Karyo-genomics in nuclear processing and DNA Damage responses

Phase Transitions and self-Assembly constitute major dynamic axis in nuclear transactions. Dinoflagellates Quasi-condensed chromosomes (QCCs) behold the third major chromosome packaging mechanism, in addition to bacterial nucleoid and nucleosomal packaging. QCCs have no canonical architectural nucleosomes and the lowest known chromosomal protein-to-DNA ratios in extant eukaryotes, with substantial replacement of thymine with the fifth base 5-hydroxymethyuracil that is non-randomly distributed. Their histone-like proteins, which belong to the linker histone- bacterial Hlp superfamily, organized DNAs in a concentration-dependent manner, including charge reversal and phase transition of the nucleic acid-protein associates. DNA damage-response is a common biomedical theme, as well as probing genome architectures, integrating our understanding in the pursuit of genome integrity. Keystone: *Nucleus as a unit of compartmenation that coupled with cytosolic commitment*

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Symbiotism, 'Minicircle (s)', and Energy Supplies

The taming of organelle genomes provisioned energy capture in eukaryotes, manifested in the current global photosynthetic and respiratory era. Both organelles maintained their respective genome obviously not without reasons. Dinoflagellate minicircles were hailed as the final station of chloroplast genes migrating to the nucleus, encoding 15-20 single-genes in strikingly small (~2 kb) plasmid-like 'minicircles'. Their genes content beholds most of the keystone component of photosynthesis, including in Symbiodinaceae, members of which provision estimated ~60% of coral host nutritional requirements. Their "bleaching", constituted by multiple mechanisms caused by climate change, are often underlined with growth discordance; recent paradigm shifts in the symbiotic dinoflagellates being 'farmed' by their hosts laid a different question in how that farmed subjects exit the nurtured boundary. The shared peridinin-ChlA photosynthetic pigments between symbiotic and free-living dinoflagellate added on to the imperative in understanding this shared

organelle genome perpetuation. Our recent studies suggested strikingly these minicircles are not in 'circular' forms, but mostly in DNA:RNA hybrids that will be subscribed to transcription-translation in-orchestration. The minicircle non-coding regions, commonly only a few hundred base-pairs in length, encrypt the knowhows for the stringent supply-demand distinctively required for the dynamic organelle(s). The alveolate sister group (apicomplexan), which contain most important human parasites (e.g. malaria), retained their ancestral chloroplast genome; this 'apicoplast' genome encodes nonetheless special lipid metabolic genes. Energy provision dictates most life on Earth, including humanity, and symbiotism is a major force in evolution and under-standing. Minicircle dynamics thus provision energy supply-demand that couple host-symbiont relationship that recent data point to being a host-farming relationship.

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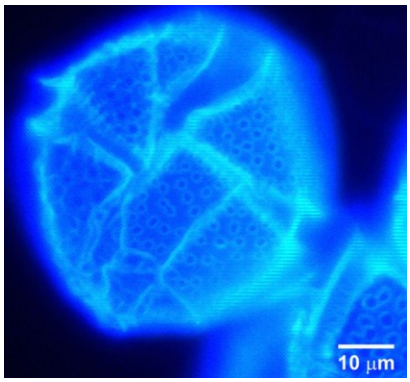
Kwok,A.C.M. and Wong, J.T.Y. Minicircle-mediated 'transformation'. (in submission)

Cellulosic Thecal Plates and Cellulose Synthesis

Cellulose is the most abundant biopolymer on earth, their hydrolysis and chemical modifications are platform technology in multiple industries, including wine, paper, biofuel, bread, food, and textile. Cellulose biogenesis in vivo commonly involves substrate provision, membrane-dependent synthesis and extracellular deposition. Thecate dinoflagellates are well known for their ability to produce intricate cellulosic thecal plates (CTPs), which are intracellular and three-dimensional. CTPs are deposited in precise arrangement (the taxonomic thecal formula) with very fine fibers and with the hardness of wood. We are interested in the molecular biology CTP biogenesis 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. CTPs are contained within the cortical amphiesmal, a dynamic structure that is continuously replaced during ecdysis; the interchange between the pellicular layer and CTP-alveolar sac layers form the basis of life cycle remodelling.



Fluorescence photomicrograph of Cellulosic Thecal Plates

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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

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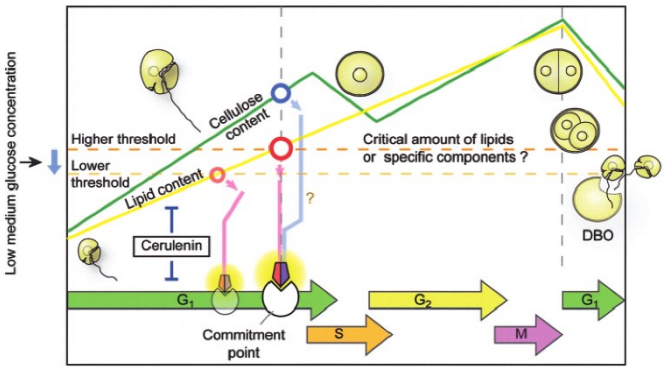
Growth aproportion in genome-growth cycle

Theoretical considerations of cellular growth



The *have* and '*have not*' are two extremes of cellular status, perception of which led to major cell-life cycle transitions in unicellular organisms, without much interception with hormonal-paracrine systems. Cellular growth and genome cycles have different operatives, permeated to all macromolecular synthesis and deposition, in the context of resource availability and passage. Cellular growth homeostasis is not only an intriguing philosophical concept, but having both applied and biomedical applications, commonly recognized in cancer biology. 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.

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Evolutionary Biology of receptors, multiple fission, and neuronal system**.**

Molecular processes were first developed in unicells that will contain simpler interactions that multicellular systems are difficult to be translated. Developing unicellular models for the in conjunction with yeasts (e.g. dinoflagellate have TRP channels, flagella IFTs and highest melatonin concentrations,) that are indicated in diseases. Alveolates are excitatory cells with circumpolar amphiesmal sacs serving as insulation, and vacuolar compartment for capacitance discharge. The intracellular signaling of receptors are masked by the dominance of extracellular metazoan hormonal-organ axis; a unicellular model will have the independent positioning. Attributed to lack of NEBD and cell cycle synchronicity, dinoflagellate cells are especially good for quantifying signal molecule changes without cross G1-G2 degradation.

Custodian of Time. From neutral theory (Nei) to selfish genes (Dawkins) to abrupt evolution (Gould), there are major gaps in our appreciation of evolutionary trajectory rather than assumptive 'forces', and the importance of intermediate population (Darwin) stages that are commonly missing in parsimonious analysis. These are of importance not only intellectually but persuade protocols with the advent of assisted evolution and synthetic biology.

Interested evolutionary topics: Evolution of the first neuronal system- *in-deterministic*, Alveolate (including malaria) evolution-*circumpolar by design*. Meiosis-multiple fission origin: *in-accuracy founder as a driver for stem cells*. First Eukaryotic Cell Cycles*: How many Nuclei*. Bioluminescence and luciferase-luciferin coupling: *who is it for* ?.
Transformation techniques for dinoflagellates: transposase, spheroplasts, minicircles, antisense, and CRISPR-cas9. The importance of monitoring GMO and potential genetic invasiveness.

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Intellectual Projects and Tertiary Science Communication

Empirical thinking and creativity in arts and in basic sciences, molecular cell biology of qi-qong and meditation. Arts-Science communications between tertiary specializations. especially on the implications of climate change, COP28 and COP29, bio-carbonate sequestration-deposition, the call from coral bleaching, demise of normal global oceanic circulation, including disappearing of West Antarctic Ice Mass. Sustainable Development Goals https://www.un.org/sustainabledevelopment/sustainable-development-goals/

ScienceArt Commune 1: Wong, J.T.Y., Whirling with Waters. Art and Science 2024, 8, https://www.openscience.fr/ScienceArt-Commune-1-Whirling-with-Waters

More ScienceArts will be coming when I find time to curate
Interested curators please contact Prof. Wong directly

Permeation

With COP28 and COP29 pledges, the world is griping with renewed drives for biofuels and carbon-minus processes. The pledges of phasing out fossil fuels and 1.5 trillion in carbon trading will progressively change the industrial landscape. It is imperative to connect the evolving Biotechnology Industry with the established industrial streams of Chemical Industry. Cellulosic polysaccharides, Microalgal lipids, co-production of Bioactive compounds, and Biofuels will be keys to next generation Chemical Biotechnology Industry.

Regulatory agencies are increasingly stringent in the taxonomic source (reproducibility) of microalgal oil. Our focus is on oleaginous dinoflagellates**.** Pyrolysis of ancient carbon, including those of dinoflagellate wall lipid components (which are highly chemical resistant, e.g. dinosporin) contributed to the formation of fossil fuels. It is perhaps not a coincidence that current dinoflagellates behold some of the highest oil content (with different polar/apolar lipid ratios) with the highest carbon negative content of DMSP/DMS at the same time. Substrate readiness are keys to many emerging techniques of carbon conversion, for instance hydropyrolysis. Uniformity and pre-activation will not only reduce energy footprint but will reduce the cost-energy pre-investment of setup required to behold reaction at the appropriate high-energy environment

Dinoflagellates are also infamous for producing repertoire of bioactive lipophilic compounds that very often modulate membrane receptor readouts that cause major seafood poisoning syndromes. Our

proposals are for harnessing the efficiency of biological carbonate sequestration-transfer for assisted carbonate deposition, with synthetic biology of microalgae producing oil.

We are actively investigating the biology of carbonate shell dinoflagellates *Thoracospaera heimii* which strikingly have a 10 µm cell size covered with carbonate deposition, qualifying as the highest carbonate content per cell. We have mastered its carbonate shedding and re-synthesis, offering a glimpse of bio-efficiency in HCo^{3-} sequestration, transfer-accumulate, and amphiesmal deposition.

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*.

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