



## Recovering the Romanovs

### Description of activity

*Recovering the Romanovs* is an excellent opening to any unit on human genetics. To complete the three parts of this module, approximately three 40-minute class periods will be required. Time will vary depending on the depth of the lesson. The activities may also be assigned for homework if Internet access is not available in the classroom.

#### **Part I:**

The students will be introduced to the Romanov family - the Tsar, Tsarina, and their five children. Students will learn that the youngest son Alexei inherited the sex-linked genetic disorder hemophilia and see how the disorder was passed through members of the royal family. Through computer links, students can learn more about the inheritance of hemophilia. The students also see something of the Romanov family's daily activities before hearing about the Russian Revolution and the execution of the Tsar and his family.

#### **Part II:**

Students will meet the woman called Anna Anderson who claimed to be Anastasia Romanov. They will use various types of evidence to compare the two women.

#### **Part III:**

Students will hear from a forensic pathologist called in to examine skeletal evidence found in a burial site in Yekaterinburg, Siberia. The site was thought to contain the remains of the Romanov family and their staff. Students then work through animations that allow them to count and analyze the evidence to determine the skeletons' gender and age. The students learn about the use of DNA technology in identification, and the difference between

DNA (mtDNA). They then link to the *Sequence Server* at the Dolan DNA Learning Center, Cold Spring Harbor Laboratory to compare the gravesite skeletons' mtDNA sequences with living relatives of the Tsarina and Tsar.

The final task is to determine whether Anna Anderson is indeed Anastasia. The students view and listen to videos about the mtDNA analysis of Anna Anderson's hair and intestinal tissue. Using real sequences from Anna Anderson's hair and intestinal tissue samples, students can solve the mystery of Anastasia.

### Learning Outcomes

#### **Part I:**

Students will:

- Identify the members of the Romanov family and describe the situation in Russia that led to their assassination.
- Explain the concept of sex-linked inheritance and apply it to the genetic disorder hemophilia.
- Describe the disorder hemophilia and explain its symptoms and causes.
- Analyze a pedigree that traces hemophilia in the Romanov family and use a Punnett square to show how Alexei inherited hemophilia from his parents.

#### **Part II:**

Students will:

- Examine and analyze evidence, such as handwriting, ear and facial features, to compare Anna Anderson and Anastasia.
- Understand how several commonly used forensic tests are not able to provide conclusive evidence about Anna Anderson's claim to be Anastasia.



## Part III:

- Compare the characteristics of nuclear and mitochondrial DNA.
- Determine family relationships based on the similarity of mitochondrial DNA.
- Compare DNA sequences to identify members of the Romanov family.
- Compare mitochondrial DNA sequences to determine if Anna Anderson was Anastasia Romanov or a German factory worker.

### Assumptions of Prior Knowledge

Students should understand basic cell structure and have a working knowledge of Mendelian genetics.

### Misconceptions

Sex-linked traits are inherited from the father.

A male can pass a sex-linked trait on to his offspring even though he does not show the trait.

### Implementing the Lesson

Become familiar with the *DNA Interactive (DNAi)* web site ([www.dnai.org](http://www.dnai.org)) and how to navigate through it. Provide students with information about navigating the site, and how to play animations and video clips.

The module may be introduced by showing the first part of the NOVA video *Anastasia: Dead or Alive?*.

### **Before class:**

Examine all three parts of the module and photocopy the student worksheets.

### **During class:**

Direct students go to the DNA Interactive web site [www.dnai.org](http://www.dnai.org) > **Applications** > **Recovering the Romanovs**.

Have students work through *Recovering the Romanovs*, completing the activities as they encounter the screens specified.

### **Part I: the Romanov family**

Activity 1; Screen #4: Students can visit *DNA from the Beginning* ([www.dnafb.org](http://www.dnafb.org)) by clicking on the Links pop-up and going to "Sex-linked Disorder," and then clicking on the animation. A pedigree of Queen Victoria and her descendents will then be displayed as a classic example of sex-linked inheritance. Students are then asked to fill out Punnett squares for the disorder hemophilia.

Note: depending on the background and focus of your class, students can also click on the Links pop-up and "Hemophilia" to learn more about the causes, symptoms, and treatment of this genetic disorder.

### **Part II: the mystery of Anna Anderson**

Activity 2; Screen #3: Students will use handwriting analysis, an ear test and a facial comparison chart to decide if Anna Anderson was really Anastasia.

### **Part III: science solves a mystery**

Activity 3; Screen #3: Students will view the Romanov burial site. They can click on each skeleton to remove it from the grave, enabling them to count the number of skeletons present.

Activity 4; Screen #5: Each of the nine skeletons will be analyzed to determine its age and sex. Wisdom teeth, vertebrae, and pelvic bones are the key skeletal structures students will examine during this activity.



Activity 5; Screen #8-11: Students are given a brief tutorial on nuclear vs. mitochondrial DNA. They are then asked to apply what they have learned to the transfer of mitochondrial DNA through the Romanov family.

Activity 6; Screens #12-14: Students will determine the closest living relative of the Tsarina by tracing mitochondrial DNA through her family pedigree.

Students will then learn how to use the *Bioservers Sequence Server* at Dolan DNA Learning Center, Cold Spring Harbor Laboratory to compare the DNA of the female skeletons found at the gravesite with a living maternal relative. This will help them to determine which females in the grave were related and therefore part of the royal family.

Activity 7; Screens #15-16: Students examine the Tsar's pedigree in order to identify his closest living maternal relative. The *Sequence Server* will again be used to compare the mtDNA of the male skeletons to identify the Tsar.

Activity 8; Screens #18-22: Students use the information they have collected to more definitively solve the mystery of Anna Anderson. They again use the *Sequence Server* to compare the mtDNA of Anna to a person thought to be her maternal relative.

## Further Explorations

### **Middle School**

Draw a pedigree of your own family. Start with your maternal and paternal grandparents. Include aunts, uncles, and cousins. If possible add great-grandparents.

Write an ending to the story of Anastasia. Write it as if Anna Anderson did indeed prove to be Anastasia.

What if someone claimed to be Anastasia's brother Alexei? Explain how you would go about determining whether or not this person really is Alexei.

Who was Rasputin and how is he part of the Romanov story?

### **High School**

Research Vladimir Lenin, the Bolsheviks and the Russian Revolution. Create a historical timeline.

Research Rasputin, the notorious monk who was very much a part of the Romanov story.

What if someone claimed to be Anastasia's brother Alexei? Are there any individuals present in either the Tsar's or Tsarina's family tree you could use to make a decision regarding the claim. If so, who are these individuals? If not, why is there no one?

Do further research to find out about other similarities between Anna Anderson and the real Anastasia. Find out who believed in her and who didn't.

After sequencing the mitochondrial DNA of the Tsar, scientists discovered another mystery. It seems that the Tsar had two types of mitochondrial DNA. One type contained a C (cytosine) at position 16169 while the other type contained a T (thymine) at the same location. His relatives only had thymine. Read the article "Calibrating the Mitochondrial Clock." (*Science*, Volume 279, 1/2/98) and answer the following questions:

- What is the scientific term used to describe the anomaly discovered in the Tsar's mtDNA?
- Why did this finding lead to controversy over the authenticity of the skeletons found in the Siberian grave?



- Explain how the mtDNA mutation rate is used as a clock to date key events in human history.
- Why has this new finding resulted in concern about the mutation rate used by scientists in the mitochondrial clock?
- How might heteroplasmy get a criminal off the hook?

## AP Biology

The *Your Genes, Your Health* ([www.ygyh.org](http://www.ygyh.org)) web site contains a wealth of information!

Have your AP students find the answers to the following questions:

About 20% of males with hemophilia get the disorder even if their mother does not carry the mutated gene. How is this possible?

Explain the difference between mild and severe cases of hemophilia. Base your answer on the different types of mutations that cause the genetic disorder.

Explain how some female carriers show a mild form of hemophilia resulting from X-inactivation.

## Resources

### Web

*Clicking Anastasia*: An educational Internet adventure where players search for the lost Romanov fortune. <http://www.lostsecrets.com>

### Video

NOVA (1995). *Anastasia: Dead or Alive?*  
<http://main.wgbh.org/wgbh/shop/products/wga2209.html>

## Books

Mironenko, S. et al. (1998). *Nicholas & Alexandra, The Last Imperial Family of Tsarist Russia*, From the State Hermitage Museum and the State Archive of the Russian Federation, Harry N. Abrams, Inc.

## Activity pages include:

5E correlation.

Anastasia teacher overview.

Student worksheets 1-8.

Answer sheets 1-8.

Reference: "Calibrating the Mitochondrial Clock."



## An introduction to the module: *Recovering the Romanovs*

Anastasia Romanov was the youngest daughter of Tsar Nicholas of Russia and his wife Tsarina Alexandra. Anastasia had three older sisters, Olga, Maria and Tatiana, and a younger brother Alexei. In 1917, the Bolshevs led by Vladimir Lenin overthrew the Romanovs. Anastasia and her family were imprisoned in Siberia and, in July of 1918, they were brutally murdered by the Bolshevik soldiers. In order to prevent those remaining loyal to the Tsar from finding his remains, the bodies were buried in a secret location.

In the 1920's an unknown woman in a mental hospital in Germany claimed to be Anastasia Romanov. While in the hospital she adopted the name Anna Anderson. Since the 1918 massacre of the Romanov family rumors have persisted that some members of the imperial family may have survived. Could this unknown woman be Anastasia Romanov the youngest daughter of Tsar Nicholas? Anna Anderson had the same hair color, eye color, height and distinctive body markings including a deformed foot, that the Romanov princess had. Could Anastasia have escaped the brutality of the Bolshevik soldiers? Anna Anderson claimed to be Anastasia until her death in 1984.

In 1991 the remains of the royal Romanov family were exhumed in Yekaterinburg, Siberia. Portions of nine skeletons were found. Scientists used various techniques to identify the skeletal remains. They were able to identify the bodies of the Tsar and Tsarina as well as three of their children. Two skeletons were missing- Anastasia and the youngest son Alexei.

What happened to Anastasia Romanov? For most of the 20<sup>th</sup> century, this question persisted without a conclusive answer. Could she have survived the massacre that took the lives of her entire family? Or did she escape and live out her life without ever being recognized for whom she truly was? In 1994, scientists were able to use modern DNA technology to analyze the evidence and determine whether Anna Anderson was really Anastasia.