

**Teacher’s Guide**

**Origin of Life**

***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

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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. Living and nonliving things obey the same physical laws. |
|  |  | 2. Only biologists and chemists study the origin of life on Earth. |
|  |  | 3. All life on Earth uses water as a solvent. |
|  |  | 4. DNA and RNA are polymers. |
|  |  | 5. Living things on Earth use more than 200 amino acids to make proteins. |
|  |  | 6. Stromatolites are rocks that may provide clues to when life began on Earth. |
|  |  | 7. Chemicals required for life have been found trapped inside meteorites that formed billions of years ago. |
|  |  | 8. DNA and RNA are made of proteins. |
|  |  | 9. Energy is required to sustain life. |
|  |  | 10. Prebiotic chemists agree about the chemistry of life’s exact origins. |

# Student Reading Comprehension Questions

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

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

1. State the six main elements that make up all living forms.
2. Define polymers and monomers. Explain how DNA is a polymer
3. What are proteins? How many proteins are needed for living things?
4. What is prebiotic chemistry?
5. Why do scientists think stromatolites are the key to the origins of life?
6. Explain how DNA works with RNA.
7. What happens to a living organism when it does not receive enough protein?
8. Explain 1 theory of how proteins and RNA were formed before they could make DNA.
9. Think about the structure of carbon, and how it bonds. Explain why there are so many different reactions with carbon-based molecules.

**Student Reading Comprehension Questions, cont.**

**Questions for Further Learning**

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

Look up the 20 amino acids that human bodies need to function. Which are the “essential” amino acids? Why are they “essential”?

# Graphic Organizer

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

**Directions**: As you read, look for the terms listed below, then list them in order from the simplest to the most complex. in the graphic organizer below.

|  |  |  |  |
| --- | --- | --- | --- |
| **Terms to use** | | | |
| Amino acid | Protein | Elements | Nucleotide |
| DNA | RNA | Enzyme | Organism |

|  |  |  |
| --- | --- | --- |
| **Term** (simplest to most complex) | **Definition in your words** | **Examples from the article** |
|  |  |  |
|  |  |  |
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|  |  |  |
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|  |  |  |

**Summary:** On the back of this sheet, write a short explanation of how scientists search for evidence regarding the origin of life on Earth.

# Answers to Reading Comprehension Questions & Graphic Organizer Rubric

1. State the six main elements that make up all living forms.

Carbon, hydrogen, oxygen, nitrogen, phosphorus, and sulfur

1. Define polymers and monomers. Explain how DNA is a polymer.

A polymer is a large molecule made up of individual monomers. A monomer is the molecular building block of the polymer. DNA is a polymer because it is a large chain of nucleotides, which would be the monomers.

1. What are proteins? How many amino acids are needed to make proteins for living organisms?

Proteins are a group of smaller molecules (called amino acids) that are linked by chemical bonds. Living organisms typically need 20 different amino acids to make the proteins.

1. What is prebiotic chemistry?

Chemistry that could have been occurring before life existed on Earth.

1. Why do scientists think stromatolites are the key to the origins of life?

The oldest stromatolites are about 3.5 billion years old. These stromatolites are formed when single celled organisms secrete minerals such as limestone, and pyrite.

1. Explain how DNA works with RNA.

The genes from the DNA are transcribed to the RNA when the DNA and RNA are attached. The RNA takes these replicated genes and translated to proteins to help build new cells or the organisms

1. What happens to a living organism when it does not receive enough protein?

Not enough protein will have an adverse effect on the body. The proteins act as enzymes that help speed up the reactions to spread DNA or to help build cell membranes.

1. Explain 1 theory of how proteins and RNA were formed before they could make DNA.

One theory is that genes existed before living organisms were formed, and the genes replicated to make the organisms over time. Another theory is that RNA was the main molecule, used for replicating and supporting living organisms before proteins were evolved to take the job from RNA.

1. Think about the structure of carbon, and how it bonds. Explain why there are so many different reactions with carbon-based molecules.

The carbon atom has 4 bonding sites, so it can form 4 single bonds, or many variations of multiple (double and triple) bonds. (For upper level chemistry students: carbon can undergo sp3, sp2, and sp hybridizations, allowing for many combinations of bonds).

**Questions for Further Learning**

Look up the 20 amino acids that human bodies need to function. Which are the “essential” amino acids? Why are they “essential”?

The 20 amino acids are (essential are in boldface):

alanine arginine asparagine aspartic acid

cysteine glutamic acid glutamine glycine

**histidine isoleucine leucine lysine**

**methionine phenylalanine**  proline serine

**threonine tryptophan**  tyrosine  **valine**

The 9 essential amino acids are the ones your body cannot produce on its own. In order for you to get these amino acids, you must eat the right foods that contain them.

**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**
  + Turn milk into plastic: <https://teachchemistry.org/classroom-resources/turn-milk-into-plastic>
  + Molecular Spaghetti:

<https://teachchemistry.org/classroom-resources/molecular-spaghetti>

* + Making Silly Putty:

<https://www.pbs.org/parents/crafts-and-experiments/two-ingredient-silly-putty-video>

* + Creating DNA:

<https://www.teachengineering.org/activities/view/cub_biomed_lesson09_activity2>

* + Everyday Polymers Lesson:

<https://www.teachengineering.org/lessons/view/csu_polymer_lesson01>

* + Polymers

<https://teachchemistry.org/classroom-resources/the-power-of-polymers>

* **Lessons and lesson plans**
  + Compound Chem:

<https://www.compoundchem.com/2015/03/24/dna/>

* + Silly Putty Polymer:

<https://www.compoundchem.com/2015/11/10/sillyputty/>

**Teaching Strategies**

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

* **Alternative to Anticipation Guide:** Before reading, ask students what chemicals are required for life, and how they think scientists study origins of life. 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 the study of the origin of life.
* After students have read and discussed the article, ask students how understanding chemistry is important for studying biology.
* The videos below may be of interest to students after they read the article to learn more about how scientists study the origin of life, including in places other than Earth.
  + Did Comets Kickstart Life on Earth? (4:14) - <https://youtu.be/FnuldVd99x8>
    - The video presents interesting theories regarding debris from the early solar system that is trapped in comets, as well as other possible sources of complex carbon molecules.
* What is Life? And how will we find it on other planets? (8:08) -<https://youtu.be/f44OWlsLeT0>
  + The video describes chemical systems that scientists are looking for on exoplanets in the search for life elsewhere in the universe.

# Chemistry Concepts and Standards

**Connections to Chemistry Concepts**

The following chemistry concepts are highlighted in this article:

* Organic chemistry
* Polymers
* Chemical change
* Nature of science

**Correlations to Next Generation Science Standards**

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

**HS-LS1-6.** Construct and revise an explanation based on evidence for how carbon, hydrogen, and oxygen from sugar molecules may combine with other elements to form amino acids and/or other large carbon-based molecules.

**Disciplinary Core Ideas:**

* PS.1.A: Structure and Properties of Matter
* LS1.A: Structure and Function

**Crosscutting Concepts:**

* Cause and effect
* Energy and matter: Flows, cycles, and conservation
* Stability and change
* Structure and function

**Science and Engineering Practices:**

* Planning and carrying out investigations
* Engaging in arguments from evidence

**Nature of Science:**

* Scientific knowledge is open to revision in light of new evidence.
* Scientific knowledge assumes an order and consistency in natural systems.
* Science addresses questions about the natural and material world.

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).