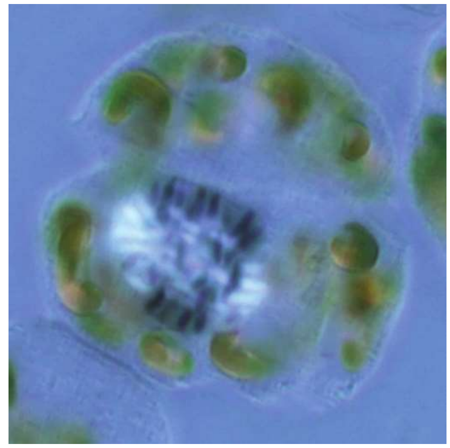
Quasi-Condensed DinoChromosomes



Birefringent photomicrograph of Karenia Chromosome visualization without staining

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.

Kwok, A.C.M., Li, C., Lam, W.T., and Wong, J.T.Y. (2022) Responses of dinoflagellate cells to ultraviolet-C irradiation. *Environ Microbiol0gy*

Yan, T.H.K., Wu, Z., Kwok, A.C.M., and Wong, J.T.Y. (2020) Knockdown of Dinoflagellate Condensin CcSMC4 Subunit Leads to S-Phase Impediment and Decompaction of Liquid Crystalline Chromosomes. *Microorganisms* **8**.

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Li, C., and Wong, J.T.Y. (2019) DNA Damage Response Pathways in Dinoflagellates. *Microorganisms* **7**: 191.

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Fojtova, M., Wong, J.T.Y., Dvorackova, M., Yan, K.T.H., Sykorova, E., and Fajkus, J. (2010) Telomere maintenance in liquid crystalline chromosomes of dinoflagellates. *Chromosoma* **119**: 485-493.

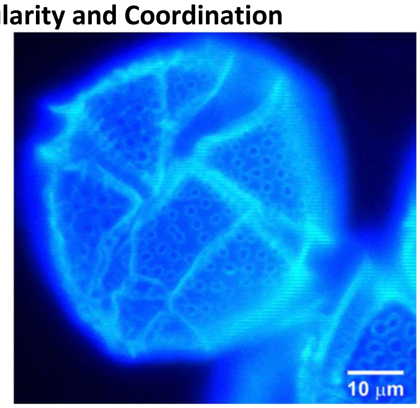
Leung, S.K., and Wong, J.T.Y. (2009) The replication of plastid minicircles involves rolling circle intermediates. *Nucleic Acids Res* **37**: 1991-2002.

Chan, Y.H., and Wong, J.T.Y. (2007) Concentration-dependent organization of DNA by the dinoflagellate histone-like protein HCc3. *Nucleic Acids Res* **35**: 2573-2583.

Mak, C.K.M., Hung, V.K.L., and Wong, J.T.Y. (2005) Type II topoisomerase activities in both the G1 and G2/M phases of the dinoflagellate cell cycle. *Chromosoma* **114**: 420-431.

Wong, J.T.Y., New, D.C., J.C.W., W., and Hung, V.K.L. (2003) The Dinoflagellate Basic Chromosomal Proteins (HCCs) have homologies to bacterial DNA-binding proteins. *Eukaryotic Cell* **2**: 646-650.

Cellulosic Thecal Plates and Cellulose Synthesis: Crystallinity, Modularity and Coordination



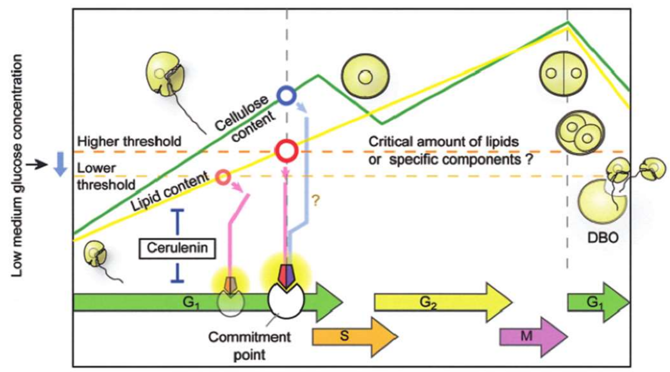
Fluorescence photomicrograph of Cellulosic Thecal Plates in a *Lingulodinium polyedrum* cell.

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.

Chan, W.S., Kwok, A.C.M., and Wong, J.T.Y. (2019) Knockdown of Dinoflagellate Cellulose Synthase *CesA1* Resulted in Malformed Intracellular Cellulosic Thecal Plates and Severely Impeded Cyst-to-Swarmer Transition. *Front Microbiol* **10**: 546.
Kwok, A.C.M., and Wong, J.T.Y. (2010) The activity of a wall-bound cellulase is required for and is coupled to cell cycle progression in the dinoflagellate *Crypthecodinium cohnii*. *Plant Cell* **22**: 1281-1298.
Kwok, A.C.M., Mak, C.K.M., Wong, F.T.W., and Wong, J.T.Y. (2007) Novel method for preparing spheroplasts from cells with an internal cellulosic cell wall. *Eukaryot Cell* **6**: 563-567.
Lau, R.K.L., Kwok, A.C.M., Chan, W.K., Zhang, T.Y., and Wong, J.T.Y. (2007) Mechanical characterization of cellulosic thecal plates in dinoflagellates by nanoindentation. *J Nanosci Nanotechnol* **7**: 452-457.
Kwok, A.C.M., and Wong, J.T.Y. (2003) Cellulose synthesis is coupled to cell cycle progression at G_1 in the dinoflagellate *Crypthecodinium cohnii*. *Plant Physiol* **131**: 1681-1691.

Growth concordance in genome-growth cycle

Theoretical considerations of cellular growth



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.

Kwok, A.C.M., Zhang, F., Ma, Z., Chan, W.S., Yu, V.C., Tsang, J.S.H., and Wong, J.T.Y. (2020) Functional responses between PMP3 small membrane proteins and membrane potential. *Environ Microbiol* **22**: 3066-3080.
Lam, C.M., Yeung, P.K., Lee, H.C., and Wong, J.T. (2009) Cyclic ADP-ribose links metabolism to multiple fission in the dinoflagellate Crypthecodinium cohnii. *Cell Calcium* **45**: 346-357.
Yeung, P.K., Lam, C.M., Ma, Z.Y., Wong, Y.H., and Wong, J.T.Y. (2006) Involvement of calcium mobilization from caffeine-sensitive stores in mechanically induced cell cycle arrest in the dinoflagellate *Crypthecodinium cohnii*. *Cell Calcium* **39**: 259-274.
Kwok, A.C.M., and Wong, J.T.Y. (2005) Lipid biosynthesis and its coordination with cell cycle progression. *Plant Cell Physiol* **46**: 1973-1986.
Wong, J.T.Y., and Kwok, A.C.M. (2005) Proliferation of dinoflagellates: blooming or bleaching. *Bioessays* **27**: 730-740.
Sheng Sun, **Wong, J.T.Y**., and T.Y. Zhang (2011) Effects of external electric fields on self-assembly of phospholipids/water mixtures Coarse-grained molecular dynamics simulations. Soft Matter, 7, 9307 – 9310
Sun, S., Yin, G., Lee, Y.-K., **Wong, J.T.Y.,** T.Y. Zhang (2011) Effects of deformability and thermal motion of lipid membrane on electroporation: By molecular dynamics simulations. Biochemical and Biophysical Research Communications 404: 684-688.
Sheng Sun, **Wong, J.T.Y**., and T.Y.Zhang (2011) Molecular dynamics simulations of phase transition of lamellar lipid membrane in water under an electric field. Soft Matter 7: 147-152.

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. At the cellular level, carbonate biomineralization can be considered as part of cellular growth-wall deposition, in the context of pH-redox regulation.

Microbially induced carbonate deposition, particularly through the activities of organisms like coccolithophores and dinoflagellates, single-celled marine microorganisms that produce calcium carbonate scales/walls, play a significant role by sequestering carbon and converting CO_2 into calcium carbonate, a process that not only helps reduce atmospheric CO_2 levels (carbon-negative) but also contributes to the oceanic carbon cycle. Furthermore, the structural integrity and growth of coral reefs are supported by carbonate deposition, which is essential for the recovery and maintenance of these biodiverse ecosystems currently facing threats from coral bleaching and acidification. The dual role of carbonate deposition, both as a natural engineering solution for carbon capture and as a support mechanism for coral ecosystems, underscores its significance in contemporary environmental science and conservation strategies. Science communication, especially through arts (please see a sample), is now recognized as part of research mission, in addition to paper publishing, for the betterment of science sustainability. Carbon capture and biological carbonate mineralization will be keys to solving climate change within the context of 1.5°C. We are very interested in molecular mechanisms of carbonate mineralization, especially those of phytoplanktons: dinoflagellate which command a cellular size 5-6 times those of coccolithophorids, and correspondingly the circum-spherical carbonate shell.

Oleaginous Heterotrophic Dinoflagellates-**Crypthecodiniaceae and Crypthecodinales**
https://www.mdpi.com/1660-3397/21/3/162
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 progressively completing analysis, including genome analysis, of our collections and will make the strains available per biotechnological requests. 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 (Nile Red stained polar lipids in *C.cohnii*)