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ADVANCES IN RADIATION BIOLOGY – HIGHLIGHTS FROM THE 16TH ICRR SPECIAL FEATURE: EDITORIAL

Advances in Radiation Biology – Highlights from the 16th ICRR special feature: introductory editorial

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Every 4 years, the global Radiation Research Community comes together, under the auspices of the International Association for Radiation Research (IARR), to review progress and state-of-the-art in radiation-related research. This timely *BJR* special feature presents some key advances in radiobiology from the 16th International Congress of Radiation Research (ICRR) which was held at Manchester Central, Manchester, UK, from 25–29 August 2019. This was hosted by the UK society, the Association for Radiation Research. Over a thousand delegates attended the meeting drawn from 45 countries around the world. The extensive congress programme had four main themes covering Basic Mechanisms, Translational Research, Radiotherapy, Health Effects and Ecology. This *BJR* special feature focuses on advances in radiation biology and includes selected papers from keynote and award lectures presented at the congress giving a timely state-of-the-art overview of current radiation-related research and future directions, from key opinion leaders in the field.

Radiobiology is the study of the action of ionizing radiations on living organisms and an understanding of it underpins the use of ionizing radiations in diagnostics and therapy in radiation oncology as well as having implications for health and radiation protection.

The first review in this collection is by Dr Ioanna Papandreaou and Dr Martin Kery, Department of Radiation Oncology at the Wexner Medical Center and Comprehensive Cancer Center, Ohio State University, USA. This is entitled "Emerging strategies to target cancer metabolism and improve radiation therapy outcomes".[1] This review focuses on opportunities to enhance the efficacy of radiotherapy by exploiting cell-inherent vulnerabilities and dynamic microenvironmental components of the tumour. Specifically, the use of selected metabolic substrates which can modify the DNA damage response and impact the tumour microenvironment are reviewed focussing on the role of glutamate, oxygen and lipid metabolism.

Professor Robert Bristow from the CRUK Manchester Institute and CRUK Manchester Centre, UK, gave the opening plenary talk of the congress entitled "Bad neighbours: hypoxia and genomic instability in prostate cancer" and he contributed a review on this topic with Dr Jack Ashton, CRUK Manchester Institute and CRUK Manchester Centre, UK.[2] This review focuses on recent findings showing that co-presence of hypoxia and genomic instability can confer a uniquely adverse prognosis in localised prostate cancer (PCa) patients. Specifically, it shows that hypoxic suppression of homologous recombination represents a "contextually lethal" vulnerability in hypoxic prostate tumours which could extend the application of existing DNA repair targeting agents including poly-ADP ribose polymerase inhibitors. This is in the context of a need for PCa patients with hypoxic tumours to be better stratified into risk categories and treated with appropriate therapies to prevent progression.

The European Radiation Research Society Bacq and Alexander lecture was delivered by Professor Markus Löbrich, Darmstadt University of Technology, Darmstadt, Germany. His review, co-authored with Dr Michael Ensminger, Darmstadt University of Technology, Darmstadt, Germany, is entitled "One end to rule them all: Non-homologous end-joining and homologous recombination".[3] This article is focussed on DNA double-strand breaks (DSBs) produced from single-stranded lesions which lead to replication fork collapse and are single-ended in contrast to those produced by direct radiation exposure which consist of two single-ends. They propose that the specific requirements of these single-ended DSBs have shaped homologous repair in a way which makes non-homologous end joining the better choice for the repair of some but not all two-ended DSB.

The 2020 Association for Radiation Research Weiss Medal lecture was delivered by Professor Penny Jeggo, Genome Damage and Stability Centre, University of Sussex, UK. This review, co-authored by Dr Atsushi Shibata, Gunma University, Maebashi, Japan, is entitled "Canonical DNA non-homologous end-joining; capacity versus fidelity"[4] and focuses on two subpathways of the canonical DNA non-homologous end-joining pathway (c-NHEJ) for repair of DSBs. These are fast processes that do not require nucleases or significant chromatin changes and a slower process that necessitates resection factors, and potentially more significant chromatin changes at the DSB. The implications of the limitations of c-NHEJ that might result in DSB misrepair are discussed.

The 20th ICRU Gray Lecture 2019 was delivered by Dr Eleanor Blakely, Lawrence Berkley National Laboratory (LBNL), USA and the Review is entitled "Health and heavy ions."[5] This review focuses on the contribution that particle radiobiology has made to our understanding of radiation safety and the underlying mechanisms of action to radiation oncology and radiation protection for space research. It highlights the significance of precise physical and biologically effective dosimetry to translational research on particle radiobiology of accelerated ions for the benefit of human health.

A review by Professor Nori Nakamura, Radiation Effects Research Foundation, Hiroshima, Japan, based on his plenary lecture, is entitled "A hypothesis: radiation carcinogenesis may result from tissue injuries and subsequent recovery processes which can act as tumour promoters and lead to an earlier onset of cancer".[6] This speculates that radiation exposures induce a broad range of tissue injuries, and that these injuries are subsequently subjected to a longlasting systemic recovery process which act as promoters for tumour cells as part of a non-targeted effect.

Dr Nobuyuki Hamada, Central Research Institute of Electric Power Industry in Tokyo, Japan and colleagues present an update on effects of ionizing radiation exposure on the eye.[7] This review paper gives an overview of the scientific basis of the 2011 ICRP recommendation for reduced dose limits for the lens to prevent vision impairing cataracts (VICs). It discusses the plausibility of two assumptions, the assumed progression of minor opacities into VICs and the absence of a dose–rate effect in the light of emerging scientific evidence, and considers the radiosensitivity of the lens among ocular structures.

In addition to the review articles in this *BJR* special feature, the collection features a Commentary from Professor Charles Limoli, University of California, Irvine, USA, which is based on his keynote lecture entitled "Can a comparison of clinical and deep space irradiation scenarios shed light on the radiation response of the brain?".[8] This compares our developing knowledge of the response of the brain from clinical exposures, where both stromal and parenchymal targets play a role alongside an exquisite sensitivity of neurogeneic populations, and their relevance for other exposure scenarios particularly related to space flight. There are surprising similarities in the response of the brain to disparate exposure scenarios.

The final paper in this collection is an original research article by Dr Katalin Lumniczky, National Public Health Institute, Budapest, Hungary and colleagues, and is entitled "The effect of ionizing radiation on the phenotype of bone marrow-derived extracellular vesicles".[9] Specifically, this reports studies on the role of intercellular communication in the bone marrow and its contribution to the development of haematological malignancies using whole body X-irradiated mouse models characterising extracellular vesicles (EVs). She reports key changes in CD29 and CD44 integrin-harbouring EVs and the relative proportion of EVs with haematopoietic stem cell or lymphoid progenitor markers increased.

We hope this collection of comprehensive Reviews, award lectures, Commentary articles and original research, from leaders in the field, presented at ICRR 2019 gives a useful update of where radiation-related research stands at present and highlights future progress. We thank all the contributors for the delivery of these timely papers.

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