**Strawberry**

**DNA Extraction**

**TEACHER’S MANUAL AND STUDENT LABSHEET AND WORKSHEETS**

C:\Documents and Settings\dbassett\Local Settings\Temporary Internet Files\Content.IE5\J5AAWQB1\MC900278848[1].wmf

C:\Documents and Settings\dbassett\Local Settings\Temporary Internet Files\Content.IE5\5XPPG90E\MC900411041[1].wmf

Adapted from

©2004 Carolina Biological Supply Company

Debra Bassett, Flint Community Schools, July 2014

**Strawberry DNA Extraction**

**TABLE OF CONTENTS**

Teacher’s Manual

Overview . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .. . . 3

Objectives . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .. . 3

Materials . . . . . . . . . . . . . . .. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .. . . 3

Classroom Options . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . ………….. 4

Background Information . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .. . . 4

Introductory Discussions. . . . . . . . . . . . . . . . .. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .. ... 7

Lesson Instructions . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .. . . . . . . . . . . 10

Questions for Discussion. . . . . . . . . . . . . . . . . . . .. . . . . . . . . . . . . . . . . . . . . . . . .. . . . . . . . . . . 12

Follow-Up Activities . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .. . . . . . . . . . .. 12

Learning Assessment Questions . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .. . . . . . . . . . . 13

Glossary . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .. . . . . . . . . . . . . . . . . . . . . . . . . ... . . . . . . . . . 13

**Photocopy Masters**

Student Instructions . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . …. . .. . . . . . . . S–1

DNA Extraction Review. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . …. . . . . . . . . . S–2

Plant Cell Diagram . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . … . . . . . . . . . S–3

.

This kit has been developed in collaboration with the Dolan DNA Learning Center,

Cold Spring Harbor Laboratory. The activities have been tested by teachers and students

participating in DNALC hands-on workshops and was adapted for use by the Flint Community Schools, July 2014

T e a c h e r ’ s M a n u a l **2**

**Strawberry DNA Extraction**

***Overview***

This kit provides teachers with the information, instructions, and materials

needed to introduce middle school students to the concept and process of

plant DNA extraction. Students will learn what DNA is, how it is structured

and contained within cells, and how it can be removed from cells. They will

use hands-on scientific procedures to break through the barriers of a plant cell

and isolate and observe actual DNA molecules from strawberry fruit.

Assessment questions and follow-up activities are included, as is a glossary of

important terms. This kit accommodates up to 32 students working in pairs.

***Objectives***

• Understand how DNA is contained within different cells

• Understand cell wall and cell membrane composition

• Understand how cell barriers are broken and how to extract DNA from

strawberry cells

***Materials***

*Included in the kit:*

* 17 50-mL tubes with lids and bases
* 33 15-mL tubes with lids
* 16 re-sealable plastic bags
* 16 wooden sticks
* 16 funnels
* 1 pack of cheesecloth
* 16 transfer pipets
* 1 bottle of ethanol, 95% (100 mL)
* 1 bottle of liquid detergent
* 10 g salt (sodium chloride, NaCl)

*Needed, but not supplied:*

* scissors for cutting cheesecloth
* container (400-mL capacity or more) for mixing extraction buffer
* 16 transfer vessels (5-mL capacity or more) for 95% ethanol
* 16 ripe, whole strawberries (fresh or frozen)
* 380 mL of water
* graduated cylinder or other device for measuring water
* freezer, refrigerator, or bucket of ice for chilling 95% ethanol
* spool of thread for demonstration

T e a c h e r ’ s M a n u a l 3

S t r a w b e r r y D N A E x t r a c t i o n

***Classroom Options***

This DNA extraction activity has been designed for a class of 32 students

working in pairs. For smaller classes, students may work independently. For

larger classes, students can work as groups and be assigned different roles, such

as Strawberry Masher, Solution Handler, DNA Spooler, etc.

***Background Information***

**DNA is the “Code of Life”**

**Deoxyribonucleic acid (DNA)** can be considered the hereditary “code of life”

because it possesses the information that determines an organism’s traits and is

transmitted from one generation to the next. DNA can be compared to a

recipe or a list of instructions about how to create and maintain a specific

living thing. The DNA in an individual’s cells contains unique genetic

instructions about how to make and operate that individual.

DNA can be removed from organisms through a common and useful scientific

procedure called **DNA extraction**. In order to understand this process, it is

useful first to identify the basic structures that hold DNA molecules within

living things.

**Cells Contain DNA**

DNA is located inside the cells of all species. However, different organisms are

made up of different types of cells. Members of the Animal, Plant, Protist

(algae, amoebas, paramecia, etc.), and Fungi (mushrooms, yeasts, molds, etc.)

kingdoms are comprised of **eukaryotic cells**. This means that these cells have

a true **nucleus**, a membrane bound **organelle** within which the DNA is

contained. The nucleus of eukaryotic cells is the “control center” that directs

all cellular activities. Members of the kingdom Monera (bacteria and

cyanobacteria) are comprised of **prokaryotic cells** that do not have nuclei. In

these cells, DNA exists as a long loop coiled loosely within the cytoplasm of

the cell.

The nucleus of eukaryotic cells is surrounded by a **nuclear membrane** (also

called a nuclear envelope) and the entire cell is bound by a **cell membrane**

(also called a plasma membrane). These barriers are both made up of two

layers of fatty, oily compounds called **lipids**. The most abundant types of

membrane lipids are **phospholipids**. These molecules have hydrophilic

(“water-loving”) heads linked by a phosphate group to two hydrophobic

(“water-hating”) tails. The formation and stability of cell membranes is based

on the orientation of phospholipid molecules in an aqueous (watery)

environment. In such surroundings, phospholipids form a barrier of two rows

with their hydrophobic tails facing each other (away from water) and their

hydrophilic heads pointed outward (in contact with the aqueous

environment). This two-layered structure is known as a **phospholipid bilayer**

(see Figure 1). Protein and carbohydrate molecules are also imbedded within

the phospholipid bilayer of cell membranes to transport particular molecules

into and out of the cell, and to conduct cellular messages.

T e a c h e r ’ s M a n u a l  **4**

S t r a w b e r r y D N A E x t r a c t i o n

All eukaryotic cells have a nuclear membrane that encircles the nucleus, as

well as a cell membrane that encases the entire cell. However, plant cells (and

some bacterial, fungal, and protist cells) have an additional barrier

surrounding the cell membrane called a **cell wall**. Animal cells do not have

cell walls. Plant cell walls are made of cellulose, which is a sturdy

polysaccharide material comprised of glucose units. Cellulose gives plants their

rigidity and provides a tough barrier that enables plant cells to hold a great

deal of fluid without bursting.

**Packaging and Structure of DNA**

The DNA of eukaryotic cells is about 100,000 times as long as the cells

themselves. However, it only takes up about 10% of the cells’ volume. This is

because DNA is highly convoluted (folded) and packaged as structures called

**chromosomes** within cell nuclei. A chromosome is a bundle of tightly wound

DNA coated with protein molecules. An organism’s chromosomes bunch

together within the nucleus like a ball of cotton, but during cell division

(mitosis) they become individually distinct (human mitotic chromosomes are

X-shaped) and can be observed as such with microscopes. DNA is not visible

to the eye unless it is amassed in large quantity by extraction from a

considerable number of cells.

When chromosomal DNA is unfolded and the proteins coating it removed,

the structure of DNA is exposed as a twisted ladder called a **double helix**. The

sides of the ladder form the DNA backbone with alternating sugar and

phosphate molecules linked by covalent bonds. The rungs of the ladder are

comprised of pairs of **nitrogenous bases** [adenine (A) with thymine (T) and

cytosine (C) with guanine (G)] joined by hydrogen bonds (see Figure 2).

Although the structure of DNA is well known and clearly defined, even the

most powerful microscopes cannot visualize the DNA double helix of

chromosomes.

****

**Figure 1.**

**Phospholipid bilayer**

**of cell membrane**

**5** T e a c h e r ’ s M a n u a l

S t r a w b e r r y D N A E x t r a c t i o n

All living things are dependent on DNA, and the structure of DNA is consistent among all species. However, the particular sequence of nitrogenous bases within DNA molecules differs between organisms to create explicit “blueprints” that specify individual living things. This sequence of base pairs is what makes an

organism an oak tree instead of a blue jay, a male instead of a female, and so forth.



**DNA Extraction From Plant Cells**

The DNA of a plant cell is located within the cell’s nucleus. The nucleus is surrounded by a nuclear membrane and the entire cell is encased in both a cell membrane and a cell wall. These barriers protect and separate the cell and its organelles from the surrounding environment. Therefore, in order to extract DNA from plant cells, the cell walls, cell membranes and nuclear membranes must first be broken. The process of breaking open a cell is called **cell lysis**. Physical actions such as mashing, blending, or crushing the cells cause their cell walls to burst. The cell membranes and nuclear membranes may then be disrupted with a detergent-based

extraction buffer. Just as a dishwashing detergent **dissolves** fats (lipids) to cleanse a frying pan, a detergent buffer dissolves the phospholipid bilayer of cell membranes. It separates the proteins from the

phospholipids and forms water-**soluble** complexes with them. Once the cell wall and cell membranes are degraded the cell contents flow out, creating a soup of DNA, cell wall fragments, dissolved membranes, cellular proteins, and other contents. This “soup” is called the **lysate** or cell extract. DNA molecules are then isolated away from the cell debris in the lysate. For this purpose, the detergent-based extraction buffer also includes salt. The salt causes some of the cellular debris in the soup to **precipitate** out of **solution**

while the DNA remains dissolved. This means that the cell debris become suspended particles that can be seen. The cell extract is then filtered through layers of cheesecloth. The cheesecloth traps the precipitated cell debris while the soluble DNA passes through. DNA is soluble in the aqueous cellular environment and in the presence of the extraction buffer, but is **insoluble** in alcohol (such as ethanol and isopropanol). Applying a layer of ethanol on top of the filtered lysate causes the DNA to precipitate out of the solution,

forming a translucent cloud of fine, stringy fibers at the point where the alcohol and cell extract meet. Cold ethanol works best to precipitate DNA to the fullest. DNA extracted from multiple cells is visible by eye and can be wound onto a wooden stick in a process known as “spooling” the DNA. Strawberry cells are excellent sources of DNA for extraction in the classroom. They are multicellular and octoploid. This means they have eight copies of their seven chromosomes in each of their many cells. Therefore, just one berry

will yield enough DNA to be easily seen and spooled. Strawberries are also a soft fruit, which makes them easy to mash. Mashing the berries breaks down the strawberry tissue, releases the individual cells, separates the seeds from the cells, and breaks the cell walls. In addition, ripe strawberries produce pectinase

and cellulase—enzymes that contribute to the breakdown of cell walls.

**Importance of DNA Extraction**

DNA extraction is a fundamental procedure in scientific laboratories around

the world. By extracting DNA, scientists can learn how DNA encodes the

instructions for all life processes. DNA extraction is important to the study of

heredity and to the treatment of many diseases through the creation of gene

therapy DNA molecules. Extracted DNA can also be used to create DNA

fingerprints to help diagnose genetic diseases, solve criminal cases, identify

victims of disaster and war, and establish paternity or maternity. Scientists can

genetically engineer changes in DNA to create robust, disease-resistant

genetically modified plants and animals. DNA extraction is also necessary in

order to sequence the DNA code (order of base pairs) of different organisms

(as in the Human Genome Project) and compare different species.

**Introductory Discussion**

Use the information in this section to facilitate class discussion and help

students understand concepts relating to DNA extraction. You may wish to

read aloud all or part of the following text, paraphrase the information, or ask

questions aloud and invite student responses. Refer to the Background

Information section as necessary. To enhance student comprehension during a

discussion of plant cells, photocopy the *Plant Cell Diagram* blackline master

from this manual and distribute copies to students. Alternatively, create an

overhead transparency of the diagram, present it to the entire class at once,

and have students draw the plant cell and label the cell parts themselves.

***What is DNA? What does it have to do with me?***

DNA encodes the molecular specifications that define an organism. It is the

hereditary information that determines the characteristics that make

something what it is. For example, our DNA controls the pigment color of our

skin. Each of our skin cells produces a specific amount of pigment (melanin

protein) according to the DNA recipe in our bodies. This is what makes our

skin colors different. *Can you think of any case where two people would have the*

*same DNA?* Identical twins are the only individuals who have the exact same

DNA code.

***Where is DNA found?***

Ask the students if they have ever eaten DNA. This may seem like a strange

question, but DNA is present in the cells of all living things. When we eat a

banana, for example, we are consuming cells from the banana, all of which

contain DNA!

T e a c h e r ’ s M a n u a l 7

S t r a w b e r r y D N A E x t r a c t i o n

Plants, animals, protists, and fungi are all made up of eukaryotic cells that have a nucleus encased by a nuclear membrane. In these cells, DNA is packaged within the nucleus. Bacteria and cyanobacteria are made up of prokaryotic cells. These types of cells do not have a nucleus. Instead, the DNA in prokaryotic cells is

found in a long loop coiled loosely throughout the cell’s cytoplasm.

***What does a plant cell look like?***

Distribute the *Plant Cell Diagram* handout to students (NOTE: you will need to number the organelles, etc. before making copies!!!) and, as the classroom discussion progresses, have them identify and label the cell membrane, the cell wall, the nucleus, and the nuclear membrane (refer to Figure 3, below). **Note:** This handout may be used as a quiz or a study sheet, and can be a useful tool for teaching more advanced cell structure lessons. We will be removing DNA from strawberry cells, so it will be helpful to

understand the structure of plant cells. All cells are surrounded by a cell membrane that protects and contains its contents, but plant cells have an *additional* barrier, called a cell wall, that surrounds the cell membrane. The cell wall gives plants their rigidity and strength. Animal cells do not have cell walls. *Where is the DNA located in a plant cell?* The DNA is located within the cell’s nucleus. Notice that the nucleus has a surrounding barrier, too, called the nuclear membrane. *What are the other structures within the plant cell?* The other structures are called organelles, or “little organs.” They all have different, specialized jobs within a cell, just like the “big” organs in our bodies have different jobs. *How many barriers must we break through in order to remove*

*the DNA from a plant cell, and what are they?* We must break through three barriers: the cell wall, the cell membrane, and the nuclear membrane.



T e a c h e r ’ s M a n u a l **8**

S t r a w b e r r y D N A E x t r a c t i o n

***What is “DNA extraction?” How will we break into the plant cells***

***of a strawberry?***

DNA extraction is the removal of DNA from the cells of an organism. In this

activity we will be removing DNA from the plant cells of a strawberry. Both a

cell wall and a cell membrane surround plant cells, and plant DNA is

contained within a membrane-bound nucleus. We need to use special means

to break these barriers. *What kind of tools or equipment would you use to remove a*

*wall in a building?* Encourage a variety of answers—hands, dynamite, a

hammer, a wrecking ball, a saw, and so on. *If you first knew what the wall was*

*made of (concrete, sheet rock, brick, paper, etc.) would it help you choose what tool*

*to use?* Yes. Before we can break cell walls and cell membranes, we should ask

the question, “What are cell walls and cell membranes made of?”

Plant cell walls are made of cellulose, which is a tough, insoluble material that

makes plants sturdy. It can be broken through physical actions. Think about

chewing on a carrot. Your teeth help to break open the cell walls of carrot cells.

In this activity, you will mash the strawberries to break through their cell walls.

Cell membranes and nuclear membranes are made up of phospholipid bilayers.

*What are lipids?* Think of the term “liposuction.” Liposuction is the removal of

fat by suction. “Lipo-” refers to fats, oils, and waxes. *What do we use in everyday*

*life that helps us to remove fats and greases from our clothes, hair, skin, or dishes?*

Detergents. You will treat the mashed strawberry cells with detergent to

dissolve their cell membranes and nuclear membranes. This causes the cell

contents and the DNA to be released.

***Once the cell barriers are broken, how will we get the DNA out?***

Once the cells are broken open, DNA and cell debris are mixed together.

However, the DNA is in solution. This means that the DNA is thoroughly

incorporated into the liquid (dissolved) and is not visible. *What happens when*

*you stir a teaspoon of sugar into a cup of water?* The sugar dissolves in the water.

It is still there; you just can’t see it. *What happens when you stir a teaspoon of*

*sand into a cup of water?* The sand does not dissolve in the water; it remains

separate from the water, and you can still see it. Like sand in water, a lot of the

cell debris is not in solution, because the salt in the extraction buffer caused it

to separate out. When the extract is poured through layers of cheesecloth,

much of the cell debris is filtered out and the DNA solution passes through.

DNA is insoluble in alcohol (such as ethanol and isopropanol). In order to

visualize the DNA, ethanol is poured over top of the filtered liquid. The DNA

then comes out of solution and is visible.

***What does DNA look like? What will we see?***

The structure of DNA is like a twisted ladder, forming what is called a double

helix. The sides of the ladder are sugar-phosphate groups joined by covalent

bonds and the rungs are nitrogenous bases joined by hydrogen bonds.

However, in order to package DNA within the nucleus of eukaryotic cells,

DNA is wound around protein molecules and tightly folded into

chromosomes. *Can we see DNA?* Yes and no. Chromosomes have been studied

using microscopes, but the double helix of unraveled chromosomes is so thin

that even the most powerful microscopes cannot detect it. *How will we see the*

*DNA we extract?* Chromosomal DNA from a single cell is not visible by eye.

T e a c h e r ’ s M a n u a l 9

When DNA is extracted from multiple cells, the amassed quantity is visible

and looks like strands of mucous-like, translucent cotton.

Perform this demonstration: Hold up a strand of thread to represent one single

strand of chromosomal DNA. Ask the students if they can easily see the

strand of thread. A single strand of thread is not easily visible by eye. Add

more strands of thread to create a bundle that is easily visible to the students.

This bundle represents multiple strands of chromosomal DNA. Using this kit,

DNA strands will be extracted from many strawberry cells, so that the strands

will be visible to the naked eye.

***Why is DNA extraction important, and what can it be used for?***

Have students brainstorm on this topic. Extracted DNA is used to sequence

the genomes of organisms, to study heredity and diseases, to create DNA

fingerprints, to genetically engineer crops, and more.

**Lesson Instruction**

**PREPARATION Before the Lesson**

• Chill the 95% ethanol by storing it in a freezer (preferred), refrigerator, or

on ice until use.

• If using frozen strawberries, allow the berries to thaw at room temperature

before use. Do not heat the strawberries to hasten thawing, as this will

hinder the DNA extraction process.

• Prepare 400 mL of DNA extraction buffer. Use one of the 50-mL tubes

(included) to measure 20 mL of detergent (included). Pour the detergent

into a container along with 380 mL of water and the entire contents

(10 g) of the salt pack (included). Stir to mix.

• 10 mL of extraction buffer into 16 15-mL tubes (the tubes are

calibrated for measuring) and SET ASIDE.

**DO NOT DISTRIBUTE THE EXTRACTION BUFFER (DETERGENT/SALT SOLUTION) TO THE STUDENTS**

**AND DO NOT TELL THE STUDENTS THAT THEY WILL BE USING THE DETERGENT**

• Prepare 16 5-mL aliquots of 95% ethanol in transfer vessels. An extra

15-mL tube is included for measuring out the 5-mL amounts.

• Unroll cheesecloth from the spool and cut 16 pieces approximately 6”

long. (The spool is about 8” wide, so each piece should measure about 6 8”.)

• Reproduce the *Strawberry DNA Extraction Student Instructions* for each

student or pair of students.

***For each pair of students, distribute the following materials:***

5-mL of 95% ethanol in transfer vessel

1 re-sealable plastic bag

1 strawberry

1 50-mL tube

1 15-mL tube

1 piece of cheesecloth

1 funnel

1 transfer pipet

1 wooden stick

T e a c h e r ’ s M a n u a l **10**

S t r a w b e r r y D N A E x t r a c t i o n

**During the Lesson**

• Distribute the instruction sheets and materials listed above, and then

Introduce the students to the DNA extraction procedure on the

*Strawberry DNA Extraction Student Instructions* (reproducible original below).

**After the Lesson**

• Review the Questions for Discussion, on the next page, orally with your students.

• Photocopy and distribute the *Strawberry DNA Extraction Review* worksheet and have

students answer the questions individually or in pairs.

The questions on the worksheet are reproduced below (with answers) in

the Learning Assessment Questions section.

**Questions for Discussion**

1. Discuss what materials were trapped in the cheesecloth and what

flowed through.

2. Describe what you saw when you added the ethanol to the filtered

cell solution.

3. Describe the appearance of your extracted DNA.

4. Discuss why you can’t see the DNA double helix and how an organism’s

DNA “fits” into the cell nucleus.

**Optional Follow-Up Activities**

***Note:*** *At the time of this printing, the following web sites are active. You may wish to*

*perform an independent search for more information on these topics.*

1. Visit an online cell picture gallery, for example,

http://www.cellsalive.com/gallery.htm. Look at various cell types how they

are structured and where their DNA is contained.

2. Have students research the genetic material of plants. Different fruits and

vegetables will vary in the number of chromosomes and copies of each

chromosome (ploidy).

3. Visit the Dolan DNA Learning Center web page on DNA packaging to

learn more about how DNA is contained within cells

(http://www.dnaftb.org/dnaftb/29/concept/). Follow the links on this site

to view microscopic images and illustrations of chromosome packaging.

4. Discuss ethical issues and current events related to DNA. Assign or

allow students to choose from topics such as gene therapy, genetic

engineering of plants, genetic engineering of animals, bacterial

transformation, and cloning.

**11** T e a c h e r ’ s M a n u a l

S t r a w b e r r y D N A E x t r a c t i o n

**Learning Assessment Questions and Answers**

**1. In your own words, describe the structure and function of DNA.**

*DNA is the hereditary code of life. It encodes the information that specifies all*

*living things and is passed on from generation to generation. DNA is structured*

*as a double helix and is packaged into chromosomes within cells.*

**2. What does mashing the strawberries and treating them with detergent do**

**to their cells?**

*Mashing the strawberries breaks open the tough cell walls of the plant cells.*

*Treating the berries with detergent dissolves the cell membranes and nuclear*

*membranes of the cells. Once the cells are lysed, their DNA and cell contents*

*are released.*

**3. Name a liquid that DNA is not soluble in. What does it mean**

**to be insoluble?**

*DNA is not soluble in alcohol, such as ethanol and isopropanol. When a*

*substance is insoluble in a fluid (like sand in water) it does not become*

*incorporated into the liquid but remains visible as distinct particles.*

**4. If you had extracted DNA from animal cells instead of plant cells, what**

**cell barrier would have been different? What do plant and animal cells**

**have that bacterial cells do not?**

*Plant cells have cell walls but animal cells do not. Both plant and animal cells*

*have cell membranes and nuclear membranes. Plant and animal cells are*

*eukaryotic and therefore have nuclei where DNA is stored. Bacteria cells are*

*prokaryotic and do not have nuclei. Their DNA is free-floating within the cell.*

**5. Do you think that DNA from animal cells would look the same as DNA**

**from plant cells?**

*Yes, the DNA from both cell types would look just the same. The structure of*

*DNA is consistent among all living things. It is a double helix-shaped molecule*

*(comprised of a sugar-phosphate backbone and paired nitrogenous bases) that*

*condenses into chromosomes for packaging into cells. It is the specific sequence*

*of base pairs within DNA molecules that dictates the specifications that define*

*an organism.*

6. **Give one example of something a scientist can do with extracted DNA.**

*Answers will vary. See “Importance of DNA Extraction” in the Background*

*Information section.*

**12** T e a c h e r ’ s M a n u a l

S t r a w b e r r y D N A E x t r a c t i o n

**Glossary**

**Cell Lysis** – The process of rupturing the barriers of a cell to release its contents

**Cell Membrane (plasma membrane)** – Fluid barrier surrounding all cells

that is comprised of lipid molecules arranged in a phospholipid bilayer. Protein

and carbohydrate molecules are also present within cell membranes to regulate

transport into and out of the cell and to communicate cellular messages.

**Cell Wall** – The strong, rigid, outermost encasement surrounding all plant

cells and some bacterial, fungal, and protist cells

**Chromosome** – Threadlike bundles of double-helical DNA coated with

protein molecules. In a human cell, there are two copies of 23 chromosomes.

In a strawberry cell, there are eight copies of 7 chromosomes.

**Deoxyribonucleic Acid (DNA)** – The molecular basis of heredity. Found in

the nucleus of eukaryotic cells, DNA exists as a double helix packaged into

chromosomes. DNA encodes the instructions for organism function and

transmits them from generation to generation.

**Dissolve** – The process of dispersing a solid substance in a liquid medium so

that it is no longer visible; to bring a substance into solution

**DNA Extraction** – The process of removing DNA from inside a cell

**Double Helix** – The basic structure of DNA comprised of two strands

twisted together into a helical shape. The strands consist of alternating sugar

and phosphate molecules bound by covalent bonds and are connected by

hydrogen bonds between paired nitrogenous bases.

**Eukaryotic Cell** – A cell with a membrane-bound, structurally discrete

nucleus and other organelles. All organisms except viruses, bacteria, and

cyanobacteria (blue-green algae) are comprised of eukaryotic cells.

**Insoluble** – Not able to be dissolved in a liquid or brought into solution

**Lipid** – Compounds such as fats, waxes, and oils that are characteristically

insoluble in water but can be dissolved by detergents

**Lysate** – The material produced as the result of a lysis event

**Nitrogenous Base** – The nitrogenous bases of DNA are adenine (A),

thymine (T), cytosine (C) and guanine (G). Their particular sequence within

DNA defines the molecular specifications of all organisms.

**Nuclear Membrane (nuclear envelope)** – Phospholipid bilayer membrane

surrounding the nucleus of a cell

**Nucleus** – The major membrane-bound organelle in eukaryotic cells that

contains DNA (in the form of chromosomes) and directs cellular activities

**Organelle** – A structurally distinct intracellular component that carries out

specialized functions within a cell

**Phospholipid** – A type of lipid that is the major component of cell

membranes. Phospholipids are comprised of hydrophilic heads linked by

phosphate groups to two hydrophobic tails.

**Phospholipid Bilayer** – A double-layer of phospholipid molecules arranged

in an aqueous environment with their hydrophobic tails facing inward and

their hydrophilic heads facing outward

**Precipitate** – The action of a solid material separating out of a liquid

**Prokaryotic cell** – A cell that lacks a membrane-bound, structurally discrete

nucleus; this includes all bacteria and cyanobacteria.

**Soluble** – Able to be dissolved in a liquid or brought into solution

**Solution** – A mixture of substances in an even distribution within a liquid,

so that they are concealed within the fluid

**13** T e a c h e r ’ s M a n u a l

Student Names \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**C:\Documents and Settings\dbassett\Local Settings\Temporary Internet Files\Content.IE5\NLNQT4FY\MC900250817[1].wmfStrawberry DNA Extraction Procedure C:\Documents and Settings\dbassett\Local Settings\Temporary Internet Files\Content.IE5\J5AAWQB1\MC900278848[1].wmf**

1. Obtain one fresh or one frozen and thawed strawberry. If you are using a fresh strawberry, remove

the green sepals (tops) from the berry.

1. Place the strawberry in a re-sealable plastic bag. Close the bag slowly, pushing all of the air out of the bag as you seal it.

***C:\Documents and Settings\dbassett\Local Settings\Temporary Internet Files\Content.IE5\7H5G7CHZ\MC900361580[1].wmfSTOP AND THINK!!!!***

1. Where is the DNA that we are supposed to extract (pull out)? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
2. Considering what you know about the cell structure, what barriers are there that will keep us from the DNA? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.
3. What is the first barrier made of and what must we do to get through it? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
4. What is the second barrier made of and how would we get through it? [Stop and think what you know about what substance the barrier is made from. Now consider what you use at home to dissolve the same substance!] What would you use and why? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
5. Once you determine what you need for the second barrier, consult with your teacher to verify that you are correct and obtain extraction buffer from her/him. Pour 10-mL of extraction buffer into the bag with the prepared strawberry. Reseal the bag.
6. Mash the strawberry for one additional minute to make sure it is mixed well with the buffer.
7. Place a funnel into a 50-mL centrifuge tube. Fold the cheesecloth in half along the longer side and

place it in the funnel to create a filter. The cheesecloth will overlap the edge of the funnel.

1. Pour the strawberry mixture into the funnel, filtering the contents through the cheesecloth and into

the 50-mL centrifuge tube. C:\Documents and Settings\dbassett\Local Settings\Temporary Internet Files\Content.IE5\7H5G7CHZ\MC900361580[1].wmf**Stop and think** about what you know about the plant cell and determine what you are “catching” in the filter that you will throw away. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

1. Carefully pour 2 mL of the filtered contents from the **50**-mL tube into a clean **15**-mL tube. Use the lines on the side of the 15-mL tube to help measure the amount added.
2. Hold the 15-mL tube at an angle. Using a transfer pipet, carefully add 5 mL of very cold 95% ethanol by running it down the inside of the tube. Add the 95% ethanol until the total volume is 7 mL (use the lines on the side of the tube to help you measure). You should have two distinct layers.

**Caution: *Do not mix*** *the strawberry extract and the ethanol!*

1. Watch closely as translucent strands of DNA begin to clump together where the ethanol layer meets the strawberry extract layer. Tiny bubbles in the ethanol layer will appear where the DNA precipitates.
2. Slowly and carefully rotate the wooden stick in the ethanol directly above the extract layer to wind (or “spool”) the DNA. Remove the wooden stick from the tube and observe the DNA (see Figure 1:

DNA Extraction).

**Figure 1. DNA Extraction**



Original Lab © 2 0 0 4 C a r o l i n a B i o l o g i c a l S u p p l y C o m p a n y

Borrowed and Adapted by Debra Bassett, Flint Community Schools July 2014

Names \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Date\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Strawberry DNA Extraction Review**

1. In your own words, describe the structure and function of DNA.

2. What does mashing the strawberries and treating them with detergent do to their cells?

3. Name a liquid that DNA is not soluble in. What does it mean to be insoluble?

4. If you had extracted DNA from animal cells instead of plant cells, what cell barrier would

have been different? What do plant and animal cells have that bacterial cells do not?

5. Do you think that DNA from animal cells would look the same as DNA from plant cells?

6. Give one example of something a scientist can do with extracted DNA.

Student Worksheet

Name \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Label the Plant Cell Diagram**

****

**1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**3. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**4. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**5. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**6. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**7. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**8. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**9. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

© 2 0 0 4 C a r o l i n a B i o l o g i c a l S u p p l y C o m p a n y