

**Teacher’s Guide**

**The Future of Forensics**

***October 2019***

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Activate students’ prior knowledge and engage them before they read the article.

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These questions are designed to help students read the article (and graphics) carefully. They can help the teacher assess how well students understand the content and help direct the need for follow-up discussions and/or activities. You’ll find the questions ordered in increasing difficulty.

[Graphic Organizer 5](#_Graphic_Organizer_1)

Thishelps students locate and analyze information from the article. Students should use their own words and not copy entire sentences from the article. Encourage the use of bullet points.

[Answers 6](#_Answers_to_Reading)

Access the answers to reading comprehension questions and a rubric to assess the graphic organizer.

[Additional Resources 8](#_Additional_Resources_1)

Here you will find additional labs, simulations, lessons, and project ideas that you can use with your students alongside this article.

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# Anticipation Guide

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

**Directions: *Before reading the article*,** in the first column, write “A” or “D,” indicating your **A**greement or **D**isagreement with each statement. Complete the activity in the box.

As you read, compare your opinions with information from the article. In the space under each statement, cite information from the article that supports or refutes your original ideas.

|  |  |  |
| --- | --- | --- |
| **Me** | **Text** | **Statement** |
|  |  | 1. The word “forensic” means debate.
 |
|  |  | 1. Most wrongful convictions are due to false or misleading forensic evidence.
 |
|  |  | 1. Ideally, forensics should connect evidence and a specific individual or source.
 |
|  |  | 1. Bite-mark analysis, microscopic hair analysis, and firearms examination have been scientifically validated as outstanding forensic evidence.
 |
|  |  | 1. Many traditional forensics methods are subjective.
 |
|  |  | 1. DNA evidence can be linked to a specific, unique source.
 |
|  |  | 1. Substances found at a crime scene can be identified in a lab using instruments to analyze samples from the crime scene.
 |
|  |  | 1. Gas chromatography identification depends on the polarity of a sample.
 |
|  |  | 1. Color-based field tests used by law enforcement must be followed up by additional testing in a lab.
 |
|  |  | 1. Fingerprint analysis is no longer used in forensics.
 |

# Student ReadingComprehension Questions

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

**Directions**: Use the article to answer the questions below.

1. What is the scientific method? How is the scientific method applied in a criminal investigation?
2. Explain the differences between class evidence and individual evidence. Give an example of each and give reasons for your choices.
3. State the pros and cons of field tests.
4. What are the top three factors that lead to false convictions?
5. What evidence was found that exonerated Santae Tribble?
6. Explain how gas chromatography works. Assuming the stationary phase in the gas chromatography machine contained a polar medium, how would that affect a polar molecule like water? How would it affect a nonpolar molecule such as benzene (C6H6)?
7. Briefly describe the FTIR instrument. Give reasons why this analysis would be more accurate than using gas chromatography analysis.
8. Some forensic techniques lack in scientific validation. Fingerprints are one example. Research and state some issues with fingerprint analysis that could result in false positives.
9. Is forensic evidence infallible? If you were a member of a jury on a murder trial, what other evidence would make you doubt the forensic evidence? What questions/concerns would a jury member be concerned about when they consider forensic evidence?

**Student Reading Comprehension Questions, cont.**

1. How would bias affect evidence gathering? What factors would be most susceptible to bias (use graph to support your answer)? How?
2. What is unique about forensic evidence that limits bias? How could forensic evidence be faulty and lead to wrong convictions?

**Questions for Further Learning**

***Write your answers on another piece of paper if needed.***

1. Research the differences between natural and synthetic substances. A great site to look at is <http://www.drugpolicy.org/drug-facts/synthetic-cannabinoids-spice-k2-facts>. Why do you think the tests that forensic scientists use on natural substances do not work on synthetic substances?
2. Below are the links of three different cases of false convictions and their exonerations. What evidence was used to convict them? What was found that exonerated them? If you were the investigator on this case, how would you handle the evidence differently?

Patrick Pursley: <http://www.law.northwestern.edu/legalclinic/wrongfulconvictions/exonerations/patrick-pursley.html>

Charles Johnson: <http://www.law.northwestern.edu/legalclinic/wrongfulconvictions/exonerations/il/charles-johnson.html>

Daniel Anderson: <http://www.law.northwestern.edu/legalclinic/wrongfulconvictions/exonerations/daniel-andersen.html>

# Graphic Organizer

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

**Directions**: As you read, complete the graphic organizer below to explain what evidence you would give more weight to as a juror.

|  |  |  |  |
| --- | --- | --- | --- |
| ***Evidence*** | ***Description*** | ***Advantages*** | ***Disadvantages*** |
| **Fingerprints** |  |  |  |
| ***Microscopic hair analysis*** |  |  |  |
| **Firearm examinations** |  |  |  |
| **DNA Analysis** |  |  |  |
| **Instrumentation analysis** |  |  |  |
| **Field tests for illicit substances** |  |  |  |

**Summary:** Write a short email (three sentences) to a friend who has been called for jury duty telling them what types of evidence might be presented at a trial that are more reliable than others.

# Answers to Reading Comprehension Questions & Graphic Organizer Rubric

1. **What is the scientific method? How is the scientific method applied in a criminal investigation?**

*The scientific method is the process used to solve scientific problems. The scientific method is applied in criminal investigations by: Making observations at the scene of the crime, collecting evidence, and develop a hypothesis based on the evidence. They do further tests to prove the hypothesis.*

1. **Explain the differences between class evidence and individual evidence. Give an example of each and give reasons for your choices.**

*Class evidence refers to evidence with characteristics that are common to a group of people. Hair strands are one example. Many people can have the same type of hair. Individual evidence is linked one specific source. DNA is an example. Everybody has their own DNA “fingerprint” that is different from everyone else.*

1. **State the pros and cons of field tests.**

*Field tests are good because you can do the tests at the scene of the crime (in the “field”). They also provide results quickly. The down side of field tests is that they may provide false positive results. Therefore, more testing needs to be done in a laboratory.*

1. **What are the top three factors that lead to false convictions?**

*According to the graph on page 16:*

*1. perjury/false accusations*

*2. Official misconduct*

*3. Mistaken witness ID*

1. **What evidence was found that exonerated Santae Tribble?**

*The evidence that was found to exonerate Santae was DNA testing on the hairs in the mask. The DNA on the mask did not match Santae’s DNA. Additionally, one of the hairs thought to be Santae’s was actually from a dog.*

1. **Explain how gas chromatography works. Assuming the stationary phase in the gas chromatography machine contained a polar medium, how would that affect a polar molecule like water? How would it affect a nonpolar molecule such as benzene (C6H6)?**

*In a gas chromatography analysis, a liquid is vaporized and passed thru the “stationary phase”. The stationary phase binds to the sample in varying degrees based on the polarity of the sample, compared to the stationary phase. If the stationary phase was polar, it would bind with any polar substances in the sample, thus slowing down their travel. The nonpolar substances would move faster thru the phase. Scientists can determine what chemicals are in a sample based on how easily they move thru the phase.*

1. **Briefly describe the FTIR instrument. Give reasons why this analysis would be more accurate than using gas chromatography analysis.**

*FTIR is more specific than gas chromatography. Infrared rays pass thru the sample, which stretches and bends the bonds in ways unique to the molecules. This is considered the “fingerprint” of the molecule.*

1. **Some forensic techniques lack in scientific validation. Fingerprints are one example. Research and state some issues with fingerprint analysis that could result in false positives.**

*One site to use is:* [*https://www.pbs.org/wgbh/frontline/article/forensic-tools-whats-reliable-and-whats-not-so-scientific/*](https://www.pbs.org/wgbh/frontline/article/forensic-tools-whats-reliable-and-whats-not-so-scientific/)*. One quote: “According to the National Academies of Sciences, no peer reviewed scientific studies have ever been done to prove the basic assumption that every person’s fingerprint is unique.”*

1. **Is forensic evidence infallible? If you were a member of a jury on a murder trial, what other evidence would make you doubt the forensic evidence? What questions/concerns would a jury member be concerned about when they consider forensic evidence?**

*Answers will vary*

1. **How would bias affect evidence gathering? What factors would be most susceptible to bias (use graph to support your answer)? How?**

*Someone who is biased will look for evidence or present evidence in a way that will favor a specific outcome. Bias could play a big role in official misconduct, perjury, and mistaken ID. These factors are not scientific, and they are only effective if the person is neutral or does not have a pre-formed opinion.*

1. **What is unique about forensic evidence that limits bias? How could forensic evidence be faulty and lead to wrong convictions?**

Forensic evidence can limit bias because it is based on facts and physical evidence. “Neutral” scientific instruments process the evidence, and they do not have any pre-conceived opinions. Forensic evidence could be faulty if the physical evidence was contaminated, or not properly collected. There could be some bias in interpreting the results of the forensic testing as well, such as misreading fingerprint samples or hair samples.

**Questions for Further Learning**

*Student answers will vary.*

**Graphic Organizer Rubric**

If you use the Graphic Organizer to evaluate student performance, you may want to develop a grading rubric such as the one below.

|  |  |  |
| --- | --- | --- |
| **Score** | **Description** | **Evidence** |
| 4 | Excellent | Complete; details provided; demonstrates deep understanding. |
| 3 | Good | Complete; few details provided; demonstrates some understanding. |
| 2 | Fair | Incomplete; few details provided; some misconceptions evident. |
| 1 | Poor | Very incomplete; no details provided; many misconceptions evident. |
| 0 | Not acceptable | So incomplete that no judgment can be made about student understanding |

# Additional Resources

**Labs and demos**

How to Extract DNA From a Strawberry: This activity demonstrates how DNA can be isolated from a strawberry using common household materials. Watch a video of the experiment to get started.

<https://www.genome.gov/Pages/Education/Modules/StrawberryExtractionInstructions.pdf>

<https://www.youtube.com/watch?v=hOpu4iN5Bh4>

Powder Analysis: A forensic scientist may discover powder at a crime scene. To determine if it is illegal or not the crime lab will identify the substance using chemistry. Have your students take the role of a forensic chemist to identify unknown substances.

<http://stem-works.com/external/activity/173>

Recasting Chemistry Labs with Forensic Themes. This is a forensics investigation that involves analysis of spectra:

<https://teachchemistry.org/periodical/issues/march-2018/recasting-chemistry-labs-with-forensic-themes>

**Videos**

Why Are Synthetic Drugs So Dangerous?: This ACS Reactions video takes a look into the science of why synthetic drugs are so dangerous. It answer this question by examining the chemistry of two kinds of synthetic drugs: bath salts and synthetic marijuana.

<https://www.acs.org/content/acs/en/pressroom/reactions/videos/2016/why-synthetic-drugs-are-as-scary-as-you-think-video.html>

**Lessons and lesson plans**

Modeling Polarity: This AACT resource teaches through movement in two activities. In the first activity, students will kinesthetically demonstrate the use of electronegativity to determine covalent bond types. In the second activity, students will model bonds in a compound to determine the overall polarity of a molecule.

<https://teachchemistry.org/periodical/issues/may-2019/modeling-polarity>

**Projects and extension activities**

Challenge your students to solve this forensic chemistry crossword puzzle:

<https://teachchemistry.org/classroom-resources/forensic-chemistry-crossword>

# Chemistry Concepts, Standards, and Teaching Strategies

**Connections to Chemistry Concepts**

The following chemistry concepts are highlighted in this article:

* Molecules and bonding
* Molecular structure
* Instrumentation

**Correlations to Next Generation Science Standards**

This article relates to the following performance expectations and dimensions of the NGSS:

**HS-PS1-3.**

Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.

**HS-ETS1-3**

Evaluate a solution to a complex real-world problem based on prioritized criteria and tradeoffs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

**Disciplinary Core Ideas:**

* PS1.A: Structure and Properties of Matter
* PS2.B: Types of Interactions
* ETS1.C: Optimizing the Design Solution

**Crosscutting Concepts:**

* Patterns
* Cause and Effect
* Structure and Function
* Stability and Change

**Science and Engineering Practices:**

* Planning and carrying out investigations
* Engaging in argument from evidence
* Obtaining, evaluating, and communication information

**Nature of Science:** Scientific knowledge is based on empirical evidence.

**Correlations to Common Core State Standards**

See how *ChemMatters* correlates to the[**Common Core State Standards** online](https://www.acs.org/content/acs/en/education/resources/highschool/chemmatters/teachers-guide.html).

**Teaching Strategies**

Consider the following tips and strategies for incorporating this article into your classroom:

* Alternative to Anticipation Guide: Before reading, ask students what forensics tests are done in order to solve crimes, and which tests are best. As they read, students should add to their original list.
* Encourage students to watch the video “[TV Forensics: What do CSIs Actually Do?](https://www.acs.org/content/acs/en/pressroom/reactions/videos/2018/tv-forensics-what-do-csis-actually-do.html)” mentioned in the article.
* Students can learn more about how to become a forensic chemist and what they do by reading “Investigate the Career Path of a Forensic Chemist” on page 19.
* Ask students what a “false positive” test means and how it relates to forensics (as well as health screening).