OXFORD Toxicology Research

Toxicology Research, 2022, 1–2
https://doi.org/10.1093/toxres/tfac056
Viewpoint

Fifty years of the BTS—some reflections

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As we celebrate 50 years of the BTS, it is timely to consider what topics and challenges dominated our thinking in toxicology 50 years ago and how things have evolved to the current day. To gain insight into this, we sought the views of several senior toxicologists who offered their observations and reflections on their careers in toxicology.

One notable trend is the changing skill sets that might be considered essential for a career in toxicology. Fifty years ago, experience of in vivo methodologies was expected whereas today's recruits into toxicology rarely have this skill set. In contrast, in silico "and" in vitro (ISIV) methods such as molecular biology and computational methods dominate our approaches; a working knowledge of bioinformatics and computational approaches would be expected today but unheard of 50 years ago (Fig. 1).

Another emerging theme is the need to make decisions based on limited data. This is well illustrated by experiences shared by Dr Diane Benford. "Whether you are working on naturally occurring compounds and toxins or those arising from human activity, you have to make decisions on limited data, with no possibility of asking a manufacturer to perform more studies." Indeed, regulatory toxicology studies conducted according to internationally agreed guidelines are commonly not available and it would often be hard to justify conducting or repeating such work. In the early days of her research, Dr Sue Barlow's research topic was potential changes in brain function after prenatal exposure to drugs. "The challenge was to work out if any of the animal cognitive behaviour techniques could be applied to very young animals, and how to interpret the results," she explained. Professor Faith Williams also pointed out that today we often rely on data that could have been generated 40 or 50 years ago "A good example of this is our dependency on legacy data on skin absorption, requiring us to have robust methodologies for extrapolation."

One of the most satisfying aspects of toxicology was, and remains, alignment with fundamental science in other disciplines such as pharmacology, biochemistry, immunology, and drug discovery. "It was always extremely rewarding when our investment in toxicology research paid real dividends in other areas," commented Professor Ian Kimber, OBE. "An important challenge was also to ensure that our investment in research had **direct and translatable impact** in terms of mechanistic understanding and hazard/risk assessment." An excellent example of this is the mode of action and species difference studies done at the British Industrial Biological Research Association (BIBRA) Laboratories, ICI Central Toxicology Laboratory (CTL), and elsewhere in the 80s and 90s demonstrating that the rodent liver tumors induced by constitutive androstane receptor and peroxisome proliferator-activated receptor alpha activators are not relevant for humans. Although there are clear advantages to viewing toxicology as an applied discipline encompassing many other fundamental sciences, Professor Faith Williams highlighted that there are downsides. "**Toxicology may lose out to other more fundamental scientific disciplines**, and academic toxicologists have always had to fight to retain funding."

Another interesting aspect to consider is the diverse routes into the discipline of toxicology taken by our senior toxicologists. "My introduction to Toxicology started at 17 when I was offered an apprenticeship to work and train at the Medical Research Council, Toxicology Unit where I learned histology," explained Professor Ted Lock. "I later requested a transfer to biochemistry and my boss John Barnes agreed to this, although he suggested that pathology was a better career route," he continued. "One of the highlights of my time at the Medical Research Council (MRC) was working with Dr Peter Magee when he discovered that the carcinogen dimethylnitrosamine methylated the DNA base guanine, a seminal discovery in that field." Sir Colin Berry explained that he became involved with toxicology when he was working in pediatric pathology at Great Ormond Street and Ros Hurley (later Dame Rosalind) asked him to join the Committee on Dental and Surgical Materials (CDSM), which dealt with dental materials, implants and so on. "She knew I had worked on embryo-culture as a possible screen for teratogens," he added. "Later Frank Sullivan asked me to join the Advisory Committee on Pesticides. So it was all an accident!" Sir Colin then went on to become Chairman of the MRC Systems Board and was on the Council as the member responsible for the MRC Toxicology Unit when Professor Lewis Smith headed it.

Dr Sue Barlow explained that her journey in toxicology started in 1969 when she joined Frank Sullivan's lab at Guy's Hospital Medical School. "I was offered the research position because I was the only candidate who asked questions!" Others were first introduced to toxicology via organizations such as BIBRA. "The focus of my early career at BIBRA was on studying mitogenic nongenotoxic agents," said Professor Brian Lake. "BIBRA was set up to study the toxicology of food additives, funded by a partnership

Received: May 20, 2022. **Revised:** July 14, 2022. **Accepted:** July 21, 2022
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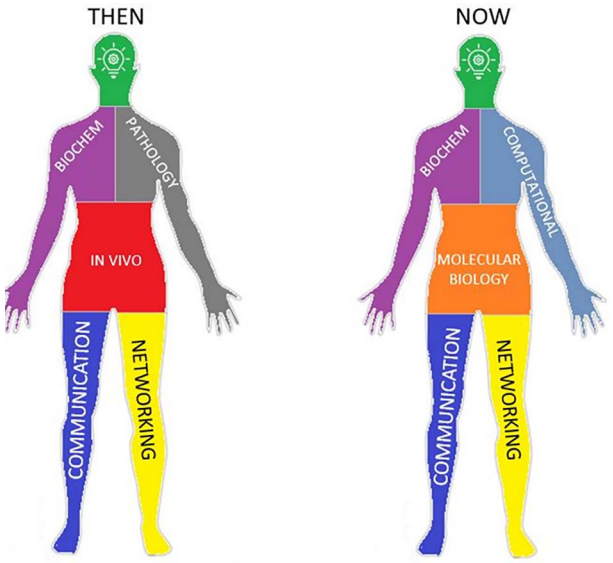

Fig. 1. Schematic depiction of the skills needed by a toxicologist then and now. Although the main body may differ, the foundations of communication and networking remain the same overseen by a questioning and curious mentality. The lightbulb depicts relentless curiosity and a questioning mentality.

between government and industry," explained Professor Lake. "BIBRA and the MRC Toxicology Unit were originally adjacent to one another, and it seemed there was little difference between them back then – how things have changed!" Likewise, Professor Ian Kimber joined Imperial Chemical Industries (ICI) CTL from a successful career as an academic immunologist to create and lead the immunotoxicology team addressing the challenges of contact and respiratory sensitization. A common thread here is that our senior toxicologists have developed from different backgrounds. "I started with a PhD in forensic medicine investigating chemicals in drug addicts, moved to clinical pharmacology then environmental and occupational medicine leading to lecturer in Toxicology," commented Professor Williams. Professor Shirley Price began her career wanting to be a biochemist until her Industrial Year where she worked on drug–drug interactions. "On returning to finish my degree I took options in what was then called 'Special Topics', essentially Systems Toxicology. It was just the beginning of a career in toxicology," commented Professor Price.

An interesting reflection from our senior toxicologists concerned changes regarding career progression and workplace culture. "I think the biggest difference between 'then' and now is that most of my appointments were word of mouth stuff, no applications or formal interviews," commented Professor Sir Colin Berry. "Also, there was then no real option of saying no, it may seem odd but if the MRC wanted you, you went." Likewise, Professor Lewis Smith once shared with me the observation that he was never offered a senior position that he was not asked to apply for and attributed his career moves to well-established working relationships based on respect, peer review, and challenge.

To counter this, it may seem to our senior toxicologists that things were different "then." But talking to our British Toxicology Society (BTS) Network of Early Stage Toxicologists (NESTs), many of them report finding their current posts through existing relationships, networking, and platforms such as LinkedIn rather than formal application. So maybe it's just the methods of networking that have evolved from then to now, where there is much more emphasis on social media. "Networking and exposure when presenting a talk or poster is still very important for young toxicologists - this has not changed even if we have instant contact on-line," commented Professor Williams. Offering an additional insight on the "workplace environment," Professor Ian Kimber recalls the culture at CTL in the 80s and 90s. "Meetings were supported by sandwiches and cans of beer – and conducted under a pall of cigarette and pipe smoke. Utterly unthinkable today."

Another notable common thread amongst our highly successful, senior toxicologists is a sense of relentless curiosity depicted by the light bulb in Fig. 1. Professor Sir Colin Berry highlighted that his invitation from Dame Rosalind to join the CDSM came because "she knew I was 'into' mechanisms." Dr Barlow mentioned earlier that she was appointed since she was the only candidate that asked questions. Professor Ian Kimber also recalls that the culture at CTL in the 80s and 90s was "scientifically competitive and enriched by some very exotic – and sometimes formidably bright – colleagues."

A further key reflection from our senior members is that The BTS has always been a welcoming and inclusive group with senior members willing to talk to and share their words of wisdom with early career and student population. "I have found the student members very keen to engage. In recent years I have seen an increase in younger people at the society meetings which is a real plus," commented Professor Heather Wallace. "I would advise them to take every opportunity and if there is a chance to volunteer do so!" Professor Shirley Price shared a similar sentiment: "At one point in my early career, I was fortunate to share an office with Professors Paul Grasso, Norman Aldridge and Richard Carter; discussions were priceless, and I was always learning!" Bridging to today, Professor Price concluded that "It was such a delight to see so many of our early career toxicologists at the 2022 BTS Annual Congress providing just a glimpse into their research areas through posters and oral communications."

In closing, I would like to share the take home messages offered by Drs Benford and Barlow and Professor Wallace. Dr Benford highlights the value and enrichment gained from working in scientific advisory committees with experts in different disciplines from around the world: "This really adds to the enjoyment; you never stop learning from each other." Dr Barlow also offers this advice to toxicologists at all stages: "Never pass up an opportunity to sail into uncharted waters." Finally, Professor Wallace notes from her personal experience that "you will make some very good friends in the BTS!" I think we can all agree with that sentiment!

Authors' contribution

RR, EM, and HW authored the manuscript. KR provided the concept and the artwork for Fig. 1.

Acknowledgments

The authors would like to thank Dr Sue Barlow, Dr Diane Benford, Professor Sir Colin Berry, Professor Ian Kimber, OBE, Professor Brian Lake, Professor Shirley Price, Professor Lewis Smith, Professor Heather Wallace, and Professor Faith Williams for sharing their experience and insights.

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