Extraction of DNA from Strawberries

Keywords: Biochemistry, Biology, Chemistry, chromosomes, DNA, extract

Meta Description

To study DNA, scientists just like you have to first extract it from the cells. This experiment allows you to extract DNA from strawberries and investigate it.

Learning Objectives

This experiment allows you to extract DNA from strawberries and to visualize the DNA strands using nothing but the naked eye.

To review the main steps involved in DNA extraction and the chemistry involved in each step.

Key Terms

DNA
Hereditary material in all living organisms. It controls the development and also the functioning of all living organisms.

Chromosomes
These are thread-like structures in which DNA strands are tightly bound to histone proteins.

Histones
These are proteins that allow for the tight packaging of DNA.

Proteins
Proteins are biomolecules consisting of amino acids linked by peptide bonds. Proteins are the primary components in many of the structures located in the body.

Polar
Refer to molecules possessing an overall charge (dipole moment).

Nonpolar
Refers to molecules possessing no overall charge.

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Method

Step 1
Place the alcohol in the freezer.

Step 2
Prepare the extraction mixture by placing ½ a teaspoon of salt, ? cup of water and 1 tablespoon of dishwashing detergent in a glass.

Step 3
Place 2-3 strawberries in the resealable plastic bag.

Step 4
Start pounding on the plastic bag using your hand or by hitting the bag continuously against a hard surface until a pulverized mixture is obtained.

Step 5
Now add about 3 tablespoons of the extraction mixture in the bag containing the mushy strawberries and mix the mixture using your hand.

Step 6
Place the coffee-filter in a funnel and placed it on top of a glass.

Step 7
Pour the mixture containing the strawberries and the extraction mixture into the funnel.

Step 8
Collect the filtrate in the small glass, when the liquid has finished filtering, remove the funnel.

Step 9
Tilt the glass gently, taking care not to spill anything, and pour the rubbing alcohol down the side to form a layer on top of the strawberry mixture.

Step 10
Allow the contents to settle for 10-15 minutes.

Step 11
A white clumpy, stringy layer forms between the two layers.

Step 12
Use the tweezers to gently pull this stringy layer which is the DNA.

Alternative Method

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This experiment can be used for all living things, since all living organisms contain DNA. Therefore be creative and try the experiment out with different fruits and different vegetables.

Instead of a coffee filter, cheesecloth can be used.

Instead of a small glass, a test tube can be used as an alternative container if you are conducting the experiment in a lab.

Precautions

There are certain health risks associated with Rubbing Alcohol, hence it is advisable to wear gloves, a lab coat/apron and safety goggles for this experiment.
http://www.sigmaaldrich.com/catalog/substance/isopropylalcohol60106763011?lang=en&region=MT

The use of an apron/lab coat for this experiment is also advisable since the experiment can get a little bit messy.

Another handy piece of advice is to keep paper towels near by.

In case of strawberry allergy, other food can easily be used for this experiment.
http://www.healthline.com/health/strawberry-allergy

Narrative

Imagine that you have captured a supervillain and you want to use his superpower to help mankind. To do this you have to first isolate their DNA, so that you can obtain his genetic code and see what genetic mutation gives them their unique gift. However, first you have to practice extracting DNA and thus, you are going to perform DNA extraction on a common household fruit, a strawberry.

Questions

What is DNA?

Hereditary material found in all living cells.

Is DNA found in all organisms?

Yes

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Is DNA found in dead bodies?

Yes, as long as the cells are not lysed or degraded.

Why do we crush the strawberries?

To break up cell walls.

Why do we use salt?

So that DNA strands aggregate together.

Why do we use detergent?

Causes DNA to move out from nucleus.

Why do we use alcohol?

So that DNA can precipitate since it is insoluble in alcohol.

Why is alcohol kept in the freezer?

The colder the alcohol, the greater the precipitation of the chromosomes.

Brief Explanation

All living organisms are made up of cells. Cells contain structures which perform specific tasks such as the removal of waste and reproduction. Within each cell there is a nucleus and this is the control center. It is capable of controlling all of the cellular activity within the cell by regulating the production of proteins.
The nucleus holds the genetic information of the cell, its DNA. DNA is the instruction guide from which all the necessary proteins can be made and tells the cell how it should function.

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DNA can be compared to a food recipe since it contains all the instructions necessary to construct other components present in the cell.
http://wikieducator.org/Lab:_DNA_extraction

DNA together with special proteins construct chromosomes. Normally these chromosomes cannot be seen by the naked eye, however, in this experiment, the chromosomes are made visible through the use of salt which clumps the DNA strands together.

In this example, we are extracting the DNA from a strawberry. Crushing the strawberries breaks apart the plant matter and releases, allowing access to the cells within. Dishwashing detergent is added as this breaks down any proteins which are capable of destroying the DNA and since the dishwashing detergent is hydrophobic (non-polar) it dissolves the hydrophobic (non-polar) cell membrane, so we can now get access to the cell's nucleus. (Remember: Like dissolves like, therefore non-polar dissolves non-polar) This allows the DNA to escape from the cells.
http://www.towson.edu/fcsm/centers/stem/loanerlab/documents/meischers-manual.pdf

After we add the extraction mixture to the strawberry pulp, the solution is filtered using a coffee filter. This removes the large cell fragments which are not required for this experiment.
http://wikieducator.org/Lab:_DNA_extraction

We then carefully ass alcohol, creating a layer on top of our solution. Since DNA is non-polar and the alcohol is polar the DNA is precipitated within this layer. (Remember: Like dissolves like) The alcohol used was cooled before we started the experiment, this allows for greater precipitation of the chromosomes.

This is a very important process in biochemistry and many other subjects. It is often the first process used in order to diagnose certain diseases.
http://serc.carleton.edu/microbelife/research_methods/genomics/dnaext.html

Detailed Explanation

In this experiment, DNA extraction was performed. DNA extraction can be simply described as the removal of the DNA from the cells (or viruses) in which it is located.
http://serc.carleton.edu/microbelife/research_methods/genomics/dnaext.html

DNA, short for deoxyribonucleic acid is the hereditary material in all living organisms. Most of the DNA is located inside of the nucleus, a membrane-bound organelle found in eukaryotic cells. The nucleus is a highly specialized organelle that serves as the information processing and administrative center of the cell. https://micro.magnet.fsu.edu/cells/nucleus/nucleus.html It functions in regulating the protein synthesis in the cytoplasm.

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In the nucleus, the DNA is compacted into thread-like structures called chromosomes. Chromosomes are made of DNA tightly wound around histone proteins.
https://ghr.nlm.nih.gov/primer/basics/chromosome
Chromosomes are invisible to the naked eye however in this experiment through the use of salt, the chromosomes become visible.

The strawberries are crushed to break up the cell walls. A detergent that contains sodium laurel sulfate is added (this is a compound that is responsible for the cleaning of dishes in order to remove the sticky fats as well as proteins). The detergent used in the extraction solution dissolves the lipids located in the membranes of the cells and releases the DNA from the nucleus. This is because cell membranes are made up of a lipid bilayer and as lipids are non-polar they dissolve in the non-polar detergent.

The released DNA contains charged phosphate groups, which polarises the molecules in the water. When the salt is added to the water, the salt dissociates into its constituent sodium ions and chloride ions. The positively charged sodium ions neutralize the negatively charged phosphate molecules of the DNA molecules. This causes the DNA strands to clump to each other.

The filtration process is done in order to remove the excess plant matter which is not required. The filtrate contains the DNA strands.

The addition of the alcohol causes the DNA strands to precipitate out. This occurs since the alcohol is overall polar, due to the polar -OH group. As the DNA being nonpolar, as it was neutralized, it precipitates out. As “like dissolves like” the polar alcohol does not dissolve the nonpolar DNA strands. http://wikieducator.org/Lab:_DNA_extraction

DNA extraction is pivotal in biotechnology. It is an early step in the process of diagnosis of certain diseases and also certain genetic conditions. DNA extraction is also needed for carrying out forensic science and the sequencing of genomes.
http://www.whatisbiotechnology.org/science/extraction

Applications and Research

Applications

DNA extraction is a routine procedure used to isolate the DNA from the nucleus of the cells. The extracted DNA can then be used for molecular analysis such as PCR and cloning.
https://www.sciencelearn.org.nz/resources/2036-dna-extraction

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Applications

DNA extraction is necessary before PCR can be initiated since PCR works on isolated DNA. PCR is short for polymerase chain reaction and it is used in order to create millions of copies of a specific section of DNA in a relatively short period of time. PCR is used for the diagnosis and monitoring of certain diseases such as tuberculosis.
https://molecular.roche.com/innovation/pcr/what-is-pcr/

Applications

Before DNA fingerprinting can be performed, DNA extraction has to be carried out. DNA fingerprinting is a laboratory technique that allows the linking between biological evidence and a suspect in a criminal investigation. It is also used for paternity testing.
https://geneed.nlm.nih.gov/topic_subtopic.php?sid=38

Research

Interesting research that was carried out in the year 2015 showed an innovative idea for the isolation of DNA from commercial olive oils. This is of great concern for the institutions and private industries due an increase in number of fraud and adulterations attempt to the market products.
http://www.sciencedirect.com.ejournals.um.edu.mt/science/article/pii/S0308814614014770

Research

A year later, an interesting paper was published in Food Chemistry which featured a fast method for DNA extraction from fresh as well as processed seafood without any purification steps. The fast DNA amplification allows for a fast processing of samples and thus any investigations on seafood can quickly be carried out.
http://www.sciencedirect.com.ejournals.um.edu.mt/science/article/pii/S0308814616302680

Investigation

DNA is found in all living cells. You can prove this by performing the experiment using different DNA sources such as banana, meat etc. However, do take note that different food sources require some modification in the methodology used.

It is important to question everything in science. Hence, why not question the different substances used in order to extract the DNA. Change the detergents used and see if the experiment performed better if it even works.

You can investigate also at which concentration of alcohol, the experiment works best i.e. at which concentration the greatest amount of DNA can be isolated.

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Subjects

Biology
Chemistry

Education

Secondary
Post Secondary

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Time Required

Few hours
Preparation: 30 mins
Conducting: 1 hr
Clean Up: 15 mins

Cost

10 – 25 €

Recommended Age

10 – 12
13 – 16

Number of People

4 participants

Supervision

Required

Location

Indoors
Outdoors
Festivals
Laboratory

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Materials

Alcohol
Strawberries
Rubbing alcohol
Dish detergent
Salt
Water
Resealable plastic bag
Coffee filter
Glass
Tweezers
Spoon
Measuring cups and spoon

Contributors

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Sources

Classroom Activities in Plant Biotechnology

http://www.apsnet.org/edcenter/K-12/TeachersGuide/PlantBiotechnology/Pages/Activity1.aspx

Meischer's Discovery
A DNA Extraction Laboratory

http://www.towson.edu/fcsm/centers/stem/loanerlab/documents/meischers-manual.pdf

DNA extraction

http://wikieducator.org/Lab:_DNA_extraction

DNA extraction

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https://learn.genetics.utah.edu/content/labs/extraction/

DNA Extraction-Microbial life

http://serc.carleton.edu/microbelife/research_methods/genomics/dnaext.html

Extract DNA from a Strawberry at Home – Cool Science Experiment

What is DNA and How Does it Work?

DNA Structure for Kids

What are Chromosomes?

Strawberry DNA Extraction

Additional Content

Biology for Kids-DNA and Genes (Beginner)

Reproduction, the genome and gene expression (Intermediate)

DNA could store all of the world's data in one room (Expert)

Cite this Experiment

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