

## Introduction

Microbes have existed without humans for billions of years, and can easily do so again. This much is obvious, as they have existed long before humans, with fossils dating back to 0.2 million years ago (Ma) [1], but very likely to have existed even before this, before 3500 Ma [2].

When it comes to treating the land with respect, and the natural order of things on Earth, the human race behaves like naïve reckless teenage believing that that they are completely autonomous and independent after coming to know a bit of the world around them. However, if this behaviour is not altered soon, we may be at risk of extinction. While microbial life is probably content to go on without us in whatever state we put the world in, humans cannot survive without microbial life. In this paper, the roles of microbial life's irreplaceable and essential role in supporting human life will be examined. This involves discussion of why microbes would be impossible to replace with human technology, both in quantity (abundance, catalysis on a global scale) and quality (complexity).

## Quantity

Firstly, simply due to the sheer number and abundance of microbes, microbes would be extremely difficult or impossible to replace. While it is common knowledge the microbial life is everywhere, quantitative classification is still largely unconsidered. Based on the work of Whitman, Coleman, and Wiebe in 1998, the number provided for prokaryotic cells on Earth was approximated to be  $4-6 \times 10^{30}$  cells, and attributing to 350-550Pg of carbon [3]. This number is so massive, it is almost easy to trivialize, since we generally do not have a concept of this number. To put this in perspective, consider that if we were to count every grain of sand on earth in all deserts and beaches, which would be roughly equal  $7.5 \times 10^{18}$  grains of sand. This does not even come close to the number of prokaryotic cells on earth. However this might have been obvious, considering the fact that microbes are everywhere and also magnitudes smaller in size. More comparably, the number of stars in the universe has been approximated to be  $7 \times 10^{22}$ . This still does not come close to the number of prokaryotic cells. Each one of these cells is constantly under natural selection pressures, evolving, and adapting to our ever changing climate, responsible for catalyzing reactions, providing energy as a primary producer, and acting

as a huge storage of all of the information used to carry out all these roles and processes. Therefore, to begin considering a life without microbes, or replacing microbes, we would have to somehow be able to do the equivalent work of  $4-6 \times 10^{30}$  cells, a number that we cannot even realistically conceptualize.

Even if we were to put the microbes' role as a large primary producer aside, that still leaves the role microbes play in the cycling of elements on a global scale. In particular, Nitrogen, which is essential for synthesis of nucleic acids and proteins, and Carbon, an essential element for all organic life. Humans have made a huge impact on the Nitrogen cycle in the 20<sup>th</sup> century, including reducing the inert form of Nitrogen,  $N^2$  to  $NH_4^+$ , implementing new agricultural practices to boost yields, and burning fossil fuels [3]. This has all been driven through thoughts of profits, and convenience. However, very little attempt has been made towards keeping the natural order or balance of things. As a result of this misuse of Nitrogen, there have been significant effects to the environment, such as nitrogen loss and subsequent eutrophication of coastal waters – where diversity of life is dying out due to the newly created hypoxic environments [3]. As indicated by this detrimental effect of humans on the Nitrogen cycle, humans *are* in fact capable of manipulating the cycling of elements on a global scale, just like the microbes. However, unlike the microbes, humans in general, unless driven by profit, do not care for what state an element is in. This means that only the only elements that we deem “useful” will be kept in supply, while others will be in whatever form or state is most convenient. This also means that the balance of elements, or preserving of the cycles, including the Nitrogen cycle, or any other cycle is of no concern at all. There is no respect, or “land ethic” that frowns upon the most efficient commercial processes that put elements out of balance and in disarray instead. Only the microbes are concerned about keeping a balance, since they are not motivated by profits, but rather, by survival. As they grow and adapt to niches, an equilibrium is achieved. If not for the microbes' essential role in cycling these elements, we would already be out of Nitrogen and extinct. An even more alarming example of element consumption is Carbon. The carbon cycle has a “leak” where a small amount of organic carbon sinks to the ocean floor and becomes part of sediment, and is unable to re-enter the cycle [4]. This leak, paired with the industrialization of the human race and burning of fossil fuels has

resulted in massive emissions of carbon dioxide into the atmosphere, could potentially result in a mass extinction within the next century [4]. In consideration of the coordination required to alter both the nitrogen and carbon cycles (ie. All of humanity's fertilization of crops, and burning fossil fuels), it is highly unlikely that the human race would be able to concert a coordinated effort towards innovation and preserving the balance of the different states of the elements until it is too late. If we are unable to replace even an aspect of microbes role in cycling the elements to prevent extinction at the sacrifice of financial profit, it is impossible to even begin considering replacing the microbes role in cycling every single element on Earth.

### Quality

Even if humans were somehow miraculously united and agreed to put all resources towards sustainable practices, research and innovation to maintain the balance of the mentioned elements, the complex roles that microbes play in an interconnected ecological web still remain to be understood. After all, how can we replace something if we don't even know what it does, or how it works? Through trial and error, evolution has given us an order of things that is sustainable, yet we are throwing things out of balance, and not stopping. Additionally, in a naïve attempt to fix some of our wrongdoings, we have made actually things worse, due to a lack of understanding of the complexity involved with a problem. For example, to manage the invasive cane toads originally brought to Australia, the Lungworms were introduced, since the introduced cane toads were overrunning the native tree frog population [5]. Unfortunately, lungworms also ended up killing the tree frog numbers as well [5]. It is wholly possible that humans trying to fix the cycling of elements on a global scale by counterbalancing with another human-introduced intervention could actually make things worse than before, similar to the cane toad example. Additionally, microbes are also involved in their own unique communities and part of every single complex ecological web on earth. Humans trying to replace the microbes in these roles without a complete understanding would be a mistake, and a complete gamble. Even then, how would we know when we have captured every aspect? Everything is interconnected, and human research has not yet come to a mature enough level to even begin understanding the intricacies and nuances of the delicate balances in the world around us. In research, we are still only capable of culturing and studying only a small fraction of microbial

life compared to the total diversity seen in nature, and still a far ways away from understanding all the interactions that the microbes have [6].

### Conclusion

In short, humans are still a long way away from replacing microbial life, while microbial life is content to exist without humans, even if we happen to go extinct. Massive innovation and leaps in our understanding are required before consideration of replacing microbial life is even possible. This innovation would have to replace the numerous microbes, and be able capture the massive storage of information that is contained within microbes that is constantly expanding to account for the changing environment, and dynamic equilibrium state of the world's elements. In addition to this, the complex interactions that the microbes are responsible for across different environments would also need to be understood before replacement or alteration of the sensitive ecological webs can occur. If microbial life were to suddenly disappear tomorrow, or even with the next few decades, humans would almost certainly face imminent extinction. Fortunately, microbes are fairly resilient, and despite our accidental efforts towards extinction of all life, they are here to stay.

### References

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