Seminar in Microbiology

Monday, November 26th, 2018

Salle de séminaire, E07.3347.a, CMU

11:30 – 12:30

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Cellulosomes and anaerobic plant cell wall degradation: Performant nanomachines and processes

Selected publications:


The current trend is aiming to reduce our dependence to the limited fossil molecules and energy stocks, to overcome the ecological problems caused by their utilisation and consequently to increase the part of the renewable material in the industry. One of the promising raw material is the vegetal biomass from the plant cell wall due to its natural abundance (produced constantly by the photosynthesis) and its low price. Also named lignocellulose, it’s mainly composed of large and intertwined biopolymers of decorated polysaccharides (hemicelluloses) and crystalline cellulose fibers (glucose multimers) bathing in a lignin gangue, a highly branched network of aromatics acting as structural cement that protect the plant from the environment and the pathogens. Highly variable in biopolymers ratio for each tissue or plant source, the lignocellulose is recalcitrant to the enzymatic degradation and its depolymerisation is energy consuming. Nevertheless, both aerobic and anaerobic cellulosylolytic microorganisms have developed specific and highly regulated/controlled ways to degrade the parietal polysaccharides and to assimilate the released products - we are currently studying in my home Lab the anaerobic processes using the model cellulolytic bacterium *Clostridium cellulolyticum* – and constant efforts are aiming to dissect these ways that could be exploited to design bio-inspired sustainable applications.

They both engineered complex and specific systems adapted to the lignocellulose complexity in order to extracellularly solubilize the plant cell wall polysaccharides using multiple carbohydrate-active enzymes, the CAZymes (hemicellulases, cellulases …). Contrary to aerobes that secrete large amount of CAZymes, the anaerobes produce in low quantity highly efficient nanomachines, the cellulosomes, where CAZymes cocktails are recruited on a proteic platform via high affinity interactions. This creates extracellular multi-enzymatic complexes that cluster enzymes functioning in tandem in order 1/ to decrease the product's wastage, 2/ to improve the degradation yield efficiency and 3/ to decrease the setting-up energy cost of this system that is then adapted to the anaerobic metabolism limitation (energy and resources).

However, the major hurdle to lignocellulose deconstruction involves the presence of the lignin limiting the access to the parietal sugars and inhibiting the CAZyme’s activity. Only data concerning the aerobic handling of the lignin by fungi and bacteria have been reported. These studies try 1/ to understand how cellulosylolytic organisms cope with the problems cited above, 2/ to characterize the very species-specific and complex lignin (and derivates) degradation/assimilation systems they have developed and 3/ to determine if they are able to metabolize this source of aromatics? Nonetheless, NO information is available in the literature concerning an extracellular lignin degradation and a full lignin metabolism in anaerobiosis. Facing the same lignin problems, anaerobes should have developed various and very specific lignin handling processes adapted to their metabolism, that should also be as sophisticated as their cellulosylolytic system and suitable with bioinspired applications design. Classic approaches having failed, we are thus aiming to dissect the anaerobic lignolysis using a deep transcriptome sequencing approach.