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Image: Judith Brodsky

# FOOD & THE PLANET 2018

## SUSTAINABILITY & THE ENVIRONMENT

**Carole Dalin, UCL Institute for Sustainable Resources**

*Measuring the environmental sustainability  
of global food production and trade*

Natural resources, essential to sustain human life and livelihoods, are under increasing pressure from socio-economic development, population growth and climate change. Rising food demand has led to an intensification of agriculture, which now uses 70% of freshwater withdrawals and 38% of land, and is responsible for 25% of global greenhouse gases (GHG) emissions. This increasing use of natural and synthesised resources, machinery and land clearing often leads to damaging environmental consequences, such as water stress, reduced biodiversity, ecosystem pollution and climate change.

These issues significantly hinder the environmental sustainability of current food production. In addition, projected population growth (by 2.3 billion people to 2050) requires further increases in food production, making sustainable agriculture intensification a major and urgent global challenge. It is thus essential to improve the understanding of the multiple environmental impacts of agriculture, accounting for different practices and local conditions, in order to provide a comprehensive assessment of agricultural sustainability and to avoid trade-offs associated with different intensification strategies.

Besides, following recent economic globalisation, international food trade has grown rapidly since the 1980s, allowing for the development of major export-oriented agricultural regions. This crucial role of trade in global agricultural systems also needs to be included in the evaluation of possible pathways for environmentally sustainable agriculture.

## SYMPOSIUM ABSTRACTS



# ABSTRACTS SUSTAINABILITY & THE ENVIRONMENT

## **Tim Smit, Eden Project**

*The vacuum that nature abhors*

On what agronomy can do to heal the Land, and through great science communication – heal the soul.

## **Marco Springmann, University of Oxford**

*Planetary boundaries of the food system: analysing the option space*

The food system is a major driver of climate change, land-use change and biodiversity loss, freshwater consumption, and pollution of aquatic and terrestrial ecosystems through fertilizer runoff. As a result of expected changes in population and income levels, the environmental impacts of the food system could increase by 60-90% between 2010 and 2050, and reach levels that are beyond the suggested planetary boundaries that define the safe operating space for humanity.

Several options exist to lower the environmental impacts of the food system, but no single measure is enough to simultaneously stay within the food-related boundaries for climate change, land-system change, freshwater use, and biogeochemical flows. Instead, a combination of reductions in food loss and waste, ambitious changes in technology and management, and ambitious changes towards healthier, more plant-based diets is required to mitigate the projected increases in environmental pressures and stay within a safe operating space for essential ecosystems.



**Gladys Oluyemisi Latunde-Dada, King's College London**

*The role of meat in iron nutrition and metabolism: can it be replaced by edible insects?*

Meat contributes a significant amount of protein and iron to the diets of a large segment of the world's population. However, livestock production imposes a staggering economic and environmental burden on sustainable food supply worldwide. This has raised much concern and highlighted the need for credible substitutes.

Coincidentally, the World Cancer Research Fund has also recommended a reduction in red meat consumption in order to avoid the increased risk of bowel cancer. Consequently, interest in the consumption of insects (entomophagy) as an alternative environmentally sustainable source of protein in the diet of humans has recently witnessed a surge particularly in Western nations. Evidence shows that insects possess nutritional, health, and environmental benefits as alternative food components. It is proposed that the superiority of meat iron bioavailability can be rivalled by edible insects to ensure optimum iron nutrition in the populace.

Evidence is provided that insects such as grasshoppers, crickets, and mealworms contain significantly higher chemically available calcium, copper, magnesium, manganese and zinc than sirloin beef. Moreover, the bioavailability of iron from buffalo worms is comparable to that of sirloin beef. Insects can, therefore, be alternative sources of iron in replacement for meat in the diets of humans.

**Dorian Q Fuller, UCL Institute of Archaeology**

*The archaeology of cooking traditions: the baked versus the boiled at the opposites end of Eurasia*

Ever wondered why an apartment of a well-off modern family in modern Shanghai is unlikely to have an oven, while it would be hard to find a modest flat in London without one? The answer lies in long-lasting and deeply entrenched cultural inheritance of the fundamentals of food and cooking, which can be traced back to the origins of agriculture and even before. Very different cooking traditions in the Levant of Southwest Asia and eastern China influenced how crops were domesticated, how they spread, and became parts of elaborated culinary traditions. Ovens for baking bread pre-date cooking pots in parts of the Fertile Crescent, while ceramic boiling and steaming pots were developed before rice or millet were domesticated in China. These cooking traditions also played a role in genetic selection on crop evolution—which is why glutinous rices and millets are traditionally restricted in eastern and southeast Asia—and why selection for high gluten protein content has been central to west Eurasian wheat evolution. These culinary traditions have filtered the spread of crops between regions, and structure how food is eaten and perceived in different regional cuisines.



# ABSTRACTS

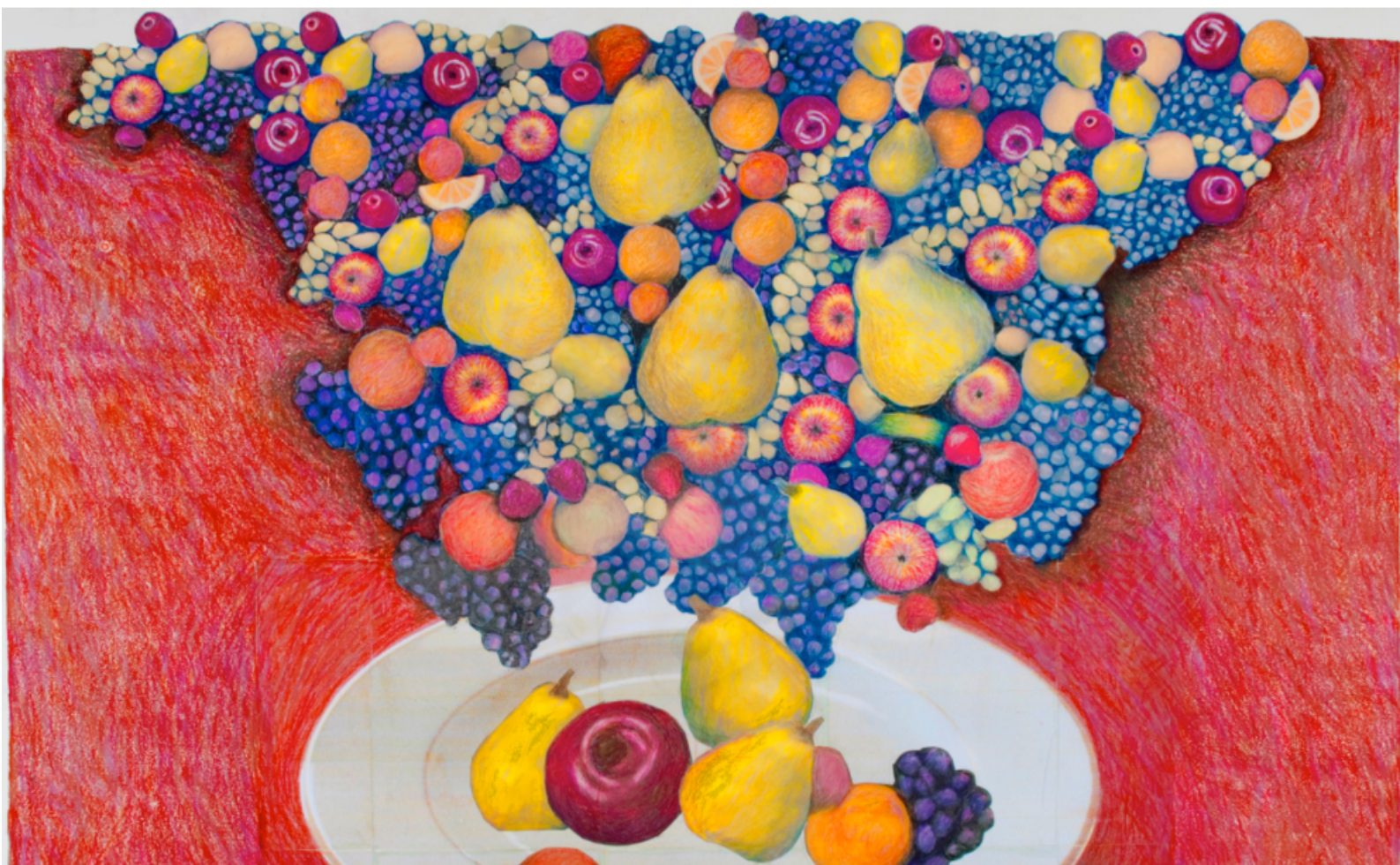
## FOOD SCIENCE

**Kent Kirshenbaum, NYU**

*Plant-Based "Meat": Innovating a bloody good burger*

The potential environmental and health benefits of a plant-based diet are becoming increasingly evident. Nevertheless, only a small percentage of consumers in the North America or Europe have adopted a vegetarian diet. This offers a compelling scientific and culinary challenge -- crafting plant-based foods that offer a truly satisfying experience for diners who prefer meat. Recent advances have brought massive new investments and formation of start-up companies that are bringing exciting new products to the marketplace, including plant-based substitutes for raw hamburger.

The Guardian recently declared plant-based meats as one of the seven "megatrends that could beat global warming". I will describe the technological challenges in developing some of these meat substitutes, along with some putative breakthroughs in creating a more robust flavour profile to mimic beef. The palatability of accepting trade-offs for these new products must be considered, including extensive food processing, reliance on GMO ingredients, or even growth of muscle cells in tissue culture. Can food science truly endow plant proteins with the hedonic rewards of meat, and what are the costs?





# ABSTRACTS METABOLIC DISEASE AND THE MICROBIOME

## **Jennie Brand-Miller, University of Sydney**

*Which diet for the healthiest planet?*

For the past three decades, health authorities have recommended we eat less fat and fewer refined sugars. Australians have obediently reduced both fat and sugar, including less sugar-sweetened beverages and fruit juices, but the obesity rate over the same timeframe has more than doubled, type 2 diabetes has tripled, and cardiovascular disease is still the number one cause of death. It is a wake-up call for other countries and those focused on sugars alone.

A new paradigm is arising: that the processed starches which replaced the energy from fat, may increase the risk of obesity, diabetes and heart disease more so than fat and sugar – a finding that has enormous implications for the global food and agricultural industry. Both quantity and quality of carbohydrate are relevant to the debate. Carbohydrates of any kind can produce adverse effects on blood glucose (blood sugar) levels after consumption, a characteristic that reflects their rate of digestion and absorption, and is assessed as their 'glycemic index' or 'glycemic load' per serving (GI and GL respectively).

This presentation will focus on well-designed studies demonstrating that carbohydrates which are slowly digested and absorbed (ie low GI or GL carbs) are good for health, helping to improve weight control, weight maintenance, insulin sensitivity, serum lipids, inflammatory markers, memory recall, physical endurance and the long term risk of chronic lifestyle-related diseases such as type 2 diabetes. These associations are independent of dietary fibre, and of the same magnitude than other recognised protective factors in food. Improving carbohydrate quality in plant-based foods is a better approach to health and sustainability concerns than ditching either meat or carbs.

*Disclosure: Jennie Brand-Miller is President of the not-for-profit Glycemic Index Foundation, director of a GI testing service at the University of Sydney, and author of books about the GI.*

## **Ian Charles, Quadram Institute**

*Exploring the microbiome at the Quadram Institute*

Quadram Institute Bioscience (QIB) is driving forward its world-leading research in food and health research. Later this year it will join partners from the University of East Anglia and the Norfolk and Norwich University Hospitals in the Quadram Institute, a new £multi-million state-of-the-art food and health research and endoscopy centre. In his seminar, Professor Ian Charles, Director of the Quadram Institute, will provide an overview of the plans for the Quadram Institute and discuss how its research will provide new insights to the relationship between the human microbiome and health.

# ABSTRACTS METABOLIC DISEASE AND THE MICROBIOME

## **Matteo Fumagalli, Imperial College London**

*How species genetically adapted to “extreme” diets*

The identification of signatures of natural selection in species adapted to extreme conditions is a promising strategy to understand the genetic basis of phenotypic variation. The Inuit people of Greenland have lived for a long time in the Arctic with a traditional diet rich in protein and omega-3 polyunsaturated fatty acids. By analysing large-scale genomic data, we found compelling evidence of natural selection targeting fatty acid desaturases, with alleles strongly associated with metabolic and anthropometric traits.

Other species with high-fat diets such as polar bears and killer whales exhibit a similar pattern of selection signatures, suggesting convergent evolution for adaptation to “extreme” diets. I will discuss how these results encourage a move beyond conventional populations in our search for the underlying genetic causes of cardiovascular diseases. Finally, I will illustrate current research trends on the identification of adaptive traits in the big data era.

## **Nick Lesica, UCL**

*A neuroscientist's view of obesity*

The overconsumption of processed foods has caused an epidemic of obesity. Decades of healthy eating initiatives have succeeded in increasing awareness of the problem, but have failed to elicit lasting change: each year millions of people attempt to improve their eating, but nearly all return to processed foods eventually.

But why is it so hard to stick to a healthy diet?

In this talk, I will give an overview of the brain circuits that control eating. I will argue that the obesity epidemic is an inevitable product of the mismatch between the environment for which these brain circuits are designed and the environment that we have created in our modern world. I will further argue that given the nature of these brain circuits, putting an end to the obesity epidemic will require dramatic environmental changes.





# ABSTRACTS METABOLIC DISEASE AND THE MICROBIOME

**Kelle H. Moley MD, University of Washington**

*Maternal metabolic disorders, oocyte quality and longterm offspring health*

Obesity currently affects over one-third of reproductive-age women in the world leading to overall health and metabolic disorders, including reproductive function. Obese women experience subfertility and infertility at greater rates but more importantly, when they do get pregnant, their offspring suffer significant health consequences.

Offspring of obese women are more likely than those born to normal-weight women to be obese at one year of age; and to have cardiometabolic sequelae, hypertension, and liver disease as they age. Given the severity and intractability of the obesity epidemic, we must identify effective means of intervention to prevent these detrimental effects of maternal obesity; this requires determination of the underlying mechanisms.

In this presentation, using a mouse diet-induced obesity model, I will discuss the rationale for attributing these offspring abnormalities to the maternal oocyte, specifically due to a metabolic aberration originating in the oocyte mitochondria. This phenomenon involves mitochondrial dynamic proteins and mtDNA transcription.

Since the maternal oocyte mitochondria are the template for all mitochondria in the offspring, we find this mitochondrial dysfunction in every organ examined in the F1, F2 and F3 generations, suggesting a germline, epigenetic phenomenon.

I will also present data to suggest that this process is not reversible by dietary changes or exercise in the mothers. Finally, I will introduce data to support possible mechanisms to explain the transgenerational transfer of these maternal metabolic abnormalities to the offspring.



# ABSTRACTS METABOLIC DISEASE AND THE MICROBIOME

**Mike Murphy, MRC Mitochondrial Biology Unit, University of Cambridge, UK**

*Mitochondrial Redox Metabolism in Health and Disease*

Mitochondrial redox metabolism is central to the life and death of the cell. For example, mitochondrial production of free radicals and subsequent oxidative damage has long been known to contribute to damage in conditions such as ischaemia-reperfusion (IR) injury in heart attack. More recently mitochondrial redox changes have also been implicated in redox signalling. Over the past years we have developed a series of mitochondria-targeted compounds designed to ameliorate or determine how these changes occur.

I will outline some of this work, which suggested that reactive oxygen species (ROS) production in IR injury was mainly coming from complex I. This led us to investigate the mechanism of the ROS production and using a metabolomic approach we found that the ROS production in IR injury came from the accumulation of succinate during ischaemia that then drove mitochondrial ROS production by reverse electron transport at complex I during reperfusion.

This surprising mechanism led us to develop further new therapeutic approaches to impact on the damage that mitochondrial ROS do in pathology and also to explore how mitochondrial ROS can act as redox signals. I will discuss how these unexpected mechanisms may lead to redox and metabolic signals from mitochondria in a range of conditions under both healthy and pathological conditions.





# ABSTRACTS METABOLIC DISEASE AND THE MICROBIOME

**Andrew Smith, Eastman Dental Institute, UCL**

*The human oral microbiome*

The oral microbiome is arguably the most well-studied human microbiome to date. We are only just beginning to identify and understand the factors which influence the development of the oral microbiome and those which result in human disease (Emerging Topics in Life Sciences Nov 30, 2017, 1 (4) 287-296). Recently, we have provided evidence supporting a major role for an individual's local environment, specifically their household, in shaping the composition of the oral microbiome (mBio. 2017 8:e01237-17).

We discovered that host genetics plays only a minor role in the oral microbiome. Our results are highly suggestive of the establishment of the oral microbiome earlier in life which affects its long-term composition. The results also support the concept that there is a consistent core oral microbiome conserved globally, which can be fine-tuned by a shared living environment.

**Megan Vaughan, UCL Institute of Advanced Studies**

*Routes to metabolic disease: insights from older people in Malawi*

In many parts of sub-Saharan Africa the growing problems posed by non-communicable disease are being approached and understood within a framework of 'metabolic syndrome' or 'metabolic disorder'. This in turn has focused data collection and health policy on questions of 'lifestyle' change and global risk factors. Whilst undoubtedly relevant, this approach, when narrowly conceived, over-privileges individual choice and elides many important questions relating to longer term economic and social conditions, developmental origins of disease, the effects of interventions in infant and child health, and the continued role of infection.

In the context of Malawi, one of the poorest and least urbanised countries in southern Africa, there may be more than one path to metabolic disease. In this paper I draw on earlier research on food systems and nutrition in Malawi, and a recent set of interviews with older people, to explore these issues and local conceptions of them. This work is part of a larger project on the history of chronic and non-communicable disease in sub-Saharan Africa, funded by a Wellcome Trust Investigator Award.

# ABSTRACTS

## METABOLISM AND DEEP TIME

**Nick Lane, Department of Genetics, Evolution and Environment, UCL**

*The Flux Capacitor: Mitochondria, metabolism and disease*

All morphologically complex life on Earth is composed of eukaryotic cells, which arose just once in 4 billion years of evolution. Recent phylogenetic evidence suggests that eukaryotes originated in a singular endosymbiosis between an archaeal host cell and a bacterial endosymbiont that eventually evolved into mitochondria. Gene loss from mitochondria, balanced by gene gain in the nucleus, produced a restructuring of eukaryotic genomes in relation to bioenergetic membranes, giving eukaryotes several orders of magnitude more energy per gene. All complex cells therefore depend on a fundamental genomic asymmetry, with two critical genomes per cell, whose products must interact with nanoscopic precision to maintain cellular function.

Yet these genomes have radically different modes and tempi of evolution, which necessitates selection for mitonuclear coadaptation each generation. I will present modelling work showing that the evolution of two sexes, and ultimately the female germline in bilaterian animals, reflects selection on mitochondrial genes, facilitating their adaptation to the nuclear background. I will close with some recent experimental work on fruit flies, which shows that mild incompatibilities between mitochondrial and nuclear genes can impair health and produce extreme differences in drug response between otherwise healthy animals.

