As technology continues to advance over time, humans must stop every now and then to review the consequences of such technology and the responsibilities that couple them. Human exploration is a major contributor to these advancements and falls subject to review. Over the past 60 years, human exploration beyond earth has blossomed from science fiction into reality and only continues to grow. Because of this, we must step back and review our impact upon the places we are exploring. More specifically, humans should ensure the sustainability of scientific study on other planetary bodies beyond Earth; this idea falls is dubbed 'Planetary Protection.' Recently, the motivation behind planetary protection has expanded from preventing contamination of other bodies to preserve scientific study, but to prevent contamination of other bodies to preserve the possible biospheres that may exist there based on ethics. Planetary protection, both from a scientific basis and ethical basis are important and necessary. To show that planetary protection is necessary, I will first discuss why it is important to scientific study and then I will discuss its ethics.

Protecting other bodies in our solar system (forward contamination) as well as Earth (backward contamination) from contamination and destruction is vital to acquiring accurate scientific data. NASA's Office of Planetary Protection states that their main objectives are: "Carefully control forward contamination of other worlds by terrestrial organisms and organic materials carried by spacecraft in order to guarantee the integrity of the search and study of extraterrestrial life, if it exists." [1] The purpose of doing this is to maintain the integrity of scientific data obtained beyond Earth. For example, "if a sample of Martian soil were contaminated with life from Earth, it might be more difficult to discern whether the sample also contained biological material from Mars."[2] In this case, the contamination of the sample would automatically make its results vastly more uncertain. It is not impossible to infer the sample's true composition, but it would need to be altered which introduces many more sources of error, thus making the sample unreliable. However, this is with the viewpoint that we *know* that the sample is contaminated by Earth-borne organic material. If we did not know about the contaminant (which is more likely), the sample would show and imply the presence of life of Mars, when in reality, that life is actually from Earth. This conclusion would have a profound impact on most fields of science, philosophy, religion, and it would likely alter the economics of space exploration. More missions would be planned to find current and past life on Mars; in fact, these missions would become prioritized and affect other space missions. Some proposed missions may lose funding and be canceled to generate funding for another Mars mission, which would have further implications for those working on and relying on data from the canceled mission. All of this, however, for naught. It should be acknowledged that more than one observation is needed to 'confirm' a result such as this. So, if all other results from all other Mars missions (which we will assume are not contaminated by Earth-life) show life to not exist there, including other samples taken from the same spot where the contaminated sample was taken, then the results from the contaminated sample could be deemed an anomaly. But if all missions were contaminated, the results of life on Mars would appear undoubtedly true and the snowball effect presented could easily occur.

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[1] https://sma.nasa.gov/sma-disciplines/planetary-protection

[2] https://www.nasa.gov/feature/new-planetary-protection-board-to-review-guidelines-for-future-solar-system-and-beyond

Forward contamination of places beyond Earth is not planetary protection's only concern. It also seeks to prevent potential life from contaminating Earth's biosphere. NASA's Office of Planetary Protection's other main objective is to "Rigorously preclude backward contamination of Earth by extraterrestrial life or bioactive molecules in returned samples from habitable worlds in order to prevent potentially harmful consequences for humans and the Earth's biosphere."[1]. Protecting the Earth and life on it is a widely held concern of most people, and large world organizations. This idea is one that did not originate in science and extends far beyond the scientific realm to impact our daily lives. Recycling, wildlife and forest preservation, reduction of greenhouse gas emissions are all important to maintaining Earth's biosphere. However, if it was infected by a foreign body, the results may be catastrophic. Take the classic example of Christopher Columbus and the Spaniards interacting with the indigenous peoples of the (future) Americas. The Europeans brought viruses and diseases with them to the new world that nearly wiped out all native peoples. The Oklahoma Medical Research Foundation states, "In Hispaniola, Columbus' first stop in the Americas, the native Taino population (an indigenous Arawak people) had no immunity to new infectious diseases, including smallpox, measles and influenza. There were an estimated 250,000 indigenous people in Hispaniola in 1492. By 1517, only 14,000 remained."[3] Humans and all other Earth life would not have any immunity to extra-terrestrial life. If introduced and spreads throughout the Earth's biosphere, it could have similar consequences. Though, it may not have any consequences. Life on earth may not react at all, maybe it could benefit life on earth is a symbiotic kind of way. Maybe it would act as a virus or disease and the immune system could take care of it. Nobody knows and nobody can know until such life is found and tested in a confined, safe environment. With planetary protection, these concerns can be mitigated and in a worst case scenario, protect Earth's biosphere from harm.

These were the initial intents of planetary protection, but the implications have expanded from beyond science into the realm of ethics. We can apply the scenario described in the previous paragraph about the destruction of Earths biosphere due to foreign contaminants to other worlds. If life does exist on Mars and it becomes contaminated by Earth life, the Mars life may be completely wiped out. Though the intentions of the mission that contaminated Mars was obviously not to destroy Mars' potential biosphere, that does not exonerate the outcome. If we look at life without a filter (life is life, whether intelligent or not, single cellular or not, etc…), it becomes evident that innocent life should be maintained. Such life would not benefit humanity in terms of survival (like how killing and eating fish provides humans a source of energy) and thus its destruction would be reckless and without purpose. This life would have evolved entirely independent of life on earth and as such, humans have no place in removing them from their initial habitat. Essentially, whatever life may be affected would not "deserve" to be potentially eliminated.

Planetary protection can be extended in two ways: forward, where contamination of other planetary bodies is prevented; and backwards where contamination of the Earth from space is prevented. The implications of these are both scientific and ethical in nature and should be rigorously followed on the bases of both. It ultimately keeps life on Earth, and life that may exist beyond Earth safe – Planetary Protection is absolutely necessary.

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[3] https://omrf.org/2013/10/10/columbus-brought-more-than-ships-to-the-new-world/