

Título: Astrobiologia
Subtítulo: Uma Ciência Emergente

Preface

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Since the dawn of civilization, we have beheld at the beauty and wonder of the natural world around us and wondered how it came to be. We have pondered the past, and have been intrigued about the future. For this we are unique. Our ancestors looked to the vastness of space and thought surely there are others out there.

We are now at a new time in human history where we can address these age-old questions with a scientific approach and study rigorously the three big questions of astrobiology: *Where do we come from?* *Where are we going?* and *Are we alone?* These fundamental questions of astrobiology correspond to those of humanity, and arguably, what makes us human. And so we cannot help but be drawn to the field.

Unlike other scientific disciplines, Astrobiology draws on the latest advances in a multitude of fields, from evolutionary and molecular biology, to prebiotic and interstellar chemistry, from astrophysics to astronomy, with a healthy dose of earth and planetary science. Astrobiology is in reality a “metadiscipline” drawing on useful science wherever it is to be found. From a practical point of view, this endeavor requires the interaction of scientists who might not normally meet each other, much less work on a common research project.

And, unlike most other scientific disciplines, Astrobiology has implications for how we see ourselves, and how we interact with the earth and beyond. *“Where do we come from”* touches on the “why” questions that have intrigued not just scientists but philosophers and theologians. *“Where are we going”* adds to these an economic and political involvement that is currently being played out with discussions of climate change. *“And are we alone”* will someday force us to face the fact that we as living creatures are not unique, or perhaps that we are utterly alone in the universe, the result of a chemical history that was so improbable as to result in a sample size of one. Either

result will force ethical considerations of either “the other” and their relationship to us, or our solitude and thus responsibility as the only life form in our cosmos.

So what is Astrobiology? Let’s start with the “*Where do we come from?*” A biologist will approach this looking at the evolution of life on earth, using such traditional tools as comparative anatomy and paleontology and newer tools such as molecular techniques. But this doesn’t address why this happened the way it did without a comprehensive understanding of the environment. What was the temperature at such and such a time? Was the earth in a snowball phase or being bombarded by meteorites -- or even just a single large, well-placed one such as struck off the Yucatan peninsula 65 million years ago. This event could not have been predicted by population genetics alone, yet it had the most profound influence on our evolution as without it, we could still be in a world dominated by dinosaurs with the mammals cowering under cover.

But it is not enough to go back to LUCA, the Last Universal Common Ancestor of all extant life. One must go back to the dawn of life. How did life arise? What was the environmental backdrop that allowed it to happen? How did we happen to end up with a habitable planet? Indeed, what is the origin and evolution of our solar system, galaxy, biogenic elements all the way back to the Big Bang.

The “*Where are we going?*” tends to be ignored in many astrobiology programs, but in fact this is of the most immediate importance to us. Whereas the past was dominated by physical and chemical processes, and organismal interactions, the future has a new major player: us. While we probably don’t have the power (yet) to stop our galaxy passing through another, or even reset the sun or stop the movement of the moon away from the earth, all of these things will influence the future of life on earth. We are already proving that we have the power to visit other bodies in our solar system, either with humans or our robotic surrogates. We are changing our atmospheric composition and thus our climate. We have the power to render species extinct, including our own. But we also have the power to use these tools for the common good, to extend our lifetimes and reclaim our rivers and forests. Which will it be?

And then there is the question where science fiction becomes a reality: “*Are we alone?*” While many people are anxious to find signs of intelligent life out there, such a creature may not share either our curiosity or values. But what if there was a beneficent alien civilization that could communicate with us, perhaps forging a mutual understanding? More likely in the foreseeable future is finding a small life, less evolved, life form. Note I did not use the word “simple” as there is nothing “simple” about life, ever. Which brings us back to the question: *what is life?*

So where does Brazil come in? For nearly a decade there has been interest in a Brazilian astrobiology program, from a small side meeting held by the Brazilian Exobiology Program (BEP) of the Brazilian National Research Council, held in Rio de Janeiro, Brazil, on August 12, 2009, in association with the IAU Assembly to subsequent workshops held in several locations and membership of the Brazilian program in the NASA Astrobiology Institute (NAI). Each time I go to Brazil, I am impressed by the enthusiasm of the community, both scientific and student, the latter an excellent omen for the future of astrobiology in Brazil. Facilities are being built to supplement the natural laboratories that Brazil is blessed to have. In my own lab I have been privileged to have a wonderful Brazilian postdoctoral fellow, Dr. Ivan Paulino-Lima, resulting in a daily reminder of the program. I am honored to have been part of the development of astrobiology in Brazil, and hope that this relationship will continue to flourish.

Clearly to advance astrobiology needs new knowledge, a reorganization of that which is known, and space missions. To help the reader join on this quest, what follows is a buffet of topics that will allow the reader to nibble on the richness that is Astrobiology. And, like a fabulous meal, it should make you want more. Welcome to Astrobiology.

From Doug:

It is a pleasure for myself to invite you to write a preface for this book. You have been supporting not only myself, Ivan, and many other Brazilian students and young researchers, but, in my view, you have been the main supporter for the development of the whole field in our country, in its modern and rigorous format (which is still being developed, of course). Due to that, I believe that your comments on this history, of your participation, outside view and even vision for the future, will be inspirational for all the Brazilian students who read the book.

As our idea is to have an ample distribution of the book, and it is part of an educational initiative, the whole material will be made available by the University of Sao Paulo in digital format (eBook), for free. We also plan to have it in printed format, depending on the demand.

I have talked to Ivan about this, and he was excited about having your participation. As it will be published in Portuguese, Ivan or myself can help by making an “official” translation of your text, so that it is presented together with your original version in English. It doesn’t have to be very lengthy, but of course, you have the freedom to adopt the format you want for it. We have also invited Marcelo Gleiser (Dartmouth) for a preface, due to his interest on the field, and due to being one of the best known science writers in Brazil. It would be fantastic if we could count with both your contributions.

I hope you can accept this invitation! Unfortunately, we do have to finish all the text and material and send to the editorial official asap, as funding may get very complicated soon (you may have heard of the ongoing political and financial crisis going on down here). I would like to send everything to them by December 12, so that we ensure that the project can be closed still in 2015. Let me know if this deadline is too tight for you, and I’m sorry for this invitation in such a short notice.

Sincerely, and a great hug,
Doug

PS: below I’m sending you the chapter distribution, in Portuguese, but at least you can get a glimpse of the names and subjects involved.

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Organizadores:
Douglas Galante
Evandro Pereira da Silva
Fabio Rodrigues
Jorge E. Horvath
Márcio Guilherme Bronzato de Avellar

Capítulos e autores:

1. Astrobiologia: estudando a vida no Universo
Autores: Fabio Rodrigues (IQ – USP), Douglas Galante (LNLS/CNPEN) e Márcio G.B Avellar (IAG – USP)
2. A origem dos elementos
Autores: Roberto D. Dias da Costa e Jorge Ernesto Horvath (IAG –USP)
3. Astroquímica: a formação, a destruição e a busca de moléculas prebiótica no espaço
Autora: Heloisa M. Boechat-Roberty (OV – UFRJ)
4. Planetas habitáveis: onde estão os lugares no Universo adequados ao nosso ou outros tipos de vida?

Autor: Gustavo Porto de Mello (OV - UFRJ)

4.1: Zona de Habitabilidade Galáctica (box a ser inserido dentro do capítulo 4)

Autor: Felipe Nóbrega Pereira (IO – USP)

5. Química prebiótica: a química da origem da vida

Autores: Dimas A.M. Zaia (DQ – UEL), Cássia T.B.V. Zaia (DCF – UEL) e Cristine E.A. Carneiro (DQ- UEL)

6. Origem da vida

Autores: Douglas Galante (LNLS/CNPEM) e Fabio Rodrigues (IQ – USP)

7. A evolução da vida num planeta em constante mudança

Autor: Daniel J.G. Lahr (IB – USP)

8. Vida ao extremo: a magnífica versatilidade da vida microbiana em ambientes extremos da Terra

Autores: Rubens T.D. Duarte (UFSC), Catherine G. Ribeiro (IO – USP) e Vivian H. Pellizari (IO – USP)

9. Metabolismos pouco convencionais

Autor: André Arashiro Pulschen (IQ – USP)

10. Quando os animais herdaram o planeta

Autores: Mirian Liza Alves Forancelli Pacheco (UFSCar Sorocaba), Bruno Becker Kerber (UFSCar Sorocaba) e Francisco Rony Gomes Barroso (UFPE)

11. Busca de vida fora da Terra – estudando o Sistema Solar

Autor: Fabio Rodrigues (IQ – USP)

12. Luas Geladas do Sistema Solar

Autor: Douglas Borges de Figueiredo (Biotec – USP)

13. Busca de vida além do Sistema Solar

Autores: Douglas Galante (LNLS/CNPEM), Rosimar Alves do Rosário e Marcio G. B. de Avellar (IAG – USP)

14. A SETI e o tamanho do palheiro... Otimismo e pessimismo na busca de nosso alter ego extraterrestre

Autor: Jorge A. Quillfeldt (ICBS – UFRGS)

15. Futuro da vida na Terra e no Universo

Autores: Douglas Galante (LNLS/CNPEM), Gabriel Guarany de Araujo (Biotec – USP), Marcio G.B. Avellar (IAG – USP), Rosimar Alves do Rosário, Fabio Rodrigues (IQ – USP) e Jorge E. Horvath (IAG – USP)

16. Exploração Interestelar: Motivações, sistemas estelares, tecnologias e financiamentos

Autora: Amanda Gonçalves Bendia (IO – USP)