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## **Letter of recommendation for Lucas Monteiro**

To whom it may concern:

It is a pleasure to write this letter of recommendation for Lucas Monteiro

I have known Lucas since he was my student in the (*Stellar*) *Astrophysics* course of the Physics BSc programme at the Faculty of Science of the University of Lisbon, class of 2020/2021. He completed the course in the top tier, with the second highest grade I gave that year (ex-aequo with another colleague).

Some time later, in May 2022, he approached me asking to do a MSc thesis project under my supervision. Lucas had enrolled in the Bioinformatics and Computational Biology MSc programme, and wished to use his background in Astrophysics. While my main research activity is centred on the structure and evolution of the Milky Way, I also have a longstanding interest in space exploration and on the long-term sustainability of outer space activities (for 10 years, I was a member of the UN-COPUOS working group dedicated to this subject). Given the imminent rebirth of human space exploration, I proposed that we explored possibilities of biocontamination in extraterrestrial conditions using bioinformatics and computational biology methods.

The idea required bringing into the team another supervisor, expert in those methods. Lucas identified my colleague Francisco Pinto, from the Chemistry and Biochemistry department, an expert on genome-scale metabolic models (GEMs), who embraced the idea.

Lucas's thesis subject consisted in adapting an existing GEM of a selected microorganism to the conditions found in extraterrestrial conditions, namely the Moon and Mars. It is worth noting that GEMs are useful for simulating how simple organisms produce biomass, needed for their growth, reproduction, structure maintenance and adaptation to environments. However, analysis of these models is often performed under normal conditions and does not consider the extreme environmental conditions expected on other planets. The project would then involve creating a method to include non-standard thermodynamic conditions of the environment in the GEM. This would be done by estimating the reaction's kinetic parameters under those conditions and analysing the stress that the organism must go through in order to adapt. The method would then be used to assess the survival of a microorganism



under realistic conditions found in the Moon and Mars. The selected microorganism was *Escherichia coli*. The choice was dictated by its simplicity, being well-studied, and its role as a contaminant on Earth, easily using humans as dissemination vectors.

Lucas proved to be a very motivated MSc student. It was a complex project with several challenges that he had to overcome. One example was dealing with inconsistent metabolite concentration values due to heterogeneous experimental conditions. For this case Lucas developed a genetic algorithm for optimising metabolite concentrations, including the estimation of model rate constants. Along this and other stages of the project he had to find ways (data curation and algorithms) to overcome the issues posed by heterogeneous or missing data. In the end, while those data limitations did not allow reaching conclusions on the survival of *E. coli* in other environments, Lucas' work has brought an excellent first step, and a clear view of what still needs to be done.

Given the above, his background and motivation; the experience of "Young Graduate Trainee in Computational Biology" would be very beneficial for Lucas' education and career. I therefore strongly support Lucas' application.

Please do not hesitate to contact me for any further information.

Lisbon, March 7, 2024

Yours truly,

André Moitinho