

Searching For Life Beyond Earth With The James Webb Telescope
Ahana Keswani
Portola Valley, California

ABSTRACT:

Introduction: The James Webb Telescope (JWST) has made it possible to study the atmospheres of exoplanets in much greater detail and search for possible signs of life beyond Earth. This paper examines recent findings and whether these observations bring us closer to answering the question of whether life exists on other planets.

Methods: This review paper analyzed five original research studies published between 2022 and 2025. The studies focused on exoplanets, biosignatures, or atmospheric observations made using JWST.

Results: The studies detected methane and carbon dioxide on K2-18 b and found possible but unconfirmed signs of DMS and DMDS. Other studies showed that TRAPPIST-1c most likely does not have a thick carbon dioxide atmosphere, GJ 341b does not have a confirmed atmosphere, and computer models suggest that some prebiotic molecules could be detected by JWST under the right conditions.

Discussion: Overall, the findings show that JWST has greatly improved our understanding of exoplanets, but no study has confirmed that life exists beyond Earth. More observations will be needed to confirm possible biosignatures and identify planets for future study.

INTRODUCTION:

For thousands of years, people have wondered whether Earth is the only planet with life. Today, we are closer than ever to answering that question. Thousands of planets outside our solar system, called exoplanets, have been discovered. More than 6,000 of them have been confirmed, providing many planets to search for possible signs of life [1]. Life on Earth needs liquid water, certain chemical elements, and a source of energy, so these are some of the first things to look for when studying other planets. Over the past few years, the James Webb Telescope (JWST) has made it possible to study the atmospheres of exoplanets in much more depth than ever before. Instead of only finding planets, JWST can also detect gases in their atmospheres that may give clues about what those planets are like. Some of these gases are called biosignatures because they are produced by living organisms and are more likely to be present when life exists. Finding evidence of life beyond Earth would help answer one of NASA's biggest scientific questions: Are we alone in this universe? [1]. Even with all the discoveries, we still do not know whether any exoplanets actually have life.

JWST has already been used to study several planets that may be able to support life. One of the most studied planets is K2-18 b, which orbits in the habitable zone of its star. Methane and carbon dioxide were detected in its atmosphere, suggesting that the planet may have a large ocean beneath its atmosphere. These discoveries made K2-18 b one of the most interesting planets to continue studying [1]. A later study reported possible signs of the gases dimethyl sulfide (DMS) and dimethyl disulfide (DMDS) [2]. On Earth, these gases are mostly produced

by tiny marine organisms, so they are considered possible biosignatures [2]. However, the evidence was not strong enough to confirm that either gas is actually present or that life exists on the planet. The study concluded that more observations will be needed before any conclusions can be made [2].

Not every planet has produced encouraging results. The TRAPPIST-1 c study found that the exoplanet most likely does not have a thick carbon dioxide atmosphere, making it less likely to support conditions similar to those on Earth [3]. Another study looked at the rocky planet GJ 341b but did not find enough evidence that it has an atmosphere. A few possible signals were found, but they could not confirm them, showing that repeated observations are important before any conclusions can be made[4]. Together, these studies show that JWST is helping improve our understanding of exoplanets more than ever before, and they show that finding evidence of life is not simple [1,2]. Some gases that look like biosignatures can also be made without living organisms, so we have to study the results carefully.

The purpose of this paper is to examine how JWST is being used to search for evidence of life on exoplanets and summarize what recent studies have discovered so far. Even though no study has proven that life exists beyond Earth, each new observation helps better understand which planets are the best places to continue searching.

METHODS:

This paper is a review paper about the search for life on exoplanets. Research articles were found using Google Scholar. The main search terms were K2-18 b, exoplanet, molecules, and James Webb Telescope. For the articles to be included in this paper, they had to be original research studies published between 2022 and 2025 that focused on exoplanets, biosignatures, or observations made with JWST or other observations of exoplanet atmospheres. Review papers, news articles, opinion pieces, and studies that did not include original research were excluded. Studies that did not focus on exoplanets for possible signs were excluded. After researching, 5 research articles that answered the research question were chosen for this paper.

RESULTS:

Two papers focused on the exoplanet K2-18 b [1,2]. The first study used the James Webb Space Telescope to observe the planet's atmosphere during a transit [1]. Methane (CH₄) and Carbon dioxide (CO₂) were detected [1]. Little evidence of ammonia (NH₃) was also reported [1]. Based on the atmospheric data, the atmosphere was rich in hydrogen [1]. The paper reported possible signs of dimethyl sulfide (DMS), but the signal was not strong enough to confirm its presence [1]. The main molecules that were found in this study are shown in the table "molecules reported in the K2-18 b studies" [1].

A second study collected more JWST observations of K2-18 b using the mid-infrared instrument (MIRI) [2]. The study searched for dimethyl sulfide (DMS) and dimethyl disulfide (DMDS) [2]. Possible signals matching both gases were found, but the evidence was not strong enough to fully confirm either one [2]. The study concluded that more observations are needed before confirming that DMS or DMDS is actually present in the atmosphere. [2]

The other studies looked at different exoplanets using JWST observations [3,5]. One study examined the rocky planet TRAPPIST-1 c to discover if it has a carbon dioxide atmosphere [3].

The results showed the planet most likely does not have a thick carbon dioxide atmosphere [3]. In contrast, the planet appears to either have a thin atmosphere or no atmosphere at all [3]. The observations also suggested that the planet has a very hot surface [3]. This conclusion was found by comparing the observations with the atmospheric models [3]. The results they came up with did not match what would be expected if the planet had a thick carbon dioxide atmosphere [3].

Another study focused on the exoplanet GJ 341b using JWST/NIRcam transmission spectroscopy [5]. Changes in starlight were measured during the planet's transit caused by phases in the planet's atmosphere [5]. Several possible atmospheric properties were found, but none were strong enough to confirm that an atmosphere is present [5]. The study concluded that more observations are needed before a solid conclusion can be made [5]. Even though some possible signals were caught, they were not strong enough to identify any atmospheric gases.

One study did not focus on one planet. Instead, computer models were used to see if prebiosignature molecules could be found by JWST [4]. These are molecules that may exist before life develops [4]. The models showed that a few of these molecules could produce signals that JWST could detect when under the right circumstances and conditions [4]. The study found several prebiosignature molecules that could be identified if the atmosphere being observed is suitable [4].

All five studies reported different results based on which planet was being studied [1-5]. Both K2-18 b studies detected or suggested molecules that are important for studying the atmosphere of planets, including methane, carbon dioxide, DMS, and DMDS [1,2]. TRAPPIST-1 c did not find evidence of a carbon dioxide atmosphere, while the GJ 341b study could not confirm that the planet has an atmosphere [3,5]. The modeling study showed that certain prebiosignature molecules could be detected by JWST if under the correct conditions [4]. Overall, JWST was used in different ways across the five studies, but all of the studies collected data on exoplanet atmospheres and molecules, which helped improve our understanding of these exoplanets. [1-5]. A summary of the main findings from the 5 articles is shown in the main conclusions figure.

Figure 1. Molecules Reported In The K2-18 b Studies	
Molecule	Result
Methane (CH ₄)	Detected [1]
Carbon Dioxide (CO ₂)	Detected [1]
Ammonia (NH ₃)	Minor evidence found [1]
Dimethyl Sulfide (DMS)	Possible, not confirmed [1,2]
Dimethyl Disulfide (DMDS)	Possible, not confirmed [2]

Figure 2. Main Conclusions		
Study	Planet	Main Finding
Madhusudhan et al 2023 [1]	K2-18 b	Methane and Carbon Dioxide detected
Madhusudhan et al 2025 [2]	K2-18 b	Possible DMs and DMDS signals, not confirmed.
Zieba et al. 2023 [3]	TRAPPIST-1 c	No thick carbon dioxide atmosphere detected.
Claringbold et al. 2023 [4]	Atmospheric Models	Many pre-biosignature molecules can be detected with JWST.
Kirk et al. 2024 [5]	GJ 341b	No atmosphere detected or confirmed.

DISCUSSION:

The purpose of this paper was to examine how JWST is being used to search for evidence of life on exoplanets and what recent studies have discovered so far. Overall, the results showed that JWST has significantly improved our ability to study the atmosphere of distant planets, but no study has found clear evidence that life exists beyond Earth. This answers the research question by showing that important progress has been made, even though no biosignatures have been confirmed.

The most significant finding comes from the two studies on K2-18 b. Both detected or suggested molecules that are important for understanding the planet's atmosphere, including methane, carbon dioxide, DMS, and DMDS [1,2]. However, neither study was able to confirm that DMS or DMDS is actually present, showing that possible biosignatures require strong evidence before they can be connected to life. The study on TRAPPIST-1 c and GJ 341b also showed that not every planet has conditions that could support life, while the modeling study suggested that JWST may be able to detect prebiosignature molecules under the right conditions [3-5]. Together, these findings show that searching for life is more complicated than looking for a single gas.

Most of these results were expected because detecting life on another planet is extremely difficult. One surprising result was that even with the advanced technology on JWST, possible biosignatures cannot be confirmed without extra observations. This shows how challenging it is to study planets that are many light-years away.

These findings line up with recently published studies showing that JWST has significantly improved the study of exoplanet atmospheres but still has not found confirmed evidence of life beyond Earth. Future observations will help determine whether a possible biosignature can be confirmed and identify the most promising planets for future study. This information can also

guide future missions by showing which planets and atmospheric molecules should receive the most attention. One of the biggest lessons from this review is that scientific discoveries require repeated observations and strong evidence before conclusions can be made, an idea that applies to many other areas of science.

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