Plant genomics – celebrating plant health, plant biology and the impact of climate change on plant genomics

In this issue of *The Biochemist*, we explore plant genomics – from new applications for molecular diagnostics in crop protection and improving grain carbohydrates for human health to biosynthetic pathways and plant–pathogen interactions.

International Year of Plant Health

The United Nations (UN) General Assembly has declared 2020 as the International Year of Plant Health (IYPH). The UN describes IYPH as 'a once in a lifetime opportunity to raise global awareness on how protecting plant health can help end hunger, reduce poverty, protect the environment and boost economic development'. Find out more at www.fao.org/plant-health-2020/home/en/

The Biochemist supports the IYPH 2020.

INTERNATIONAL YEAR OF PLANT HEALTH 2020

New to plant genomics?

If you are one of our post-16 readers or you are a researcher who has not worked on plants since your undergraduate years, and you would like a refresher on some of the key aspects of plant biochemistry, we've got you covered.

Understanding biochemistry: photosynthesis is an open access article, giving a full introduction to this key process – refresh your memory or learn something new today. https://bit.ly/UBPhotosynthesis

Genomics is the branch of molecular biology concerned with the structure, function, evolution and mapping of genomes, and rather than looking at single genes, genomics explores the sum of the genetic material within an organism. One mechanism of controlling gene expression is through cytosine DNA methylation, which is widespread in plants due to the plant-specific chromomethylase (CMT) and RNA-directed DNA methylation (RdDM) pathways. These pathways appear to have evolved through multiple rounds of gene duplication and gene loss, generating epigenomic variation both within and between species. They regulate both transposable elements and genes, ensure genome integrity and ultimately influence development and environmental responses. In these capacities, non-CG methylation influence and shape plant genomes. Read the article here: https://doi.org/10.1042/EBC20190032

One of the main benefits of editing plant genomes is to cultivate crops with improved characteristics or yield. One of the primary targets for enhancing productivity is changing the architecture of inflorescences (the flower head of a plant), since in many species it determines fruit and seed yield, and this review looks at the genomics of *Arabidopsis*, rice, barley, wheat and maize (https://doi.org/10.1042/BST20190441).

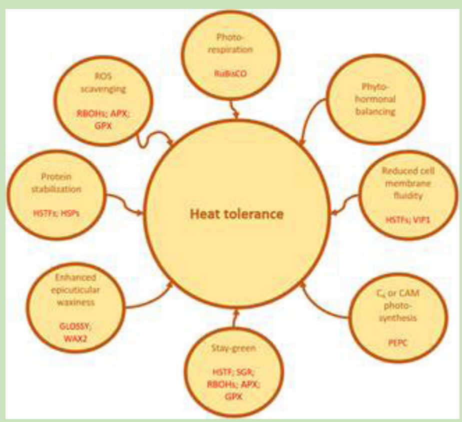
Impact of climate change

Climate change will impact plants – particularly valuable crop plants – in many ways, with increased temperatures, longer periods of drought and increased CO_2 levels all affecting plant biology. The most important aspects of climate change with respect to plants relate to water availability and heat stress.

Ethiopia's native staple food grain teff is at risk, with 80% of production likely to be affected by higher temperatures soon, but now scientists have mapped thousands of the crop's varieties to fast-track efforts to save it (find more on the story here: https://www.eurekalert.org/pub_releases/2020-06/icft-sus061820.php)

Plants are sessile organisms, and as such are well equipped to respond to environmental stressors with genetic adaptations. Evolution of plants onto land was enabled by the ability to tolerate extreme water loss, and this review explores the genome-level responses associated with desiccation tolerance, whose understanding could lead to the production of crops with greater drought tolerance than is currently realized (https://doi.org/10.1042/ETLS20180139).

Over multiple decades, the plant research community has amassed a highly comprehensive understanding of the physiological mechanisms that facilitate the maintenance of productivity in response to drought, flooding and heat stress. Learn more about climate change and abiotic stress mechanisms in plants in this mini-review (https://doi.org/10.1042/ETLS20180105).



This diagram represents a subset of the most important adaptive mechanisms that facilitate thermotolerance.

Mechanisms are highlighted in brown and, where appropriate, genes or gene families that are known to contribute to associated mechanisms are highlighted in red. Taken from https://doi.org/10.1042/ETLS2018010

Chloroplasts: the capture and production modules of plants

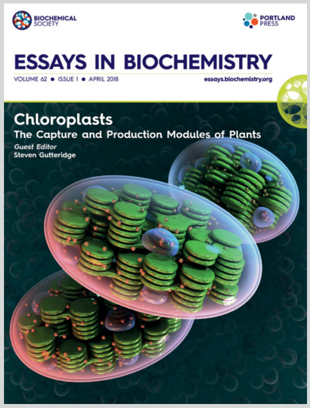
Edited by Steven Gutteridge,
https://portlandpress.com/essaysbiochem/issue/62/1
FMC Corporation, Stine Research Center, USA

Includes:

Chloroplast signalling and quality control
Jean-David Rochaix (Geneva) and Silvia Ramundo (UCSF)

RNA stabilization factors in chloroplasts of vascular plants (open access)
Jörg Meurer (Munich)

Increasing metabolic potential: C-fixation
Martin A.J. Parry (Lancaster)



Gene editing in agriculture: biotechnology and biosafety

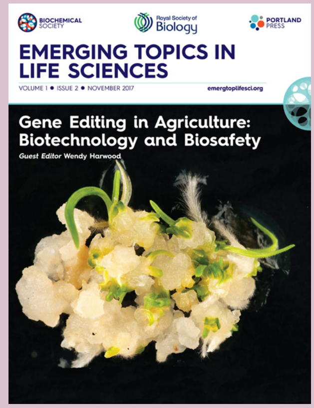
Edited by Wendy Harwood
https://portlandpress.com/emergtoplifesci/issue/1/2
John Innes Centre, UK

Includes

Potential impact of genome editing in world agriculture
Huw D. Jones (Aberystwyth)

CRISPR-based tools for plant genome engineering (open access)
Nicola Patron (The Earlham Institute)

Risk associated with off-target plant genome editing and methods for its limitation (open access)
Jeffrey D. Wolt (Iowa)



Photosynthesis collection from the *Biochemical Journal*

Guest edited by Professor Christine Foyer, Professor Jeremy Harbinson and Dr Alberta Pinnola
https://portlandpress.com/collection/806/Photosynthesis

Photosynthesis is the engine for life on Earth. The rate and efficiency of photosynthesis are major traits determining crop yields. Understanding the mechanisms that regulate light energy usage and chloroplast metabolism is fundamental to crop improvement. The papers in this collection, published in the *Biochemical Journal* and guest edited by Professor Christine Foyer, Professor Jeremy Harbinson and Dr Alberta Pinnola, seek to characterize these regulatory networks and identify the bottlenecks that limit photosynthetic efficiency. Moreover, they add to our understanding of how chloroplasts function as sensors of changes in light intensity and other environmental cues, instigating signalling cascades that influence gene expression. This work also encompasses how photosynthetic metabolism might adapt to a high CO_2 world with its increasingly unpredictable climate in future.

Seeds collection from the *Biochemical Journal*

Guest edited by Professor Christine Foyer, Professor Ilse Kranner and Dr Wanda Waterworth
https://portlandpress.com/collection/805/Seeds

Seeds underpin global agriculture and natural ecosystems. Understanding seed biology is fundamental to help mitigate the effects of changing climates and population growth on crop production and ecosystems threatened by environmental change. In this collection published in the *Biochemical Journal*, guest edited by Professor Christine Foyer, Professor Ilse Kranner and Dr Wanda Waterworth, articles highlight current research in seed biology, providing new insight into aspects ranging from seed development, seed longevity and germination to nutritional aspects of seeds. This work ranges from the fundamental biological mechanisms that underlie the development, storability and subsequent germination of seeds to the applications of seed science, including resilience of seed germination under stress.

You might also be interested in *Plant Hormone Signalling*, which is available at
https://portlandpress.com/essaysbiochem/issue/volume/58
Edited by Thomas Guilfoyle and Gretchen Hagen