Quasi-Condensed Chromosomes

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.


### 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.


### A proposed solution to Climate change through assisted carbonate deposition - synthetic biology of microalgae producing carbonate and oil, utilizing organic carbon source

Oleaginous Heterotrophic Dinoflagellates-*Cryptophyceae cohnii* and *Cryptophyceae*


The heterotrophic *Cryptophyceae 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 Cryptophyceae 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 analysed inter-specific variations within the Crypthecodiniaceae. We isolated a series of novel species and described *Crypthecodinium croucheri* sp. nov. Kwok, Law, and Wong, which have different genome sizes, ribotypes, and amplification fragment length polymorphism profiles when compared to the *C. cohnii*. The long genetic distances between Crypthecodiniaceae and other dinoflagellate orders support the separation of the group, which includes related taxons with high oil content and degenerative thecal plates, to be ratified to the order level (Cryptodiniales).

We are progressively completing analysis, including genome analysis, of our collections and will make the strains available per biotechnological requests. We are also analyzing a free-living *Amphidinium* spp. with confirmed smallest genome size for a free-living autotrophic dinoflagellate, including its genome analysis (Protist 1000). Our interests and knowhow in UVc interactomes with dinoflagellates posit the laboratory in seeking the minimal dinoflagellate as a synthetic biology platform, as well as predicting dinoflagellates (esp. Symbiodinaceae) responses to increasing UVc doses with seawater warming-acidification. There are several carbonate-producing dinoflagellates that have cellular biomass-carbonate exceeding those of the coccolithophorids, and we have mastered synchronization method for investigating the molecular process of HCO$_3^-$ concentration, intercellular transport-pre-formation, and cortical carbonate deposition (see Science Art). This is a unifying multidisciplinary section, seeking molecular biological solutions to our global warming-climate change problem, through assisted CO$_2$ sequestration and deposition, deploying carbon minus (DMSP producer) microalgae, utilizing heterotropically organic carbon sources (preferably liquid domestic waste, and producing oil for biofuel-DHA exploitation) Nile Red stained polar lipids in *C.cohnii*.