowing the concentration of the acid solution before adsorption (C_0) and after adsorption (C), calculate the number of moles of acetic acid, which has been adsorbed by 1 g of activated carbon.

$XA=(C0 - C) \times VA$; $XB=(C0 - C) \times VB$

for flask A: $VA=45\ cm^3$
for flask B: $VB=40\ cm^3$