The hidden sensory world of fungi

Fungi interact with other organisms across a remarkable spectrum of lifestyles, ranging from plant pathogenesis to highly integrated mutualistic symbioses such as lichens. To navigate these environments, fungi must perceive external signals and translate them into appropriate developmental and physiological responses. Yet, how fungi sense their surroundings remains surprisingly poorly understood. A major part of this challenge lies within the so-called dark proteome: proteins whose functions remain unknown, despite the increasing availability of fungal genome sequences.

In this talk, I will introduce how we combine structural biology, bioinformatics, biochemistry, and cell biology to shed light on this hidden sensory world. Our research focuses on G-protein-coupled receptors (GPCRs), a widespread family of signaling proteins that remains largely unexplored in fungi. Using structure-guided approaches, we have uncovered previously unrecognized receptor diversity and begun to decipher how these proteins recognize environmental signals. Using the maize pathogen *Ustilago maydis* as an example, I will illustrate how a structure-guided approach led to the identification of a diverse repertoire of GPCRs and the discovery of an unexpected signaling mechanism: the receptor Gpe1 recognizes a peptide released from a fungal effector protein through the activity of plant proteases, allowing the fungus to sense its host environment and coordinate infection-related development.

Building on this discovery, I will discuss how we extend structure-guided receptor identification across the fungal kingdom to explore GPCR diversity, evolution, and molecular function, including their potential roles across diverse interactions. Beyond the scientific findings, I will provide insights into how these research directions developed from initial ideas into an independent research program, highlighting the role of collaborations, different funding opportunities, and the challenges of establishing new research directions.