

**Title: Dr. Rosalind Franklin and DNA****Author:** Tanja Smith**Grade Level:** 10<sup>th</sup> grade**Lesson Source:** Brenda Maddox's book: *Rosalind Franklin: The Dark Lady of DNA*, Mrs. Katie Donaldson, and [http://gemsclub.org/yahoo\\_site\\_admin/assets/docs/StrawberryDNAExtra.4395135.pdf](http://gemsclub.org/yahoo_site_admin/assets/docs/StrawberryDNAExtra.4395135.pdf)**Texas Essential Knowledge and Skills (Process TEKS):**

(1) Scientific processes. The student, for at least 40% of instructional time, conducts laboratory and field investigations using safe, environmentally appropriate, and ethical practices. The student is expected to:

(A) demonstrate safe practices during laboratory and field investigations; and

(B) demonstrate an understanding of the use and conservation of resources and the proper disposal or recycling of materials.

(2) Scientific processes. The student uses scientific methods and equipment during laboratory and field investigations. The student is expected to:

(F) collect and organize qualitative and quantitative data and make measurements with accuracy and precision using tools such as calculators, spreadsheet software, data-collecting probes, computers, standard laboratory glassware, microscopes, various prepared slides, stereoscopes, metric rulers, electronic balances, gel electrophoresis apparatuses, micropipettors, hand lenses, Celsius thermometers, hot plates, lab notebooks or journals, timing devices, cameras, Petri dishes, lab incubators, dissection equipment, meter sticks, and models, diagrams, or samples of biological specimens or structures;

(H) communicate valid conclusions supported by the data through methods such as lab reports, labeled drawings, graphic organizers, journals, summaries, oral reports, and technology-based reports.

(3) Scientific processes. The student uses critical thinking, scientific reasoning, and problem solving to make informed decisions within and outside the classroom. The student is expected to:

(D) evaluate the impact of scientific research on society and the environment;

(E) evaluate models according to their limitations in representing biological objects or events; and

(F) research and describe the history of biology and contributions of scientists.

**Texas Essential Knowledge and Skills (Concept TEKS):**

(6) Science concepts. The student knows the mechanisms of genetics, including the role of nucleic acids and the principles of Mendelian Genetics. The student is expected to:

(A) identify components of DNA, and describe how information for specifying the traits of an organism is carried in the DNA;

### **Concepts Statement:**

This lesson is one in a series of lessons about women in science that will emphasize the relatedness of all the disciplines, physics, chemistry, biology, geology, astronomy, and the common language of science, mathematics. This lesson plan concentrates on the biochemist Dr. Rosalind Franklin and contains a lab for the extraction of DNA from strawberries. Performing the lab will help students understand the kind of material that Dr. Franklin had to work with to take her photographs that were so important to discovering the double helical nature of DNA. Students will learn about the contributions of Rosalind Franklin and her tenacity at following the scientific method. Students will observe first hand that DNA is in the food that they eat. Students will learn the simple method to extract DNA and why each step is necessary due to the complex organization of DNA in cells. Students will learn why it is important for scientist to extract DNA from organisms. Strawberries are an exceptional fruit to use for this lesson because each individual student is able to complete the process by themselves and strawberries yield more DNA than any other fruit (i.e. banana, kiwi, etc.). Strawberries are octoploid, meaning that they have eight copies of each type of chromosome.

### **Objectives:**

Students will be able to:

- ✓ Recognize the accomplishments of Dr. Rosalind Franklin and her role in the discovery of the structure of DNA;
- ✓ Compare Dr. Franklin's accomplishment to other women scientists already covered in previous class discussions;
- ✓ Identify and label a plant cell with chromatids, nuclear membrane, cell membrane, and cell wall;
- ✓ Explain simple DNA extraction, using terms emulsifiers and proteases;
- ✓ Examine DNA in its hydrated form just like Dr. Franklin.

### **Appropriateness of Lesson to the Grade Level:**

Students work in groups.

### **Materials List:**

6 -Sandwich size re-sealable bags  
Detergent solution  
6 - Funnels  
6 bottles of Ice cold 100% ethanol

12 Strawberries  
12 - 150 mL Beakers  
6 - Coffee filters  
6 - Glass rods or wooden skewers

### Advanced Preparations:

The teacher will prepare the detergent solution:

100mL Dawn detergent

900 mL of water

10 g salt

The teacher will also prepare six stations for student groups to perform lab. Each station will have one sandwich size re-sealable bag, two strawberries, two 150 mL beakers, one funnel, one coffee filter, and four glass rods or wooden skewers.

The teacher will obtain one cooler of ice to cool six bottles of 100% ethanol.

### Safety:

The teacher will instruct students to wear gloves and goggles and use caution when pouring ethanol. Care must be taken to not inhale fumes. The teacher will instruct students to not consume anything from the lab. Any glassware must immediately be reported to the teacher. Glassware precautions must be in place and all broken glassware disposed of in the appropriate container.

ENGAGEMENT		Time: <u>5</u> Minutes
What the Teacher Will Do	Probing/Eliciting Questions	Student Responses and Misconceptions
The teacher will say, "Good morning, students. Let's review and have some fun learning in class today."	What types of molecules make up cell membranes and walls?	Phospholipids, lipids, lipid bilayer.
	Is the nuclear membrane composed of lipids?	Yes.
	What is a lipid?	A fatty molecule.
	Can you think of anything that is great at breaking down fats?	Soap!
The teacher will say, "We are going to continue our section about women in science. Today we will talk about Dr. Rosalind Franklin and the structure of DNA."	Does anyone know who discovered the structure of DNA?	Watson and Crick, Wilkins and Franklin, I don't know.
The discovery of the structure of DNA was made in 1953. There were a lot of theories and definitive proof was needed.	How do you think the structure was revealed?  What science background	Special photography, x-rays, chemical analysis, mathematics.

<p>Dr. Franklin was able to manipulate a crystalline sample of DNA and obtain a photograph using a very special camera and x-ray crystallography.”</p>	<p>would you need to have to solve the problem of DNA structure? Why?</p>	<p>Biology, because DNA is a biological molecule, chemistry so you can figure out how molecules would be arranged and interact, physics so you can take exact measurements.</p>
<p>Let’s think about x-ray crystallography when we complete our lab.</p>	<p>What do you think x-ray crystallography is?</p>	<p>I don’t know.</p>

<b>EXPLORATION</b>		<b>Time: <u>  15  </u> Minutes</b>
<b>What the Teacher Will Do</b>	<b>Probing/Eliciting Questions</b>	<b>Student Responses and Misconceptions</b>
<p>Our lab will be a DNA extraction from strawberries. We will not be able to see the actual helix structure, but we will examine the substance that Dr. Franklin had to work with. Strawberries are soft and easy to pulverize. Strawberries have large genomes; they are octoploid. Thus, strawberries are an exceptional fruit to use in DNA extraction labs because they contain such a large amount of DNA. We will put the strawberries in a baggie, add some detergent solution, strain the mixture, carefully add some ethanol and look at DNA. DNA is not soluble in ethanol. The colder the ethanol, the less soluble the DNA will be in it. So we must make sure to keep the ethanol in the freezer or on ice.</p>	<p>If human germ cells are haploid and human somatic cells are diploid, what do you think octoploid means?</p> <p>Where is DNA located in the cell?</p> <p>Why do we need to use soap for the DNA extraction?</p> <p>Why is salt necessary?</p>	<p>They have eight of each type of chromosome in each cell.</p> <p>In the nucleus.</p> <p>The soap helps to dissolve the phospholipid bilayers of the cell membrane and organelles</p> <p>The salt is used to break up protein chains that bind around the nucleic acids.</p>
<p>When you add ethanol to the strawberry extract, you will see the fine white strands of DNA precipitate. The DNA will form cotton like fibers that will spool onto the stirring rod. Let’s break into our groups</p>	<p>Can you try to pull out a string of DNA? What do you see? Why are there bubbles?</p>	<p>It doesn’t look like much. Just looks like gooey stuff with bubbles.</p> <p>Because the ethanol is taking out the water from the DNA.</p>

and get started.		
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<b>EXPLANATION</b>		<b>Time: __ 15 __ Minutes</b>
<b>What the Teacher Will Do</b>	<b>Probing/Eliciting Questions</b>	<b>Student Responses and Misconceptions</b>
Rosalind Franklin was born in London, England in 1920 to a wealthy Jewish family.		
In 1935, a young Rosalind declares her desire to become a scientist.		
In 1941 she received a B.A. in Chemistry from Cambridge University.		
Miss Franklin earned a Ph.D. in physical chemistry from Cambridge University in 1945. Her thesis was based on her work on coal. She was working on finding the reason for why different types of coal have different sized pores. Her discoveries in coal aided the development of better gas masks for the war effort and were beneficial to commercial industries.		
In 1947, Dr. Franklin began X-ray crystallography work at a Parisian laboratory where she perfected her technique.		
She returned to King's College to continue her research in 1951.		
Scientists had known that there were two forms of DNA: the A form and the B form. In 1952, Dr. Franklin captured the "B" form of DNA with Photograph 51.		
Dr. Franklin worked as a Birkbeck research fellow from 1953 to 1958, working on the tobacco mosaic virus. There, she discovered the way that		

viruses invaded cells. Her work in virology was very important.		
In 1958, she published an article in Nature regarding the structure of DNA and Rosalind Franklin dies of ovarian cancer at age 37.		
The Nobel Prize was awarded to James Watson, Francis Crick and Maurice Wilkins for their DNA work in 1962. No mention of Rosalind Franklin was made, nor was she ever mentioned in the award process. Nobel prizes cannot be awarded post humously.		

<b>ELABORATION</b>		<b>Time: <u>  5  </u> Minutes</b>
<b>What the Teacher Will Do</b>	<b>Probing/Eliciting Questions</b>	<b>Student Responses and Misconceptions</b>
X-ray crystallography is a method of determining the arrangement of atoms within a crystal, in which a beam of X-rays strikes a crystal and diffracts into many specific directions. From the angles and intensities of these diffracted beams, a crystallographer can produce a three-dimensional picture of the density of electrons within the crystal. From this electron density, the mean positions of the atoms in the crystal can be determined, as well as their chemical bonds, their disorder and various other information.		

<b>EVALUATION</b>		<b>Time: <u>  5  </u> Minutes</b>
<b>What the Teacher Will Do</b>	<b>Probing/Eliciting Questions</b>	<b>Student Responses and Misconceptions</b>
The teacher will say, "Now that we have finished our lesson, let's take a short quiz and see		

what we learned. Please place your quiz in the basket before leaving class.		
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Include copies of one page evaluation and handouts if used.

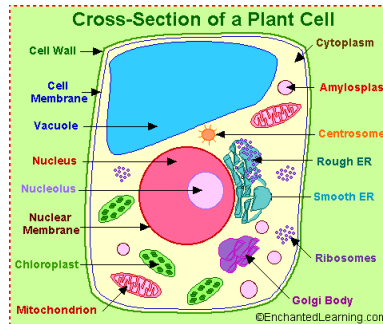
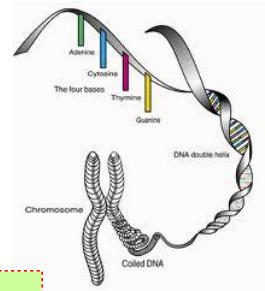
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### Incredibly Easy DNA Extraction from Strawberries

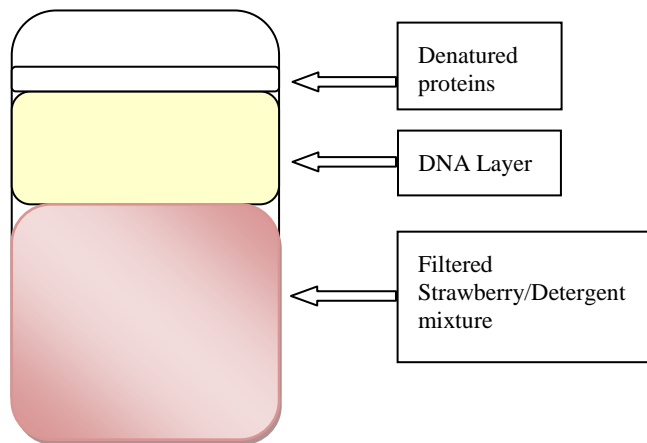
**Materials:**

- 6 -Sandwich size re-sealable bags
- 12 Strawberries
- Detergent solution
- 6 - 150 mL Beakers
- 6 - Funnels
- 6 - Coffee filters
- Ice cold 100% ethanol (keep bottle in freezer)
- 6 - Glass rods or wooden skewers



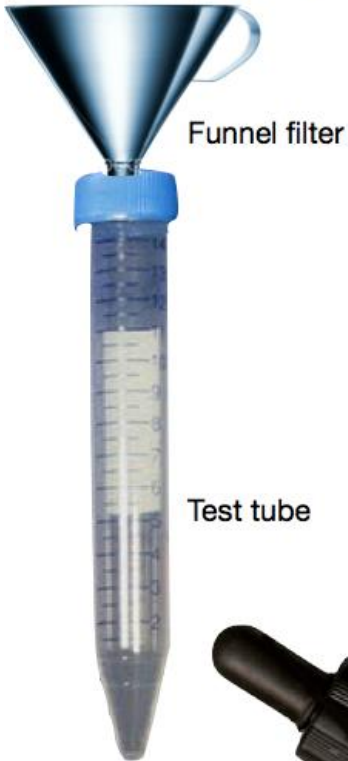
**Procedure:**

1. Place 2 strawberries in a re-sealable bag with 20mL of detergent solution.
2. Smash them into a liquid.
3. Put funnel into beaker and place a coffee filter in the funnel.
4. Put strawberry mixture into funnel and let it drip through the filter and into the beaker. If it is too thick, you can add a little more detergent solution.
5. Collect enough to fill the beaker about 1/2 full.
6. Gently pour a few mL of ice-cold ethanol down the side of the beaker. It will form a layer on the top. The DNA precipitates and forms a whitish stringy solid just below the alcohol layer.
7. Students can spool it out with a glass rod or wooden skewer.





**Step 3**  
Filter the solid parts  
of the strawberry  
from the DNA buffer



**Steps 1 & 2**  
Mash up strawberries in a  
ziploc bag and thoroughly  
mix with the DNA  
extraction buffer



Test tube

**Step 4**  
Carefully drip cold alcohol  
into the test tube with  
the eyedropper



Observe what  
happens at  
the line  
between the  
buffer and the  
alcohol!



Name: \_\_\_\_\_

Date: \_\_\_\_\_

Dr. Rosalind Franklin and DNA

Post-Test

1. Strawberry DNA was collected by crushing the fruit and breaking down the lipid cell walls and nuclear membranes with \_\_\_\_\_.

2. What was in the detergent solution that helped to denature the proteins that hold the membranes in place? \_\_\_\_\_.

3. \_\_\_\_\_ is added to the filtered fruit mixture in order to remove water from solution. DNA is not soluble in \_\_\_\_\_ and will begin to come out of solution.

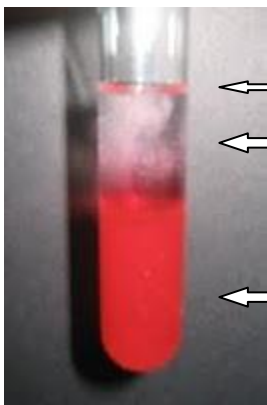
4. Dr. Rosalind Franklin's work was instrumental in discovering the \_\_\_\_\_ of DNA.

5. What three scientific disciplines did Dr. Franklin use to come to her discovery in DNA?

a. \_\_\_\_\_ b. \_\_\_\_\_ c. \_\_\_\_\_



Please label the drawings below:



\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

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