

Exploring Electrophoresis Using Forensic DNA Evidence

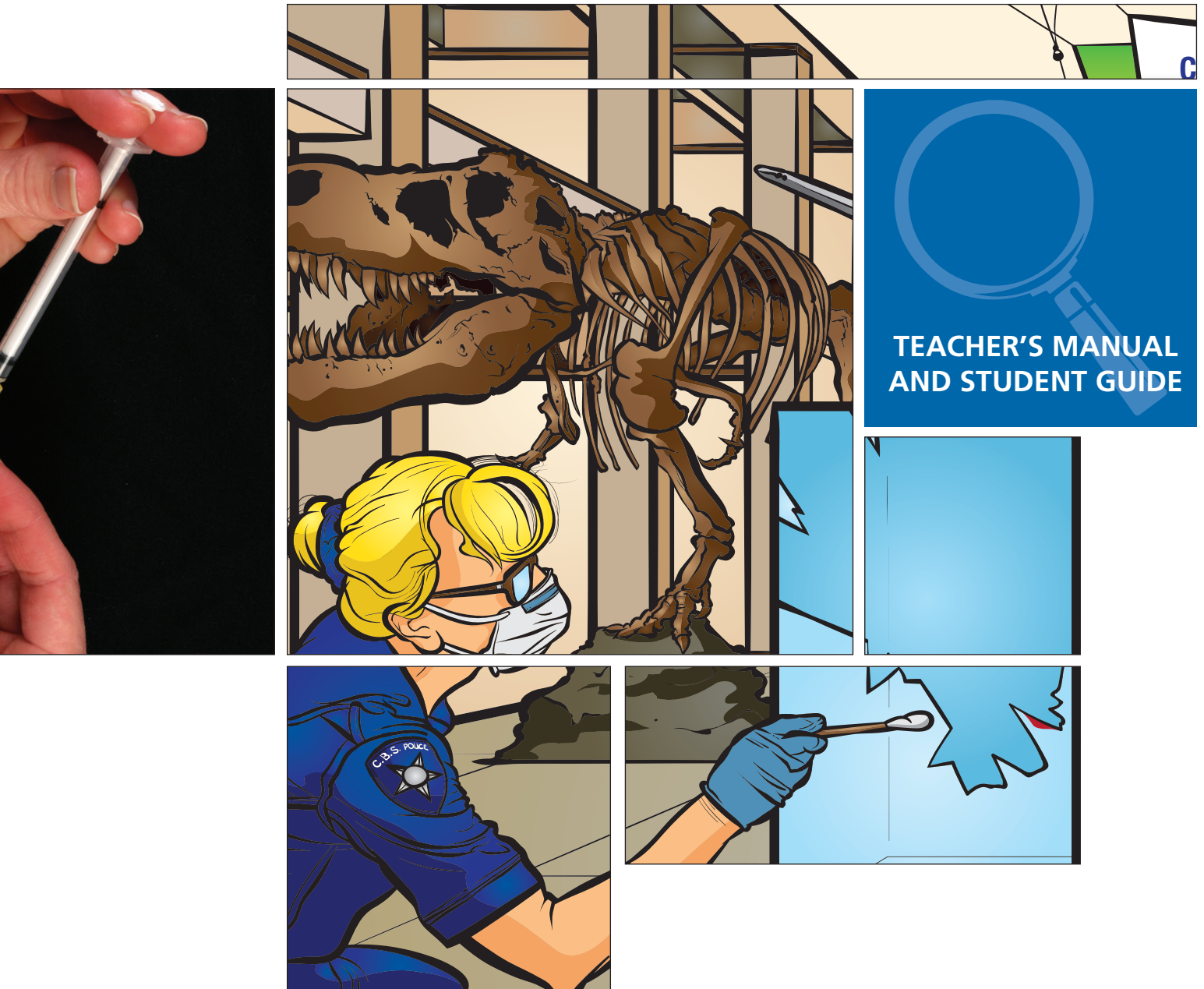


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Acknowledgments

The electrophoresis equipment in this kit was originally developed in 1993 by Dean Madden and John Schollar at the National Centre for Biotechnology Education at the University of Reading (United Kingdom). The material in this Teacher's Manual and Student Guide is copyrighted, but it may be photocopied for non-profit-making use by educational institutions, providing due acknowledgement is made of the source. Should you wish to use this material in whole or in part for commercial purposes, or to republish it in any form, please contact Carolina Biological Supply Company.



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Investigative Phenomenon

The Investigative Phenomenon is a fictional scenario in which a forensics technician analyzes the results of a crime scene. Blood evidence left by a burglar at the scene was collected to determine if a match could be made to one of two potential suspects. Students are presented with the crime scene, the suspects, the PCR process used to prepare the evidence, and are then asked to set up, run, and analyze an electrophoresis gel to determine whether one of the suspects is connected to the crime. The question that drives their investigation is “How do we use DNA evidence, and what must be done in order to use it?”

Related Performance Expectations

The activities in this kit build toward the following Performance Expectations of the Next Generation Science Standards*:

HS-LS1-3. Ask questions to clarify relationships about the role of DNA and chromosomes in coding the instructions for characteristic traits passed from parents to offspring.

HS-LS3-2. Make and defend a claim based on evidence that inheritable genetic variations may result from (1) new genetic combinations through meiosis, (2) viable errors occurring during replication, and/or (3) mutations caused by environmental factors.

Three-Dimensional Learning

The activities in this kit address the following dimensions of the Next Generation Science Standards.

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
<p>Engaging in Argument from Evidence</p> <ul style="list-style-type: none"> Make and defend a claim based on evidence about the natural world that reflects scientific knowledge and student-generated evidence. 	<p>LS3.B: Variation of Traits</p> <ul style="list-style-type: none"> In sexual reproduction, chromosomes can sometimes swap sections during the process of meiosis (cell division), thereby creating new genetic combinations and thus more genetic variation. Although DNA replication is tightly regulated and remarkably accurate, errors do occur and result in mutations, which are also a source of genetic variation. Environmental factors can also cause mutations in genes, and viable mutations are inherited. 	<p>Cause and Effect</p> <ul style="list-style-type: none"> Empirical evidence is required to differentiate between cause and correlation and make claims about specific causes and effects.

*“Next Generation Science Standards” is a registered trademark of Achieve. Neither Achieve nor the lead states and partners that developed the Next Generation Science Standards was involved in the production of, and does not endorse, this product.

Source: NGSS Lead States, 2013. *Next Generation Science Standards: For States, By States*. Retrieved from www.nextgenscience.org or ngss.nsta.org.

Accessing Carolina's Digital Resources

This kit includes free 1-year access to digital resources designed to support the lab content.

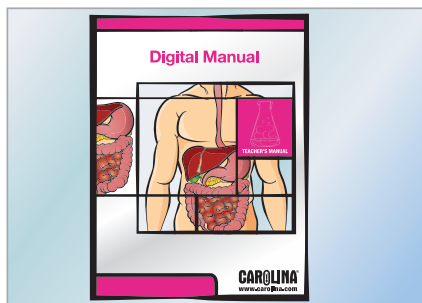
We sent the purchaser of the kit an e-mail with the access code to unlock the free resources for this product. If you did not receive the e-mail, call 800.334.5551 or e-mail us at csu_support@carolina.com to get the access code. When contacting us, please provide your order number, school/district name, and the purchaser's name if possible.

To redeem your access code, visit carolinascienceonline.com and follow these steps:

1. If you do not have an account, click on Teacher Login to create one.
2. If you already have an account, log in.
3. Click "redeem access code" and enter your code.

After you redeem your code, you can access the complete playlist of digital resources bundled with this kit. An example playlist is shown below. See the next page for a list of resources specific to your playlist, which may include videos and interactive lessons, as well as a Digital Teacher's Manual.

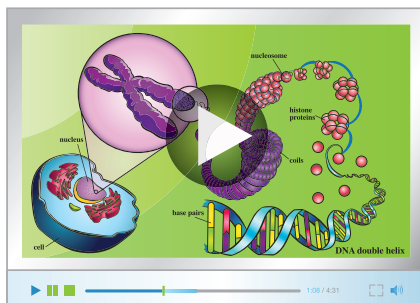
Digital Teacher's Manual



Digital Teacher's Manual:

- ◆ Digital version of the printed manual
- ◆ Viewable on any device
- ◆ Links to downloadable resources

Video



Videos may include:

- ◆ Safety
- ◆ Animations
- ◆ Procedures
- ◆ Phenomena

Interactive Digital Lesson



Interactive Digital Lessons may include:

- ◆ Prelabs
- ◆ Postlabs
- ◆ How-to Lessons
- ◆ Safety Lessons
- ◆ Assessments
- ◆ Simulations

You can assign these resources to your students' CSO accounts! Find these tutorials, before log-in, at carolinascienceonline.com. Look for this icon:



Create an Assignment

You can create classes online, then assign rich and diverse digital content to your students.

[Read More](#)
[View Video Tutorial](#)

Your Digital Resources

Your digital resources will be available to you for 1 year after you redeem your access code.

Record the date of first access: _____/_____/_____

Digital Teacher's Manual

The Digital Teacher's Manual is an HTML version of the printed manual. It can be viewed on any device. In addition to the contents of the entire printed manual, the Digital Teacher's Manual includes hyperlinks to the **downloadable** and **printable** resources listed in the table below. If you are currently viewing the Digital Teacher's Manual, you can click on any resource in the table and view, download, or print it.

Resource (click to access)	How to Use
Student Guide PDF	This digital version of the Student Guide can be printed and distributed to students or groups. As a paper-saving alternative, however, you also can assign it for viewing on students' electronic devices.
Fill-in Answer Sheets	This is a PDF of the manual's questions and data tables, without lab procedures and illustrations. You can send these to your students electronically or print them. Students can provide their answers digitally, save the document, and send it back to you (or print it out).
Editable Assessment Questions	This Microsoft® Word document contains all the assessment questions found in the Student Guide. You can edit these questions or add your own, and then print them or assign them to students electronically.
Whiteboard Resources	This PDF is a compilation of the important photos and illustrations in the Teacher's Manual and Student Guide. Use them on a whiteboard as instructional tools and incorporate them into laboratory investigations, class discussions, presentations, and assessments.

Video:

- Loading an Exploring Electrophoresis Gel
- Pouring a Gel
- Melting Powdered Agarose for a Gel

Interactive Digital Lessons:

- Exploring Electrophoresis Using Forensic DNA Evidence Prelab Activity – Students learn about PCR and sequence the procedural steps of the lab
- Exploring Electrolysis Using Forensic DNA Evidence Postlab Activity – Students are assessed on their understanding of how variation in DNA affects electrophoresis results.

Student Artifacts

Students will produce artifacts as evidence of three-dimensional learning, including but not limited to the following:

Prelab

- An initial claim that addresses the Driving Question and immediately engages students in the SEP Engaging in Argument from Evidence and the CCC Cause and Effect's emphasis on the need for empirical evidence in order to claim cause in the case of correlation

Laboratory Investigation

- Stop-and-Think answers that address some aspects of the DCI Variation in Traits as well as ETS2.A the Interdependence of Science, Engineering, and Technology

Analysis and Assessment

- The team's completed gel and a photograph of it, both serving as empirical evidence for the students' claim
- An evidence-based claim as to which suspect is guilty
- Revised claim regarding the Driving Question

Objectives

Students' performance objectives are to

- explain at a basic level how the electrophoresis of DNA works.
- describe the aspects of DNA structure that make its analysis by electrophoresis possible.
- describe why "DNA fingerprints" or "DNA profiles" vary from person to person.
- be able to compare the DNA fingerprints from different people and to draw conclusions from those comparisons.
- be able to describe the significance of forensic DNA analysis to society

Prerequisite Knowledge and Skills

- basic knowledge of DNA structure
- basic knowledge of molecules and how they are structured
- basic understanding of electricity, current, and charge



Time Requirements

Teacher Preparation	45 minutes
Prelab	30 minutes
Investigation	One 3-hour period or two 50-minute periods
Assessment	30 minutes

The lab may be performed according to various schedules. If you have a 3-hour time block and you use five 9-volt batteries or the designated power supply, the lab can be completed in one period. Alternatively, the gels can be run overnight (12 hours) using one battery per gel and then stained the next day by the instructor if students are not available, or stained by the instructor after the run is completed on the first day. Destaining can either be done overnight or over a 40-minute period. For optimum viewing of bands, destain the gel for a minimum of 5 hours.




Safety

Use this kit only in accordance with established laboratory safety practices, including appropriate personal protective equipment (PPE) such as gloves, chemical splash goggles, and lab coats or aprons. Ensure that students understand and adhere to these practices. Know and follow all federal, state, and local regulations as well as school district guidelines for the disposal of laboratory wastes. Students should not eat, drink, or chew gum in the lab and should wash their hands after entering and before exiting the lab.

Download Safety Data Sheets (SDS) at carolina.com/sds or scan this code:



Agarose

 **WARNING!** When melting the agarose gel, ensure that the agarose suspension to be melted is placed in an *unsealed* container. Hot, molten agarose can scald and it must be handled with care.

Electrode Tissue

The carbon fiber electrode tissue may release small fibers that can cause minor skin irritation when handled. It is a wise precaution to wear gloves if you find the tissue unpleasant to handle. Any fibers released are too large