STUDENT LABORATORY WORKSHEET EXPERIMENT A:

NATURAL NANOMATERIALS

Student name:……

Date:……..

AIM: - Learn about the existence of natural nanomaterials

- Light interaction with colloids
- Gelatine and milk as examples of natural colloids
- Relationship between milk's "macro" properties (colour, smell, taste, consistency) and its molecular structure
- Understanding of the relationship between molecular structure of milk (nanostructures) and its properties, and how these can be manipulated to obtain different products (cheese, yogurt etc).

BEFORE YOU FILL IN THIS WORKSHEET:

- read the EXPERIMENT A-STUDENT BACKGROUND READING
- ask your teachers questions if you have any

MATERIALS:

- 1 hotplate
- 2 beakers 50 mL
- 1 beaker 200 mL
- 2 beakers 500 mL
- 0.5 g gelatine powder (Sigma-Aldrich product number G1890)
- 1 tablespoon
- 800 mL of skim milk
- 4 tablespoons of white vinegar
- thermometer
- 1 spatula
- latex gloves
- safety glasses

The research leading to these results has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 233433

PROCEDURE

1. Prepare and test gelatine

In this part of the experiment you will prepare gelatine and test it with a laser pen to confirm its colloidal nature.

STEP 1

Prepare a 10 mg/mL gelatine sample by mixing 0.5 mg of gelatine powder with 50 mL of cold water. Place on the hotplate and heat the water and gelatine mixture. Stir with the spatula as the mixture heats up. Bring close to boil (check temperature with thermometer), then turn off the hotplate and let the mixture cool down. **SAFETY NOTE:** Do not touch the beaker immediately as it will be very hot. When it has cooled down, remove it from the hotplate and carefully place it on the bench. Otherwise use safety gloves.

STEP 2

Once the gel is formed, test it with a laser pen. Place a piece of white paper on the other side of the beaker. Shine the laser beam through the gelatine sample and record your observations. **WARNING**: never shine a laser beam near the eyes nor look straight into the beam!! You must wear **safety glasses** when doing this test.

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STEP 3

Repeat the laser test but this time testing a beaker of plain water.

Q1. Based on the laser test, is gelatine a colloid? Why?

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Q2. Based on the laser test, is water a colloid? Why?

2. Milk and its properties

Milk is a natural colloid and you will confirm this as you did with gelatine, using a laser pen (using diluted milk). You will then treat milk with acid to disrupt its molecular nanostructure and induce aggregation. You should wear safety glasses and gloves during the entire experiment.

STEP 1

WARNING: never shine a laser beam near the eyes nor look straight into the beam!! You must wear **safety glasses** when doing this test.

- Wear safety glasses

- Milk is a natural colloid but unlike gelatine it is not transparent. Pour 400 mL of milk in a beaker. Try to test it with a laser pen as you did with gelatine, can you see a path of scattered light?

……..

Now dilute milk. Take 150 mL of distilled water in a beaker or glass, and add 1-2 droplets of milk (using a pipette). Mix and let the solution stand for a couple of minutes (you don't want air bubbles). The solution will look pale-grey. Now test it again using the laser pen.

Can you see the path of scattered light?.....

Q3. Based on your visual observation, is milk a colloid?

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Q4. Milk owes its properties to the existence of casein micelles, which are nanostructures about 50-300 nm. Select from the images provided at the end of this worksheet the AFM image that you think corresponds to casein micelles. Paste the image here.

STEP 2

- Use the same beaker containing milk that you used in STEP 1. With the use of a pH paper, record the pH of skim milk (fill table provided in next page).

- Now place the same beaker containing milk on a hotplate, turn the hotplate on and warm the milk to about 60° C. If a hotplate is not available, the milk can be heated using water that has been boiled separately and poured into a water bath container. Your teacher will instruct you on how to warm up the milk.

STEP 3

- To the hot milk (about 60° C) add 2 tablespoons of white vinegar and stir well as you do so. Remember that the beaker will be hot! What happens? Record your observations in the table provided. Record the **pH of the liquid** (in the table provided). **Safety note**: You should not taste aggregated acid-milk!

STEP 4

- Repeat the test but without heating the milk. Take a clean beaker and add another sample of 400 mL of cold milk. Without heating, add 2 tablespoons of white vinegar and stir. What happens? Record your observations in the table provided. Record the **pH of the liquid** (fill the table provided below):

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Milk before test: pH…..			
	Temperature of Milk	**Effect of adding vinegar**	**pH**
TEST 1			
TEST 2			

Q5. Was there a clear difference in adding vinegar to warm milk or cold milk? If yes, describe.

……

……

Q6. Based on the results of the test of adding vinegar to warm milk or to cold milk, do you think the reaction that takes place is entirely an acid-base reaction? Explain.

……..

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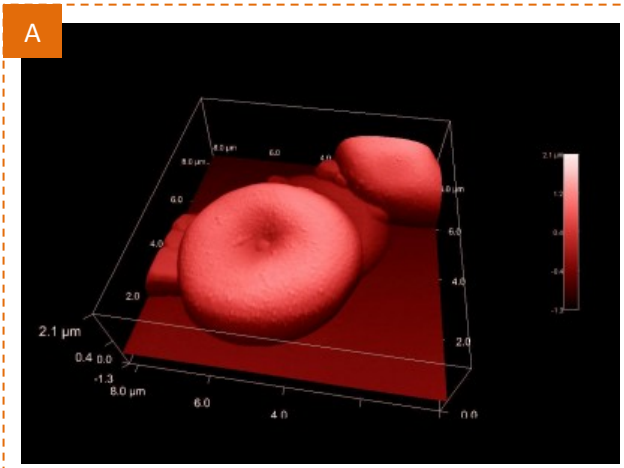
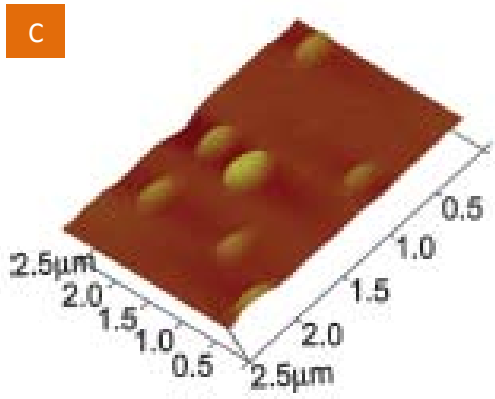
Images for question Q4: Cut out the image you think is the right one and paste it in the space provided in Q4.

A

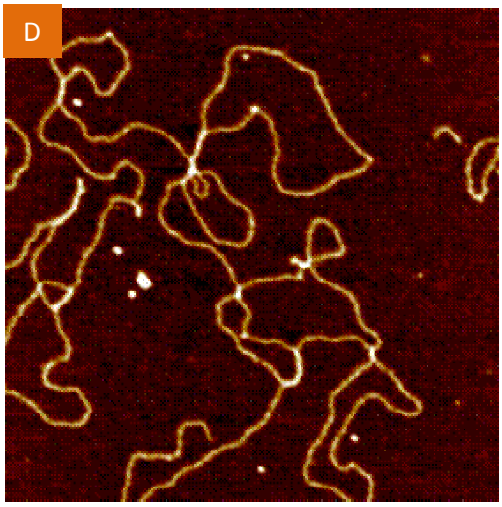


B

C



D



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