Sir Dai Rees (28 April 1936 to 10 June 2021)

Dai Rees was born in Silloth on the Solway Firth. His father James was a chemist, his mother Elsie a librarian and Dai attended Hawarden Grammar School in Flint. He then won a scholarship (open to families who had left Wales for work) to the University College of North Wales in Bangor. The department head was the eminent carbohydrate chemist Stanley Peat, a student of Sir Norman Haworth (Nobel Prize for vitamin C) and this is where he learnt carbohydrate chemistry. After a BSc in 1956 he studied for a PhD under Jim Turvey on the chemistry of the polysaccharide porphyran (lava bread) from *Porphyra umbilicalis*. At Bangor, Dai met fellow student Myfanwy Parry Owen, who became a teacher and later a psychoanalyst; they married in 1959. Following his PhD, Dai took a lectureship in the Chemistry Department at Edinburgh University with Sir Edmund Hirst (also ex-Haworth).

He took as the subject for his research a study of the relationships between polysaccharide structure and their physical function and in particular how this is related to the formation of gels by carrageenans, sulphated galactans found in the red seaweeds (*Rhodophyta*). This was a subject that soon attracted interest from industry both from manufacturers (Bulmers, Marine Colloids) and from users (Unilever) as these functional properties provide texture to many commercial products. However, up to this point, polysaccharide chemistry had been largely confined to the study of primary covalent structures and little methodology existed for secondary and tertiary structural investigations. Dai therefore employed techniques from protein chemistry (X-ray crystallography, optical rotatory dispersion, circular dichroism). Also, having established that all known carrageenans had a strictly alternating α1,3 β1,4 galactose backbone, he was able to model the preferred lowest energy conformation of a polysaccharide chain (using the Manchester University Atlas Autocode computer). The result suggested that the chain formed a helix, a result later confirmed by X-ray crystallography. In order to achieve gelation, the helices must combine with other helices to form a network and through further modelling, spectroscopy and chemistry, it was found that the insertion of anhydrogalactose 'kink' residues allowed helix sections to recombine to form the desired network.

At Edinburgh he was a very engaged and active PhD supervisor having regular question and answer sessions in the department and with drinks in his house. He also enjoyed practical jokes. On one occasion he was collaborating with Ian Sutherland in microbiology to sort out the structure of a bacterial polysaccharide. He gave a sample to a visiting professor from California (Henry Nakada) who took it back to the USA but the structure was then solved quite quickly using a new NMR in Edinburgh. Sometime later, a letter arrived from Nakada suggesting that he had worked it out before the Edinburgh result, much to the irritation of the student who had obtained the result (Chris Lawson). It then emerged that the letter was a hoax. Dai got his own back by telling the ringleader (Alastair Penman, who much later became head of the Unilever Colworth research lab) that his external examiner was to be someone with a surname beginning with 'B', a new professor at a Scottish university. Alastair immediately assumed that it was John Brimacombe from Dundee who had a fearsome reputation so he spent much time in the library boning up on Brimacombe's publications. However, his examiner was actually Grant Buchanan, a much less scary option from the Heriot Watt – Dai got his own back!

Every self-respecting food manufacturing industry knows it must understand and control its ingredients and for Unilever, a scientific gap was in polysaccharides, which were increasingly important in dressings, desserts and ice cream. The solution was to recruit Dai and most of his research team from Edinburgh. The driving force in all of his subsequent career was a fundamental interest to see innovation and an enormous talent to 'see the big picture'. At Colworth, Dai extended his understanding of structure–function relationships to other polysaccharides such as the important glycosaminoglycans and the synergy between apparently diverse glycans such as galactomannans and xanthan gum. Further studies revealed the way in which alginates, polyuronides from brown algae (*Phaeophyceae*), form gels in an 'eggbox' structure, holding calcium ions between linear chains. These discoveries have helped to gain a better understanding of how glycosaminoglycans such as heparin prevent blood clots, how hemicelluloses in the plant cell wall form matrices with cellulose and how bacterial polysaccharides form protective capsules around the cell.

Shortly after his arrival at Unilever, the Corporate Research and Engineering Fund was established. This large research budget was charged with looking over the head of the existing business to see where science and technology could contribute to future business. For Dai and his senior colleagues Tony James (lipids) and Felix Franks (water), this was the ideal situation to develop strategy, and the resources to action new research; and for those working for them or with them, only the highest academic standards were acceptable. The technical basis for products which are now household brands in Foods and Personal care were established in this era. Dai always wanted to be recognized as the best in everything he and his research teams could do. Competition was recognized

and defeated wherever it arose, which did not always make him the most popular leader. The trouble was that he usually was the quickest and most far sighted of his colleagues. No one grasped new results faster and could add infuriatingly bright suggestions on what else could be done, so that working in Corporate was like belonging to a high-class research faculty in any university.

Perhaps Dai would have liked to be the Unilever board member for R&D, but that was not to be, and his past involvement with the UK Medical Research Council (MRC) meant that he was headhunted in 1982 and, to his surprise, was offered the directorship of the UK National Institute for Medical Research (NIMR) to implement the recommendations he had helped to shape. He placed the research programmes within four new supergroups, brought in new blood and set about refurbishing laboratories and upgrading the facilities, leaving staff posts vacant to balance the books. He also encouraged direct links between MRC scientists and industry and in 1986 set up a dedicated incubator for this purpose, the MRC Collaborative Centre. Within a few years it had grown to an enterprise employing more than 50 scientists. The centre charged industry for the services it provided, one of which was the 'humanizing' of mouse antibodies, a technology invented at the MRC Laboratory of Molecular Biology (LMB) in Cambridge.

In 1987, Dai was appointed head of the MRC. He revolutionized the way the MRC interacted with industry. Under his leadership, centres were established with strong industrial links, with the aim of encouraging the practical application of MRC research and inventions. The work of these centres contributed to the development of the 'blockbuster' Keytruda antibody for cancer treatment and of the world's top-selling pharmaceutical drug, the antibody Humira, which treats rheumatoid arthritis and Crohn's disease. Four of the antibodies created at Mill Hill for pharmaceutical companies were later approved for marketing, including Keytruda. Indeed, the royalties from Keytruda currently fund the activities of LifeArc, a UK medical research charity spun from the MRC. The fostering of these principles was involved in the development of the Clearblue pregnancy test and eventually helped make Covid Lateral Flow Tests a household device.

Dai Rees and his Research Group in 1968

In 1990, he set up the council's first interdisciplinary research centre, the Centre for Protein Engineering (CPE), in Cambridge. He also facilitated the spinning out of the biotechnology company Cambridge Antibody Technology (CAT) from further inventions at the LMB and CPE. Within a few years CAT had helped create Humira.

He was awarded the Colworth research medal of the Biochemical Society (1970), the first Tate & Lyle medal from the RSC (1970) and elected fellow of the Royal Society (1981). In 1993 he was knighted. He retired from the MRC in 1996 and focused on his role as president of the European Science Foundation (1994–1999).

In the mid-1990s Dai was an active member of the steering group developing the government's Technology Foresight programme, which aimed to identify and fund areas of research most likely to lead to practical application. When the Department of Biology at York established the Centre for Novel Agricultural Products, Dai enthusiastically chaired Prof Diana Bowles Steering Committee.

But it wasn't all work. Dai could relax by birdwatching, much of it done from his vintage cruiser (Think Tank), on the inland waterways. Family and friends were often invited, and he was not only a brilliant thinker, but very good company.

He is survived by Myfanwy; their daughter, Olwen; two sons, Lewis and Dan; three grandsons, Lorcan, Alex and Owen; and a granddaughter, Olivia.

Peter Lillford, CBE, FRSC
Chris Lawson, FRSC