Victora studies the basic biology of how antibodies are generated in response to infection and immunization. This includes the evolutionary process of affinity maturation in germinal centers, which is essential to improve antibodies’ powerful targeting capabilities, and the dynamics with which the diversity of antibody responses are pruned and focused on subsequent exposures.

When a pathogen invades the human body, the immune system responds by producing proteins called antibodies that are precisely targeted at the invader. These antibodies become part of the immunological memory that confers resistance to subsequent exposures to the same pathogen, and form the basis for vaccination.

Antibodies are tuned to efficiently recognize a specific invader through affinity maturation, in which a small region of the antibody undergoes random hypermutation, followed by the proliferation of mutants with high affinity to the pathogen. This process occurs in anatomical structures within lymphoid organs known as germinal centers (GCs), where B cells—the cells that produce antibodies—multiply and mutate. The Victora lab is currently investigating the mechanistic details of this process. His research could lead to more effective vaccines against pathogens such as influenza or HIV, and could help explain how affinity maturation can malfunction in diseases such as allergies.

In previous work, Victora developed techniques to label and observe cells within the lymph nodes of live mice, and was able to shed light on how B cells with high-affinity antibodies are selected and amplified. In addition to defining the types of B cells in GCs and their migration patterns, the research identified another major component of the immune system, helper T cells, as the regulators of this process, being responsible for comparing B cells bearing different mutations and selecting the best ones for subsequent proliferation.

To gain a deeper understanding of how high-affinity antibodies are generated and evolve during this complex process, the Victora lab is now exploring three complementary perspectives: those of molecules, cells, and whole organs. On the molecular scale, research is underway to identify the key genes involved in how B cells respond to help from T cells, and how this help allows the fittest B cells to proliferate to become the dominant population in the GC in which they were selected. At the cellular level, the lab is exploring how physical interactions between cells transmit the information required for affinity maturation and other immune processes. Finally, Victora and colleagues are investigating how the diversity of antibodies made in an entire B cell response is constrained by the evolutionary culling required for selection of the best binders.

By applying a broad scope in their work—from individual genes to the dynamics within the spleen and lymph nodes—the Victora lab hopes to gain insight into the critical evolutionary processes by which the immune system refines its response to an infection or vaccine.