Quasi-Condensed DinoChromosomes
Phase Transitions and Self-Assembly is a major axis in nuclear transactions. At high concentrations, aqueous DNAs can form liquid crystalline phases. Biophysical studies suggested highly anisotropic organized domains, manifested as strong birefringence when observed under polarizing light in dinoflagellates Quasi-condensed chromosomes (QCCs). DNA damage-response is a common biomedical theme, as well as probing genome architectures, uniting our understanding and pursuits of genome integrity. QCCs had no canonical architectural nucleosomes and have the lowest known chromosomal protein-to-DNA ratios in extant life-forms. Their histone-like proteins, which belong to the linker histone super family histones, organized DNAs in a concentration-dependent manner, including charge reversal and phase transition of the nucleic acid-protein condensates


Cellulosic Thecal Plates and Cellulose Synthesis: Crystallinity, Modularity and Coordination
Cellulose is the most abundant biopolymer on earth, their synthesis and hydrolysis are the platform technology in multiple industries, including paper, biomedical and textile. Thecate dinoflagellates are well known for their ability to produce intricate cellulosic thecal plates (CTPs), which are intracellular and three-dimensional, contrast with extracellular and two-dimensional nature of plant cell wall. CTPs are deposited in precision arrangement with very fine fibers and with the hardness of wood. We are interested in the mechanism leading to the biodeposition of CTPs and its potential biotechnological application. With dinoflagellates being the major algal bloom agents, and the major producers of the carbon negative DMS/DMSP, CTPs are potential next generation green source of cellulose.
Amphiesma (Dinoflagellates) and unicellular cell walls (coccolithophorids) are sites of carbonate deposition, molecular biology of which dictate the major natural carbon dioxide biogeochemical sink on Earth, as they sink to the bottom of the sea. Carbonate deposition encompasses both geochemical and biological dimensions that are crucial in the fight against global warming and in the preservation of marine ecosystems such as coral reefs that are threatened by coral bleaching. Biological carbonate deposition does NOT stand alone as a chemical process (which chemical capture does) as some considered, but should be considered from the biological prospective; fixed carbon that is sunk either as carbonate shell or coral carbonate, increase the resident time of carbon in the sea (more importantly in the cell!!! and not in the seawater), and buffered with not only the dissolved HCO$_3^-$ pool, but other biological pools of carbon(s) that constitute the biological carbon sequestration mechanisms.

The dual role of carbonate deposition, both as a natural engineering solution for carbon capture and as a support mechanism for coral ecosystem trophic transfer, underscores its significance in contemporary environmental science and conservation strategies. Carbon capture and biological carbonate mineralization will be keys to solving climate change within the context of 1.5°C.

Growth concordance in genome-growth cycle
Cellular growth and genome cycles have different operatives, permeated to all macromolecular synthesis and deposition, in the context of resource availability and trending. Cellular growth homeostasis is not only an intriguing philosophical concept, but have both applied and biomedical applications, commonly recognized in cancer biology, but factually affecting all biological processes. In dinoflagellates, growth-genome cycles feature prominently in coral-zooxanthellae relationship, affecting bioactive compound production, cell proliferation rates in algal blooms, niche in the ecosystem and global productivity. Polysaccharide and membrane deposition increased non-stochastically with genome progression, reflecting coordination between growth and deposition, the mechanisms of which are little explored.

**Oleaginous Heterotrophic Dinoflagellates—Crypthecodiniaceae and Crypthecodinales**


Membranes and lipids are the major biomasses, prior transfer to fixed carbon storage of polysaccharides or biomineralization. Lipid synthesis and storage, or its transfer between membrane lipids and lipid bodies, are tightly regulated with cellular growth. The heterotrophic *Crypthecodinium cohnii* is a major model for dinoflagellate cell biology, and a major industrial producer of docosahexaenoic acid (DHA), a key nutraceutical and added pharmaceutical compound. Despite their biotechnological significances, with different strains deployed for DHA production supplement in infant formulas, the family Crypthecodiniaceae was not fully described, which is partly attributable to their degenerative thecal plates, as well as the lack of ribotype-referred morphological description in many taxons. We isolated a series of novel species and described *Crypthecodinium croucherii* sp. nov. Kwok, Law, and Wong, which have different genome sizes, ribotypes, and amplification fragment length polymorphism profiles when compared to the *C. cohnii*. We are especially interested in deploying oleaginous dinoflagellates for converting feedstocks to bio-lipids.