

**Teacher’s Guide**

**The Opioid Epidemic: How Did It Get This Bad?**

***October 2022***

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

[***Reading Comprehension Questions***](#_heading=h.3znysh7) ***3***

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***](#_heading=h.9f8azrtnp6p5) ***5***

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***](#_heading=h.djipzn7z1r1b) ***6***

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

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

***[Chemistry Concepts and Standards](#_heading=h.clgirpnv7ahk) 10***

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

# Anticipation Guide

**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. Opioid-related deaths are decreasing worldwide. |
|  |  | 2. Illicit drug use among teens in the U.S. has decreased. |
|  |  | 3. Opium poppies have been cultivated for thousands of years. |
|  |  | 4. The primary compound in opium is morphine. |
|  |  | 5. All opioid painkillers are addictive. |
|  |  | 6. Opioids block pain signals from getting to the brain. |
|  |  | 7. Oxycodone is a better painkiller than morphine. |
|  |  | 8. Opioids can affect nerves controlling respiration. |
|  |  | 9. Fentanyl is made using opium poppies. |
|  |  | 10. Naloxone works by blocking opioid receptors in nerves. |

# Student Reading Comprehension Questions

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

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

1. Which agency is responsible for monitoring and responding to public health threats?
2. Create a data table of fentanyl-related overdose deaths in teens in the United States in 2019, 2020, and 2021.
3. What is the scientific name for the opium poppy?
4. Which two medications can be used to treat opioid overdoses?
5. What is the trade name for diacetylmorphine?
6. What is the name of the compound used to create oxycodone?
7. Why are opioids prescribed even though they are addictive?
8. List at least three common symptoms of opioid withdrawal.
9. Describe the solubility differences between polar and nonpolar molecules. What is each type of molecule soluble in?
10. Explain how Naloxone works to prevent an opioid overdose.
11. Create a timeline that includes the dates of development and the company/person credited with developing the following: heroin, oxycodone, morphine, and fentanyl.

**Student Reading Comprehension Questions, cont.**

**Questions for Further Learning**

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

1. Explain the impact of opioids on the nervous system.
2. When thinking about its chemical structure, why is fentanyl more lipid soluble than morphine?
3. Compare the production and effectiveness between fentanyl and morphine.
4. The last paragraph of the article explains some of the steps that federal, state, and local governments are taking to reduce the opioid epidemic. These include improving treatments for addiction, increasing the oversight of the opioid trade, developing non-addictive pain medications, and increasing the availability of overdose-reversing drugs. Select one of the steps to research and explain what is being done and its potential impact on the epidemic.
5. The blood brain barrier consists of a phospholipid bilayer. Identify at least three items that can cross the blood brain barrier and describe their chemical structures. What characteristics do they have that allow them to cross the blood brain barrier?

# Graphic Organizer

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

**Directions**: As you read, complete the graphic organizer below to compare the drugs described in the article.

|  |  |  |  |
| --- | --- | --- | --- |
| **Drug** | **Effectiveness as a painkiller** (1=most effective; 5=least) | **How addictive?** (1=most addictive; 5 =least) | **At least 3 other facts about the drug, including the source, when it was first developed, and legitimate uses (if any).** |
| **Opium** |  |  |  |
| **Morphine** |  |  |  |
| **Heroin** |  |  |  |
| **Oxycodone** |  |  |  |
| **Fentanyl** |  |  |  |

**Summary:** On the back of this sheet, write a short text to a friend describing what you learned about the chemistry of opioids from reading the article.

# Answers to Reading Comprehension Questions & Graphic Organizer Rubric

1. Which agency is responsible for monitoring and responding to public health threats?

The agency responsible for monitoring and responding to public health threats is the Centers for Disease Control and Prevention.

1. Create a data table of fentanyl-related overdose deaths in teens in the United States in 2019, 2020, and 2021.

Fentanyl-Related Overdose Deaths

| Year | Number of Overdose  Deaths |
| --- | --- |
| 2019 | 492 |
| 2020 | 954 |
| 2021 | 1,146 |

1. What is the scientific name for the opium poppy?

The scientific name for the opium poppy is Papaver somniferum.

1. Which two medications can be used to treat opioid overdoses?

Naloxone and Narcan can be used to treat opioid overdoses.

1. What is the trade name for diacetylmorphine?

Heroin is the trade name for diacetylmorphine.

1. What is the name of the compound used to create oxycodone?

Thebaine is used to create oxycodone.

1. Why are opioids prescribed even though they are addictive?

Opioids are prescribed despite their addictive qualities because they can relieve severe pain.

1. List at least three common symptoms of opioid withdrawal.

Common symptoms of opioid withdrawal include body aches, diarrhea, vomiting, profuse sweating, fever, and shaking.

1. Describe the solubility differences between polar and nonpolar molecules. What is each type of molecule soluble in?

Polar molecules are soluble in water and nonpolar molecules are soluble in lipids.

1. Explain how Naloxone works to prevent an opioid overdose.

Naloxone binds to opioid receptors and displaces opioids.

1. Create a timeline that includes the dates of development and the company/person credited with developing the following: heroin, oxycodone, morphine, and fentanyl.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Year | 1804 | 1874 | 1916 | 1960 |
| Opioid | Morphine | Heroin | Oxycodone | Fentanyl |
| Person/Company responsible for development | Friedrich Wilhelm Serturner | Bayer | Bayer | Paul Janssen |

**Questions for Further Learning**

1. Describe the impact of opioids on the nervous system.

Opioids attach to opioid receptors and prevent pain signals from traveling to the brain. They also block the brain cells that turn off the release of dopamine.

1. When thinking about its chemical structure, why is fentanyl more lipid soluble than morphine?

Fentanyl is more lipid soluble because it is nonpolar and has a low molecular weight.

1. Compare the production and effectiveness of fentanyl and morphine.

Fentanyl is easier to mass produce because it does not require the growth of large fields of poppies, and it is more effective at blocking pain.

1. The last paragraph of the article explains some of the steps that federal, state, and local governments are taking to reduce the opioid epidemic. These include improving treatments for addiction, increasing the oversight of the opioid trade, developing non-addictive pain medications, and increasing the availability of overdose-reversing drugs. Select one of the steps to research and explain what is being done and its potential impact on the epidemic.

Student responses will vary.

1. The blood brain barrier consists of a phospholipid bilayer. Identify at least three items that can cross the blood brain barrier and write their chemical formulas. What characteristics do they have that allow them to cross the blood brain barrier?

Student responses 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 |

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# Additional Resources and Teaching Strategies

**Additional Resources**

* **Labs and demos**

* + [Diffusion Across Biological Membranes](https://cpb-us-e1.wpmucdn.com/blogs.cornell.edu/dist/3/1009/files/2015/05/Diffusion-Lab-Teacher-Edition-CIBT-19tdolk.pdf) - Students can use this lab to explore the process of diffusion.
* **Simulations**
  + [How Pain works in the Body and the Brain](https://learn.genetics.utah.edu/content/addiction/howpainworks) - This page includes an interactive simulation designed to help students learn about pain pathways. It also contains additional information and resources to explain different types of pain.
  + [Opioids and the Physiology of Tolerance](https://learn.genetics.utah.edu/content/addiction/tolerance) - This interactive explains how opioid use can lead to tolerance and withdrawal.
* **Lessons and lesson plans**
  + [The Opioid Epidemic](https://cdn.kqed.org/wp-content/uploads/sites/26/2018/01/The-Opioid-Epidemic-lesson-plan.pdf) - In this lesson plan, students access a variety of resources to learn more about the opioid epidemic in the United States.
  + [Cell Membrane Structure and Function](https://www.teachengineering.org/lessons/view/van_membrane_lesson2) - While completing this lesson, students will learn more about cell membranes and the different ways that substances can move through them.

**Teaching Strategies**

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

* **Alternative to Anticipation Guide:** Before reading, ask students what they know about opioids, including their names, and the opioid epidemic. Their initial ideas can be collected electronically via Jamboard, Padlet, or similar technology.
  + As they read, students can find information to confirm or refute their original ideas.
  + After they read, ask students what they learned about opioids.
* After students have read and discussed the article, ask students what surprised them and what they want to remember from the reading.
* These ACS Reactions videos may be used to guide class discussions after students have read the article. The first one is also a good summary of the information in the reading.
  + *Can we make opioids less addictive?* (5:34) -<https://youtu.be/8xoOF2x0XzM>
    - This video is a good overview of the history of opioids, including why new opioids were developed, the role of dopamine in addiction, and ideas for making opioids less addictive.
  + *What happens when you overdose?* (5:51) -<https://youtu.be/xLSz3wEgwJ8>
    - This video describes the effects of overdoses for different drugs including depressants such as alcohol and benzodiazepines, opioids, and stimulants such as caffeine and methamphetamines.

# Chemistry Concepts and Standards

**Connections to Chemistry Concepts**

The following chemistry concepts are highlighted in this article:

* Intermolecular forces
* Molecular structure
* Functional groups
* Pharmaceuticals

**Correlations to Next Generation Science Standards**

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

**HS-LS1-2.** Develop and use a model to illustrate the hierarchical organization of interacting systems that provide specific functions within multicellular organisms.

**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:**

* LS.1.A: Structure and Function
* ETS1.B: Developing Possible Solutions

**Crosscutting Concepts:**

* Cause and effect
* Structure and function
* Stability and change

**Science and Engineering Practices:**

* Obtaining, evaluating, and communicating information

**Nature of Science:**

* Science is a human endeavor.

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).