Development of immunity in basal metazoans

Corals are one of the most important ecosystems on the planet as they support a wide and diverse array of organisms and human activities. Unfortunately, however, they are also one of the most vulnerable. Corals are categorised as anthozoans, a class shared by anemones, and are made up of small, colonial animals which come together to create reefs. As coral tissues contain symbiotic algae, they can only live within a “goldilocks zone”, where the waters are suitably warm and where the algae receive enough light to photosynthesise and support their coraline hosts. Climate change has reduced the size of the area habitable by corals due to ocean warming, and has caused further issues that include ocean acidification and an increased prevalence of coral diseases. As such, swathes of reef are being lost around the world due to bleaching (when symbiotic algae leave their coral host).

It is imperative that we find ways to improve corals’ resilience against worsening environmental conditions and the range of problems they can cause. Dr Mauricio Rodriguez-Lanetty from Florida International University (FIU), is currently conducting research that focuses on immunological priming in corals and anemones, a process by which an animal can resist pathogens through repeated, non-lethal exposure. As corals are at risk due to climate change, this is an important project to help further our understanding of their immunity. The project also includes an outreach programme to motivate minority students to pursue science as a career.

Dr Mauricio Rodriguez-Lanetty is currently leading a programme to research immunological priming in anthozoans and determine if these animals can be inoculated against disease. His programme will also provide educational and research experiences to high school, undergraduate, and postgraduate students to inspire the next generation of scientists.

Coral disease

Not only are corals very visually appealing, attracting thousands of tourists every year, they provide numerous services to local populations. They act as nurseries for fish, support fisheries, and protect coastlines from wave energy. Therefore, it is likely to encounter the same pathogens as corals in this area, making it susceptible to certain diseases such as humans and other vertebrates, which allow it to be used in place of corals in this research. By studying immunological priming in brown anemones, our understanding of the processes behind immunological defence in anthozoans, and the evolution of immunity in basal metazoans (species that diverged early on in evolution and have remained relatively unchanged since) will expand.

Immunological priming

Immunological priming is a process by which the immune response of an organism is strengthened by repeated exposure to a pathogen. This is common in more advanced species, such as humans and other vertebrates, but research suggests that priming could have developed much earlier in the evolutionary tree. In his initial research proposal for the CAREER programme, Dr Rodriguez-Lanetty hypothesised that sub-lethal exposure to a pathogen could result in anthozoans establishing a defensive response that they will be able to express more effectively when they encounter the pathogen again in the future.

To determine if this is the case, brown anemones were repeatedly exposed to Vibrio coralliilyticus – a bacterial species known to cause morbidity and bleaching in both corals and anemones. It was found that three days of exposure to the bacterium could be considered “sub-lethal”, and anemones exposed to the pathogen twice were more likely to survive future encounters to it, than those naïve to it. This is an exciting finding that suggests learnt immune responses such as this are not limited to complex vertebrates. As a result, this has opened many doors for further research into the immunological processes of anthozoans.

Differences in proteins between unexposed and exposed anemones were also identified, suggesting that this defensive mechanism is controlled at a molecular level. The identified proteins were similar to genes associated with immune responses in other organisms. One in particular was similar to inotropic glutamate receptors (iGluR), which are associated with neurotransmissions in animals with a nervous system, and are common in exposed anemones. Again, using brown anemones as a model system, nine iGluR-like genes were identified and found to change when the animal was exposed to a pathogen. This is a particularly interesting finding, as it suggests these types of receptors are more widespread than previously thought, and that they originated as mechanisms for sensing cues early on in evolutionary history.

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higher education. For this reason, the growth is expected to originate from the field.

By 2050, 60% of the US' population hopes to motivate minority high school students to consider scientic research as a career. This is inspired by his own experience held at Florida International University (FIU, Miami). After obtaining a bachelor degree in Biology in Venezuela, Dr Rodriguez-Lanetty achieved a PhD in Marine Studies from the University of Queensland (Australia) and is now the Principal Investigator of the IMAGES lab at FIU.

CAREER DEVELOPMENT

Inspiring future generations is a vital part of the scientific process. An important component of the CAREER programme is outreach to students from high school to postgraduate levels, and particularly to minorities who are underrepresented in science. This is highly important as it encourages those that may not pursue careers in science to consider entering the field.

By 2050, 60% of the US’ population hopes to originate from the Hispanic community, however, Hispanic people are the least likely to enter higher education. For this reason, the educational aspect of the programme focuses on engaging Hispanic students and other minorities.

Conducting a summer science programme entitled “Aventura Cientiica”, Dr Rodriguez-Lanetty hopes to motivate minority high school students to consider scientic research as a career. This is inspired by his own experiences, attributing a large part of his success to the positive role models he encountered throughout school and extra-curricular activities.

Aventura Cientiica is a four-week long experience held at Florida International University that will involve high school students in subjects included in the QBIC Programme (Quantifying Biology in the Classroom). Associated Molecular Patterns (PAMPs) for studying cnidarian symbionts benefit from each other, caught in a dozen of individuals to a population of hundreds in a month of the lab. All these features make the anemones the right ‘laboratory mouse’ to study corals.

What must be considered when using anemones as proxies for studying corals?

Coral species are very slow-growing organisms in average, extend their calcareous skeleton a few centimetres per year, and consequently, this poses a challenge to set up well replicated experiments that can be conducted in a reasonable timeframe to study how corals function and how they respond to biotic and abiotic factors around their changing environments. Hence, a surrogate model to study corals has been in need. Over the last ten years, several of us in the field of coral biology have proposed and are actively working using the sea anemone Eupaxiapina palmae, as a model organism to study corals. The important features considered in this selection were attributed to the fact that these anemones engage symbiotically with similar microorganisms as corals do and therefore, make them a good proxy to study coral biology and ecology. Furthermore, these anemones are fast growers and easy to culture in captivity and in laboratory conditions. A great advantage of this system is that clonal populations of anemones can be raised from a dozen of individuals to a population of hundreds in a month of the lab. All these features make the anemones the right ‘laboratory mouse’ to study corals.

How similar are the immune responses of anemones to our own immunological priming mechanisms?

In many cellular and molecular aspects, there are considerable differences between the immune system of anemones and those from humans, however, we have also learned they share more similarities that we once considered the long evolutionary history separating anemones from us.

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