

IS4-1

Food Waste as Food, Feed, Fertilizer and Fuel- with a Focus on Fish Feed

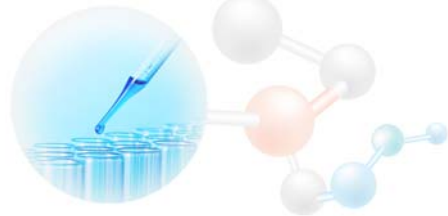
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Most of the over 3,600 tonnes (about 36% of the municipal waste) of food waste generated daily in Hong Kong has been disposed of directly to landfills. The amount generated daily was increased by 13% from 3,227 tonnes in 2004 to 3,648 tonnes in 2013, and the trend is on the rise. Decomposition of food waste within landfills will generate landfill gas and leachate, and odour nuisance. Waste management pilot programmes and awareness raising campaigns have been launched by the government, in order to reduce the amount of food waste. By mapping out four strategies: reduction at source, reuse and donation, recyclable collection, and turning food waste into energy, the Environment Bureau (2014) set the target of reducing food waste disposal to landfills by 40% in 2022. Food waste should be regarded as valuable resources, and proper recycling will fully reutilize the residual nutrients and energy it contained. This will also provide a good opportunity to assist the government's initiation for adopting a more proactive approach towards the modernization and sustainable development of local agriculture. This is mainly due to the fact that recent status of farming and fisheries in Hong Kong has witnessed an unacceptable decline during the past few decades, the cheaper imported foods together with perceptions of downstream contamination, uncertain waste management practices and less wholesome and healthful food production methods. In this presentation, the feasibility of turning food waste into food, feed, fertilizer and fuel is reviewed: (1) Food- microbial (fungi, yeasts and bacteria) protein through fermentation, and mushrooms; (2) Feed- animal feed pellets for chicken, pig and fish; (3) Fertilizer- through composting and pyrolysis (into biochar); and (4) Fuel- through biochemical processes and thermochemical processes. Through the practice of integrated agriculture-aquaculture system with food waste the main energy source, the ultimate goal is locally-sourced, high quality fresh, safe and wholesome food (crops and fish), with reduced transportation and a substantially lowered environmental foot print. The presentation will focus on turning food waste into fish feed pellets, citing examples of our former project sponsored by the Environmental Conservation Fund, and two on-going projects sponsored by the Innovative Technology Fund, and Sustainable Agricultural Development Fund, for rearing freshwater and marine fish. Attempts have been made to formulate and upgrade different feed pellets, catering for enhancing growth and immunity of fish. It is hoped that the information will serve as a reference for the administrators to address the food waste problem, and to redevelop local agriculture and aquaculture.





IS4-2

The generation mechanism of persistent free radical in carbon materials and their applications in mediating degradation of emerging organic contaminants in water

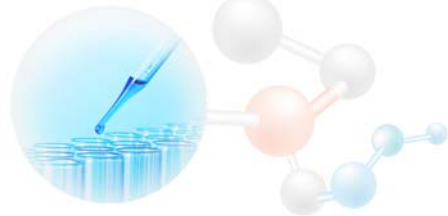
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Carbon materials, which contain abundant persistent free radicals (PFRs), have been proved to directly or indirectly mediated the degradation of organic and inorganic contaminants. Recently, the formation mechanisms of PFRs in different carbon nanomaterials synthesized through pyrolysis and hydrothermal carbonization as well as their further applications in the removal of emerging organic contaminants (EOCs) were summarized detailed. All of the synthesis parameters, such as temperature, time, and carbon sources significantly influence the types and concentrations of PFRs and thus affect the removal efficiency of EOCs mediated by carbon materials. Meanwhile, the compost products of chicken manure and several kinds of saccharides as the precursors for the synthesis of hydrothermal carbon, and systematically investigated and the degradation of alachlor in the Fe(III)/H₂O₂ Fenton-like reaction was also conducted. The results indicated that hydrothermal carbon could enhance alachlor degradation in Fe(III)/H₂O₂ Fenton-like system by promoting the Fe(III)/Fe(II) cycle via electron transfer from hydrothermal carbon to Fe(III) ions. The electron spin resonance spectra analysis revealed that hydrothermal carbon was of abundant carbon-centered PFRs to act as the electron donor. And the hydroxyl groups on the surface of hydrothermal carbon could complex with Fe(III) to favour the electron transfer from hydroxyl groups to Fe(III). Though the activity of hydrothermal carbon synthesized with the compost products of chicken manure was much lower than those synthesized with saccharides, and the glucose modification could effectively enhance its activity by promoting the concentration of PFRs and oxygen-containing functional groups. Finally, Laser flash photolysis, electron spin resonance, and other modern analysis technologies were further used to investigate the formation mechanism of PFRs in carbon materials including hydrothermal carbon and biochar. The transformation mechanisms of PFRs as well as the degradation mechanism of alachlor were also studied to clarify the interaction mechanism between EOCs and PFRs. The purpose of our study is to review and highlight the applications of carbon materials in the protection of environmental health.

Keywords: Carbon materials, Persistent free radicals, Radical mediated degradation, Emerging organic contaminants.





IS4-3

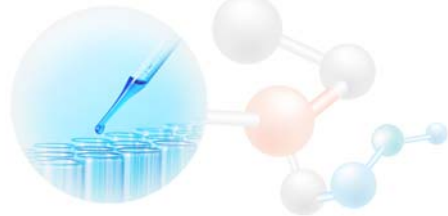
***Yellow-g* and *Yellow-g2* are required for egg desiccation resistance
of the Asian tiger mosquito, *Aedes albopictus***

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The Asian tiger mosquito, *Aedes albopictus*, is a potential vector to transmit various viruses including dengue, yellow fever, chikungunya, and Zika. One of the main factors for rapid spread of this mosquito across the world is that their eggs possess high desiccation resistance. Melanization and/or hardening of mosquito eggshell are critical for desiccation resistance to protect embryo from adverse environment. It has been suggested that dopachrome-conversion enzyme (DCE, yellow) significantly accelerates the melanin synthesis during tanning process in the chorion of mosquito eggs. In this study, we demonstrated functional importance of two ovary-specific *yellow* genes, *AalY-g* and *AalY-g2*, in desiccation resistance of *A. albopictus* eggs. The transcripts of both genes were only detected in the ovary of mature adult females 36 - 48 h after blood feeding. Injection of dsRNAs for *AalY-g* or *AalY-g2* into adult females had no effect on their fecundity. However, the outermost transparent exochorion of the eggs obtained from the dsRNA-treated females was fragile and partially peeled off. In addition, initial melanization of the endochorion was obviously delayed. Under the air-dry condition, eggs from control females exhibited high desiccation resistance, whereas 60-70% of eggs from ds*AalY-g*- or ds*AalY-g2*-treated females were collapsed. TEM analysis revealed abnormal morphology and ultrastructure of the endochorion and the innermost serosal cuticle in the *AalY-g* and *AalY-g2* deficient eggshell. These results indicate that *AalY-g* and *AalY-g2* are critical for integrity and desiccation resistance of the *Ae. albopictus* eggs. This work was supported by NRF (NRF-2015R1A2A2A01006614 and NRF-2015R1A6A3A04060323).





IS4-4

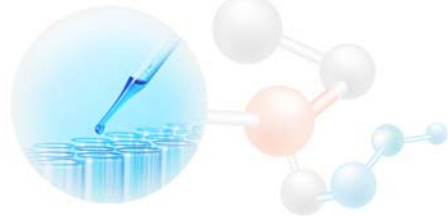
Biofilm Biology-Informed Biofilm Engineering for Environmental Biotechnology

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Biofilms represent the predominant mode of growth of microorganisms in natural, engineered and medical habitats. Microbial biofilms can be either beneficial or detrimental in different settings. While an enhanced understanding of the fundamentals of biofilm biology is required to fully control detrimental biofilms and to harness the power of beneficial biofilms, progress in biofilm research in recent years has enabled the a better understanding of biofilm bioprocesses and engineering or control of biofilm bioprocesses in various chemical, energy and environmental applications. In this presentation, several examples of biofilm engineering informed by current understanding of biofilm biology and enabled by multidisciplinary approaches will be discussed.





IS4-5

Investigation of DNA damage in bacteria and human cell lines by comprehensive LC/ESI-MS/MS approaches

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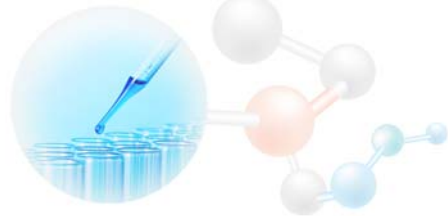
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Exposure of cellular DNA to both endogenous and exogenous chemicals may result in the production of DNA damage in the form of DNA adducts. Formation of DNA adducts may result in downstream deleterious effects to organisms if not repaired. Currently, comprehensive non-targeted approaches to detect and identify DNA adducts through the use of different types of mass spectrometry techniques are under development by researchers in this field (DNA adductomics). In our laboratory we are developing methods that utilize liquid chromatography electrospray ionization tandem mass spectrometry (LC/ESI-MS/MS) as an analytical tool for conducting such DNA damage assessments because LC/ESI-MS/MS provides a balance of selectivity, sensitivity and cost.

One of the aims of DNA adductomics is to analyze large numbers of DNA adducts present in a particular DNA sample obtained at a specific point in time. Data may be visualized through the production of DNA adductome maps and the identities of specific DNA adducts revealed by the maps may be determined by different techniques. The methodology is designed to detect the neutral loss of 2'-deoxyribose from positively ionized 2'-deoxynucleoside adducts by using multiple reaction monitoring mode (MRM) transmitting the $[M + H]^+ > [M + H - 116]^+$ transition over multiple transitions. This methodology takes advantage of the fact that the glycosidic bond between the modified base and 2'-deoxyribose readily undergoes cleavage at relatively low collision energies in the second quadrupole of the tandem mass spectrometer. Data analysis is optimized and coupled with a comprehensive manual screening process designed to minimize the number of artifactual DNA modifications that appear in the final analyses. Finally, identification of DNA adducts revealed by the final analysis may be conducted through the utilization of authentic DNA adduct standards, DNA adduct standard stable isotope dilution methods and/or product ion scan analyses.

The methodology of DNA adductomics and recent work where it has been applied to investigate DNA adducts in different types of living cells after exposure to potentially mutagenic organic chemicals will be presented.





IS4-6

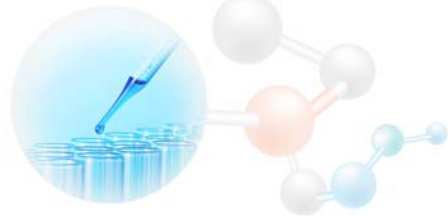
Regional Characteristics of Organic Contaminants in Agricultural Soils

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To reveal the pollution status associated with rapid urbanization and economic growth, extensive areas of agricultural soils in the Yangtze River Delta (YRD) of China were investigated with respect to selected organic contaminants, including phthalate esters (PAEs), organochlorine pesticides (OCPs), polybrominated diphenyl ethers (PBDEs), polychlorinated biphenyls (PCBs), organochlorine pesticides (OCPs), parent polycyclic aromatic hydrocarbons (PPAHs), nitro-, oxy-, and methylated derivatives. We extensively and holistically evaluated the spatial distribution, compositional variation, source apportionment, vertical profile, ecological effects, and human health risks. We discussed the environmental implications and linkages with historical and current land uses. Our results illustrate the importance of field monitoring and proper regulation to safeguard the environment and food security.





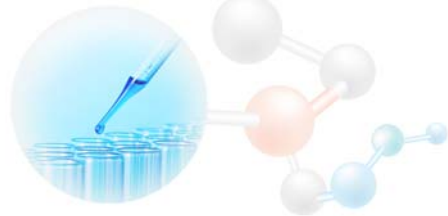
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Heavy Metal Contaminated Soil Immobilization by Plant Extracts and Urease-producing Bacteria

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Acid mine drainage occurrence is a serious environmental problem by mining industry; it usually contain high levels of metal ions, such as iron, copper, zinc, aluminum, and manganese, as well as metalloids of which arsenic is generally of greatest concern. It causes mine impacted soil pollution with mining and smelting activities, fossil fuel combustion, and waste disposal. In the present study, the abilities of crude extracts of *Canavalia ensiformis*, a plant biomaterial, to produce calcium carbonate in columns packed with heavy metal contaminated mine wastes collected from an abandoned mine area were compared. X-ray diffraction and scanning electron microscopy were employed to elucidate the mechanism underlying CaCO_3 precipitation from *Canavalia ensiformis* crude extracts. Urease in the *Canavalia ensiformis* extracts catalyzed the hydrolysis of urea and decreased the amounts of the heavy metals As, Mn, Zn, Pb, Cr, and Cu in leachates from treated mine waste columns by 31.7%, 65.8%, 50.6%, 51.6%, 45.1%, and 49.7%, respectively. Comparisons of plant extracts untreated and treated samples using PCR-DGGE of 16S rDNA, showed that many microorganisms were present, even in heavy metal contaminated environments, suggesting that PCR-DGGE assays of treated mine wastes may be used to determine long-term changes in bacterial communities and the effects of particular bioremediation processes. Furthermore, 3 bacterial strains capable of producing urease were isolated by selective enrichment of heavy metal contaminated mine impacted soils. All isolated bacterial strains were identified *Sporosarcina* sp. with more than 98% of similarity. The heavy metals detected from the collected mine soils containing bacterial isolates as Mn (170.50 mg/kg), As (114.05 mg/kg), Zn (92.07 mg/kg), Cu (62.44 mg/kg), and Pb (40.29 mg/kg). The bacterial strains were shown to be able to precipitate calcium carbonate using urea as an energy source that was amended with calcium chloride. These results demonstrate that all isolated bacterial strains or plant extracts could potentially be used in the bioremediation of acidic soil contaminated by heavy metals by mining activity.



S4-2

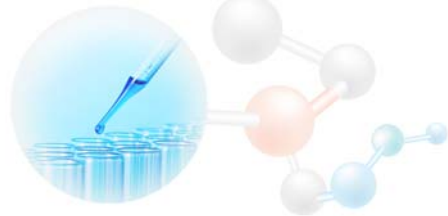
Biotransformation of arsenic and antimony in plants and nutrient solution

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Arsenic (As) and antimony (Sb) are in the same periodic group and chemio-toxicological similarity exists between As and Sb. The two biological important states of As and Sb are trivalent and pentavalent forms and trivalent forms are known to be more toxic than pentavalent forms. Although As and Sb are biologically transformed in plants, the mechanism of As and Sb uptake and species in plants have not been fully elucidated. Therefore, the study tested As and Sb biotransformation by plants grown in nutrient solutions amended with trivalent and pentavalent forms of As and Sb. Arsenic and Sb species in plants and nutrient solution was analyzed using X-ray absorption fine structure (XAFs) and solid phase extraction column, respectively. Plant transformed As(V) to As(III) and released As(III) to nutrient solution in both As(III) and As(V) amended nutrient solution. Arsenic in plants mainly exists as As(III) coordinated with oxygen and sulfur. Arsenic in leaves was coordinated with more sulfur than roots indicating more As-glutathione complexes were formed in leaves. Although Sb was thought to react same as As, plant did not transform Sb in nutrient solution. In addition, plant transformed Sb(III) to Sb(V) in Sb(III) amended nutrient solution and Sb in plant mainly exists as Sb(V) oxide form in both plant leaves and roots. The reason of different biotransformation of As and Sb despite their chemical similarity needs to be further studied and elucidated.





S4-3

Current issues on the establishment of inorganic As in rice and code of practice for the reduction As for rice plant in Korea

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2014 and has been discussing a code of practice for the prevention and reduction of As contamination in rice since 2013. Managing arsenic (As) in rice (*Oryza sativa* L.) plants is challenging and different strategies are being developed for mitigating As loading into the rice grains. This study reviewed the establishment of inorganic As criteria in rice and investigated the effect of water management and the use of soil amendments on As accumulation in brown rice. A field plot experiment was conducted with five water management regimes [Flooded control, alternate wetting drying (AWD – 60 and 40) and row (R-60 and R-40)] using two rice cultivars (Indica and Japonica). In another field experiment, the effect of soil amendments, phosphate, silicate and rice husk biochar on As accumulation in brown rice (HKNR and SK varieties of Japonica cultivar) was investigated. Compared to the flooded control, all the four treatments significantly reduced the concentration of As in brown rice with R-40 showing the least concentration. AWD and row treatments reduced As levels by 45-60% and by 32-55% in Indica and Japonica cultivars, respectively. However, increased Cd concentrations were noticed in row and AWD treatments. AWD-60 treatment for As and Cd in Indica cultivar reduced As without greatly increasing Cd concentration in brown rice. While phosphate reduced As accumulation in SK variety, silicate increased As concentration in both the varieties. Biochar increased As concentration in SK variety with no significant change in HKNR variety. AWD water management and phosphate/silicate amendments offer some promising solutions, however, additional field studies and As bioaccessibility research are required to control As in paddy soils and rice grains.

