Make stringy DNA molecules visible

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Aims of the GP

The aim of this simple experiment is to provide the students with an introduction to DNA and the procedures that are used in molecular biology. Often, the techniques used in modern microbiology laboratories are based on simple operations like this one. Students normally find extracting their own DNA interesting and exciting.

Teaching material

This lab can be realized with minimal laboratory equipment.

- Micropipettes are not required but can be used to transfer liquids. Instead, you can use normal plastic transfer pipettes for all the liquid measurements. (Suggestion: one pipette per student and four per workstation).
- A refrigerator to cool down 250 ml of 91% isopropanol or 95% ethanol for all students.
- A container of ice, a water bath (a pot with 500 cm^3 water), *circa* 40 ml of liquid detergent, a thermometer set at 50 °C, permanent markers, *circa* 5g salt/100 ml sterile water. Pineapple juice -3 ml.
- The teacher prepares aliquoting of solutions for each student workstation (4 students/station):

  1 micro test tube with 5 ml of detergent (shampoo with EDTA), 1 ml per student.

  4 micro test tubes labelled “liquid detergent” (1 ml per student).

  1 micro test tube labelled “salt”, containing 500 µl of salt (125 µl per student).

  1 micro test tube labelled “prot” containing 400 µl of pineapple juice (100 µl per student). (Optional) If you have a chemical protease, it is better.

  All tubes are in a foam micro-test tube holder.

  A beaker with 3 ml sterile water (per student).

  4 empty 15 ml test tubes (1 per student).

4 plastic Pasteur pipettes or syringes without needles, with the possibility of measuring volumes of liquids.

Pupils can prepare foam holders before the lesson.

Teacher's station

A water bath at 50°C (pot with 50 °C hot water). An ice-cold bottle (container of ice). 250 ml of 91 % isopropanol or 95 % ethanol on ice, or in the refrigerator (8 ml per student). Alcohol is best left in the refrigerator overnight; if you do not have access to a refrigerator, chop ice into deep bowls and place the alcohol on top of it. Note: The teacher should be the only one to handle the alcohol and should help the students to pour it into their tubes.

Age of the students

11-18 years

Preparation and teaching time

90 min

Experiment instructions

Groups of four students will work as a team with a micro tube containing the lysis buffer (EDTA shampoo), a micro tube containing pineapple juice (proteases) and a tube of salt solute in water. In addition, they should each have a 15 ml tube for extracting DNA. They should label them with their initials using a permanent marker.

For about 1 minute they should chew the foam micro tube held against their cheek and with their teeth try to collect as many cells as possible from inside the mouth. Then they must rinse their mouths with sterile water and spit out all cells/material into the empty 15 ml tube. They should use the plastic pipette to add 1ml of liquid detergent very gently, trying not to make bubbles. Add pineapple juice at the same time (a few drops). Then students should place their 15 ml test tubes in the foam micro-test tube holder and incubate it in 50°C water for 10 minutes.

To remove the tubes from the water bath use a plastic transfer pipette. They should add about 2 drops from the tube labelled "salt" (previously diluted in a water) into the tube containing their cell extract.

It is necessary to cover the tube and gently invert 5 times to mix. Then they obtain a plastic transfer pipette and will fill it with cold alcohol (about 10 ml). It is necessary to pour the alcohol into the glass very slowly and down the side of the glass at a 45° angle so that it forms a separate layer on top of the cell

mixture. Fill nearly to the top. Slowly inverting the tube 5 times during 3 to 5 minutes they observe what happens. They should see white fluffy clouds of DNA floating in the mixture. This means they have extracted DNA successfully and can see what DNA looks like to the naked eye. Note that there is a lot of DNA present, which is why it can be seen, but scientists normally work with many fewer cells. The DNA will look white and stringy. This is called precipitation. At the end, with a transfer pipette, students gently withdraw their precipitated DNA along with about 500 µl of alcohol solution and transfer it into the screw cap tube. They can take home their own genetics information as a visible structure.

Questionnaire

Why can't you see the double helix?

- It is too small to be seen with the naked eye.
- The helix is broken during the observation.
- DNA is dissolved into the cytoplasm during the observation.

Why do we add a lysis buffer to cells?

- To achieve the rupture of cell membranes.
- To remove debris.
- To make DNA structure visible.

What does the salt do?

- It achieves the rupture of cell membranes.
- It provides the DNA with a favourable environment.
- To make DNA structure visible.

What do you think will help the detergent break open the cell?

- Warm water.
- Cold water.
- Proteases.

Is there the same amount of DNA in all human cells?

- Yes / No

Select the appropriate pair

- Lipid - DNA.
- DNA – chromosome.
- Breaking of membrane - alcohol.

A human cell contains

- A cell wall.
- Vacuoles.
- A nucleus coated by cell membrane.

Arrange the procedure in the lab according to the chronological arrangement.

1. Precipitation. 2. Disruption of cell membranes. 3. Collection of cells.

Teacher reviews

This GP is very important for the students, as according to the Portuguese teacher “laboratory activities are of utmost importance for understanding the content and this GP was particularly attractive: the mystery involved in making invisible DNA visible, research, problem solving and understanding of contents”. The fact that students have to extract their own DNA was very motivational for them, but in a few cases in Belgium parents were not willing to let their children extract their own DNA. In this case the teacher decided to extract DNA from a kiwi with the students, which was equally interesting. In general, as mentioned by the Slovenian teacher, the students “were fascinated by the fact that DNA molecules are unique in the living world, and it doesn’t matter what kind of cells they use for the isolation, kiwi, banana, tomato or human epithelia cells”.

The SPICE project

SPICE was a two-year project (December 2009 – November 2011) carried out by **European Schoolnet** (http://europeanschoonet.org) together with **Direção Geral de Inovação e Desenvolvimento Curricular** (http://sitio.dgidc.min-edu.pt/Paginas/default.aspx) from Portugal and **Dum Zahranicnich Sluzeb MSMT** (http://www.dzs.cz/) from the Czech Republic.

The primary objective of the SPICE project was to collect, analyse, validate and share innovative pedagogical practices, particularly those using inquiry-based learning, whilst enhancing pupils' interest in the sciences. SPICE supported this objective by singling out, analysing and validating good practice pedagogies and practices in maths, science and technology (mostly ICT-based) and disseminating them across Europe. SPICE involved 24 teachers from 16 different educational systems (from 15 different countries). This teachers’ panel helped the SPICE partners in defining good practices that were then tested in classes by 41 teachers during the school year 2010-2011.

For more information see: **http://spice.eun.org**

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