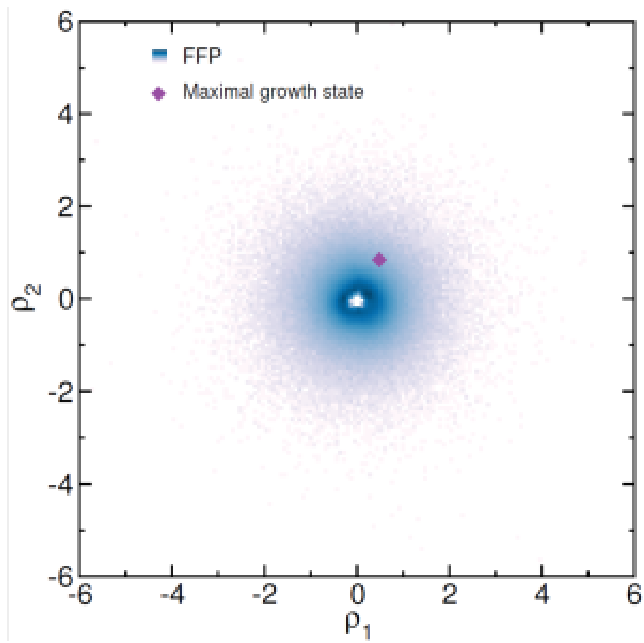
What is really driving our need for food, besides the pleasure of taste?

We all know that this need is related, in some way, with life sustainability, but just how, exactly? The task of converting food into energy --and back again into organic compounds-- is carried out by our metabolism, which, for instance, allows us to do sports using food as a fuel. This magic happens thanks to a complex set of chemical reactions that break down molecules into energy and vice-versa. Metabolism is thus what allows our cells to "carry on" and keeps us alive. Studying how metabolism works will allow us therefore to unveil the fundamental processes that sustain life. Additionally, a deep understanding of these processes may also help to devise strategies to tackle all those diseases in which cellular metabolism deviates from its normal behaviour, as, for instance, in the case of cancer.



Although one may imagine that studying these problems is mainly an experimental task, we have today enough computational resources and empirical data to reproduce biological systems in a computer, saving much time and money. This is exactly what we have done in our work: we have simulated a metabolic system in a computer and studied its behaviour under different circumstances. As it is normally done in science, where one studies first a model system, we examined in our work the reduced metabolic network of *Escherichia coli,* a bacterium commonly found in wild type in the lower track of our intestines. Much like us, bacteria need to "eat" and do convert the nutrients they get from the environment into growth and energy, but are much simpler organisms easier to study as compared to human cells.

Although computational studies of cell metabolism were already carried out before, those works generally focused on one possible state only, i.e. the one that maximizes growth. In a simile, they only considered the situation in which, having eaten chocolate, your body invests it all into growth. But, of course, depending on the circumstances, your metabolism may need to use food in some other way, as, for instance, to convert it into physical activity. Our work takes look at all possible metabolic states - what we call in our paper the feasible flux phenotypic space (FFP) - for different growth conditions of the bacterium E. coli. The full characterisation of this space provided us with a reference frame to quantitatively assess the difference between metabolic states. With this tool at our disposal, we were next able to check that the maximal growth condition is rather different from the bulk of possible states. This finding is very interesting from an evolutionary perspective, since it suggests that, to attain maximal growth --which is often observed experimentally-- evolution pushed metabolism towards a rather atypical region of the metabolic space. Last but not least, we were also able to reproduce and locate in the space some specific metabolic states that were observed experimentally but not by using other computational approaches. Quite interestingly, these states resemble a metabolic behaviour that is found in cancerous cells: by describing these states at the whole cellular system level, our work may ultimately provide hints on how to rescue a physiological state.

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Publication

Mapping high-growth phenotypes in the flux space of microbial metabolism.
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