Prof. Joseph T.Y. Wong Laboratory

*Cellular growth concordance with membrane-lipid axis, cellulose deposition, and genome physical karyotypes*

Many dinoflagellate cells are large, with nuclear size larger than a yeast cell, and a chromosome larger than a bacteria (!) they are not merely good looking and full of energy (try Blue tears) [https://www.youtube.com/watch?v=uUhBGeMp_JY](https://www.youtube.com/watch?v=uUhBGeMp_JY)

And are very Green---being the group that produced the highest greenhouse positive compound DMSP/DMS [https://academic.oup.com/nsr/article/8/2/nwaa140/5861306](https://academic.oup.com/nsr/article/8/2/nwaa140/5861306)

The Wong Lab utilizes yeast ( budding and fission), bacteria, plant protoplasts, and dinoflagellate cells to address major problems in basic biology, as well as enlightening the emerging system to biotechnology.

**Quasi-Condensed Chromosomes: Phase Transitions and Self-Assembly.** Under high concentrations and strong volume depletion force, aqueous DNAs can form liquid crystalline and colloidal phases. Biophysical studies suggested highly anisotropic organization, manifested as strong birefringence in dinoflagellates Quasi-Condensed Chromosomes (QCCs), which some of the largest-eukaryotic genomes (up to 80 times human genome size) but counter-intuitively had no architectural nucleosomes. Dinoflagellate histone-like proteins, which is part of the Hup-linker histone superfamily (Wong et al., 2003), organized DNAs in a concentration-dependent manner, including looping of DNAs and protein-nucleic acid phase transitional events, including charge reversal (Chan et al., 2007). Nuclear genome dynamics, DNA damage responses, and the architectural organization of tandem repeat arrays, need to be orchestrated with the ionotropic conditionings of the chromosome territories.

Yan, KHT, Ng, CN, Kwok, ACM, and Wong, JTY (2020) Knockdown of dinoflagellate condensin CeSMC4 subunit led to S-phase impediment and decompaction of liquid crystalline chromosomes. *Microorganism*


Mak CKM, Hung VKL, and Wong JTY (2005) Type II Topoisomerase activities in both G1 and G2/M phases of the dinoflagellate cell cycle. *Chromosoma* 114:420-431

**Cellulosic Thecal Plates and Cellulose Synthesis: Crystallinity and Coordination with Cellular Growth**

Cellulose is the most abundant biopolymer on earth. Thecate dinoflagellates are well known for their ability to produce intricate cellulosic thecal plates (CTPs), which are intracellular and three-dimensional, contrasting with extracellular and two-dimensional nature of plant cell wall. CTPs also have the hardness of wood (plant secondary cell wall) without requirement of lignin fortification. CTP formation encompasses carbon fixation, cellulose biogenesis, and vesicular transport; many species also have calcium carbonate wall deposition, with substantial biomasses of carbon dioxide sequestrations. The ongoing genetic dissection and genome annotations will put amphiesma-CTP explorations at cross-forefronts between physical biology, biochemistry, synthetic biology, carbon neutrality and molecular biology.


Kwok ACM and Wong JTY (2003) Cellulose synthesis is coupled to cell cycle progression at g_1 in the dinoflagellate *Cryptecodinium cohnii*. *Plant Physiology* 131:1681-1691.

**Cellular Growth concordance**

Cellular growths are regulated within a small range in response to prevailing nutritional conditionings in most unicell. Wall polysacharides and membranes increased non-stochastically with cellular growth progression (Kwok and Wong, 2003, 2005). Under nutritional shift-up conditions, a growth-dependent cyclic ADP-ribose transient (with vacuoles and mitochondria being the major sites of production) as the messengers for growth rate variations (Lam et al., 2009,).

DNA Damage Responses, Genome changes, and Biotechnology

DNA damage responses (DDRs) are not only important in cancer biology and environmental biology but are basic to all cells for survival, ROS-pH maintenance, and for chromosomal operations (e.g. telomere biology). The adoption of DDRs and responses to invasive nucleic acids will be keys to developing next-generation mutagenesis and recombinant DNA technology.

With non-nucleosomal genome architecture and tandem-repeat encoding, and no nuclear envelope breakdown, the system is well poised for synthetic biological manipulations, as well as addressing major questions in evolution. Many species produce bioactive compounds, including DMSP/DMS, carotenoids, lipophilic toxins, and DHA in relative high concentrations. With the development of genetic transformation systems and published genomes, it is a strategic time in studying dinoflagellates. We are developing the group, and particularly a small genome size dinoflagellate, as a model system for cell biology and synthetic biology.


Kwok, ACM, Li C., Lam, W.T. and Wong JTY (2022) DNA damage responses in dinoflagellates. Environmental Microbiology


