Nanoparticles - 4. Nanoparticles diffusion model

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Lab objectives

- Identify important parameters for the diffusion of particles in a medium, with a focus on dimension
- Elaborate a model to describe nanoparticles diffusion in human tissue
- Practice data collection and analysis through digital images

Featurese

Implies possible systematic data collection and analysis with typical school lab methodology; difficulty level: easy.

In the lab electronic mobile devices (smartphones, tablets, etc.) can be effectively used to collect data (by digital images).

From the website www.nanolab.unimore.it , in the corresponding section, it is possible to download *the* ***Complete Didactical Guide.*** Inside the guide all the experiments within the thematic area "***nanoparticles"*** are collected and described in a combined and highly integrated way**.** You will also find tips and didactical suggestions, detailed assembly instructions, different options for set ups and procedures, info about finding the necessary materials (outside standard lab equipment) and on available computer simulation or data analysis software. Curriculum alignment tips and examples on how to fit the experiments in usual classroom practice are offered together with references to research materials (external links and background reading).

What's to be observed

Gelatine is a polymeric organic substance with many properties similar to those of extracellular connective matrix in cancer tissue, therefore it makes a suitable model for investigating diffusion in organic environment. Moreover food colouring is comparable for molecular weight and transport properties to many chemotherapeutic substances and their concentration can be easily determined through colour intensity. Diffusion of different food colouring will be investigated to define whether molecular weight, and eventually dimension, makes the difference. Being able to predict the exact position of nanoparticles once they 've been injected is fundamental to activate them promptly and effectively, thus a theoretical model for diffusion is developed.

Equipment (for one working group only)

- food gelatine (at least 2 packets each 0,5 L)
- food colouring
- non-stick baking pan
- cookie cutter
- graduate beaker
- spatula
- 4 syringes(10 cc)
- 4 paper glasses
- 4 Petri dishes
- 4 white sheets
- bunsen tripod
- photo camera
- computer
- Image processing software

Procedure

A – Collect materials

You will need gelatine and food coloring; 4 syringes, 4 Petri dishes, a circular cookie cutter and a photocamera. Gelatine should be prepared one day in advance. Take a non sticking pan large enough to cut out at least four disks with the cookie cutter. Pour enough water to cover the pan uniformly with 1 cm high of liquid. Count approx. 2 gelatine packets each 0,5 lt of water. Gelatine should be quite hard.

B – Cut the gelatine disks

This is a most delicate step: the utmost care must be taken not to damage the disk surface or you will put at risk the symmetry of the diffusion process. Cut the disks neatly into the gelatine using the cookie cutter. Use a spatula to remove the disks and put each of them in the center of a Petri dish. Be careful to keep the circular shape! Put the Petri dishes on white sheets so the diffusion process can be better observed and recorded. Tape the sheets to the table.

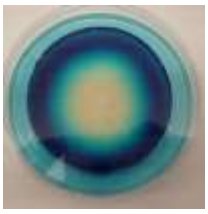
C –Inject food colouring

Dilute always the same number of drops of food coloring in 20 ml of water in 4 different glasses: blue, red, yellow and orange (obtained by mixing red and yellow together in the same percentage). The solution should have a bright but clear colour. Fill two different syringes (without needle) with 10 cc of coloured solution. As you inject the color at the bottom of the Petri dish, be careful not to touch the disk border. The liquid volume should not exceed ¾ of the gelatine disk height. Use the same amount of liquid for each coloured solution. Collect data for at least 6-7 days. Find a quiet spot in the lab and don't move the plates anymore throughout the whole data collection.

D – Monitor food colouring diffusion through digital images

Take a picture of each sample twice a day. Keep always the same distance from the sample while you take the pictures. Resting the camera face down on a bunsen tripod can be of help to maintain it always at the same distance and parallel to the desk. Uncover the Petri dish to take the photo (you will avoid excessive light reflection) then put the cover back again to avoid contamination. Write date and hour in the photo. A sample series can be downloaded from Nanolab website.

E – Diffusion rate analysis



With pencil and ruler or making use of dedicated software (such as Tracker) measure and annotate the distance covered by food colouring at different recording times. Since the gelatin disk is not a perfect cylinder calculate the average diameter on many measures taken along different directions. If the rings fringes are blurred take the measures from the centre and stick to this procedure throughout data collection.

Credits

The experiment has been partially adapted from *"* Diffusion *of* Food Coloring *Through* Gelatin *Lab: A Model for* Diffusion *of Nanoscale Particles Through Cells" http://*umassk12.net/nano/