The World Chemistry Leadership Meeting (WCLM)

TRUST IN SCIENCE AND THE RIGHT TO SCIENCE

Kuala Lumpur, Malaysia | July 15 | 08:00-11:00

The 50th World Chemistry Congress (50WCC)

08:00	**Introductory remarks:** **Ehud Keinan**, IUPAC President
08:15	**Dorothy J. Phillips**, 2025 ACS President Will Communicating the “Right to Science” Promote Trust in Science?
08:30	**Helen Pain**, Chief Executive, Royal Society of Chemistry Chemistry’s role in building a fairer, safer, and more sustainable world.
08:45	**Omar M. Yaghi**, University of California, Berkeley The Future of Science in the Digital Age.
09:00	**Elizabeth A. H. Hall**, University of Cambridge, UK The science, the interpretation or the integrity: where are we failing?
09:15	**Paul T. Anastas**, Yale University Science, Worthy of Preserving, Protecting, and Defending.
09:30	**Peter Mahaffy**, King’s University, Edmonton, Canada, Building Trust in Science.
09:45	**David Winkler**, La Trobe University, Monash University, University of Nottingham The “Hydra's head” of attacks on science.
10:00	**Open discussion**
10:50	**Concluding remards**

Speakers:

Ehud Keinan

Dorothy J. Phillips

Helen Pain

Omar M. Yaghi

Elizabeth Hall

Paul T. Anastas

Peter Mahaffy

David Winkler

Trust in Science and the Right to Science - Introductory Remarks

Prof. Ehud Keinan

IUPAC President

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Although science vulnerability is not a new problem, the trend has been amplified and accelerated in the digital ecosystem and cyberspace by AI, social media, and the Internet. The multi-faceted challenge and its far-reaching social and political implications arise from several developments:

1. **Scientific misconduct**. Breaching codes of ethics integrity and credibility, and intensified trends of fabrication, falsification, and plagiarism (FFP), oversimplification, and sensationalism. These trends result in staggering irreproducible published results, retracted scientific articles, and over 18,000 predatory journals.
2. **Systemic threats**. Misinformation, pseudoscience, conspiracy theories, deepfakes, junk science, AI-generated publications, and AI-peer reviews.
3. **Amplification of bias**. Echo chambers and filter bubbles reinforce beliefs and ideologies, distort scientific debates, impede objective evaluation of evidence, and hinder open-mindedness, fact-checking, and critical thinking.
4. **Harassment of scientists**: Cyberbullying and trolling intimidate and discourage researchers involved in politically sensitive research.
5. **Cyber-attacks**: deepfake images and videos, disinformation, misinformation, conspiracy theories, pseudoscience, AI-powered bots, automated accounts, and manipulation of social media.

Marginalized communities are more vulnerable to stereotyping and identity politics, bias amplification, distrust in science, spreading misinformation, false health claims, fact denial, Woke propaganda, and mistrust in democratic processes and institutions. Deepfake images and videos distort reality, manipulate public opinion, sow division, polarize, and undermine societal cohesion in service of populist politicians.

In addition to the six global challenges that threaten humankind, including (1) atmospheric changes, (2) sustainable energy, (3) dwindling raw materials, (4) water scarcity and safety, (5) food security, and (6) public health, we should consider science vulnerability as the seventh challenge.

Beyond diagnosing and assessing the threats, it is our responsibility as scientists to propose modes of action to mitigate the problem and restore trust in science. A way to recruit the public to this mission is by delivering the message that everyone is entitled to the fundamental right to participate in science and to benefit from its advancements. These are declared by Article 27 in the Universal Declaration of Human Rights, 1948.

I thank the seven global chemistry leaders for accepting my invitation to illuminate these intricate problems from their preferred angle, highlight issues that deserve high priority, and propose a mode of action. Following their short presentations, the team will respond to questions and comments from the floor.

Will Communicating the "Right to Science" Promote Trust in Science?

Dr. Dorothy J. Phillips

2025 President of the American Chemical Society

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During my ten years with the American Association for the Advancement of Science (AAAS) Science and Human Rights Coalition (2014–2023), I developed a deep appreciation for the "Right to Science" as a fundamental human right. Jessica Wyndham, former Director of the AAAS Scientific Responsibility, Human Rights, and Law Program, played a pivotal role in advancing this right through the United Nations.

The Right to Science has been recognized for 77 years, originating in Article 27 of the Universal Declaration of Human Rights (UDHR, 1948) and further detailed in Article 15 of the International Covenant on Economic, Social and Cultural Rights (ICESCR, 1966). This right encompasses access to scientific knowledge, education, training, and mentoring, as well as the ability to benefit from scientific progress. It applies universally—across all demographics, disciplines, and aspects of life.

Simply put, everyone has the right to access the latest scientific information and benefit from scientific advancements. This includes ensuring that students, especially school-aged children, are aware of this right. Education at all levels, regardless of race, ethnicity, or socioeconomic status, is essential to fostering this awareness.

The 2020 General Comment No. 25, issued by the UN Committee on Economic, Social and Cultural Rights (CESCR), provides guidance for implementing this right. It outlines core obligations for states, including the promotion of accurate scientific information and the prevention of disinformation—key to maintaining public trust in science.

The General Comment emphasizes that states must not only avoid interfering with scientific freedom but also take proactive steps to support scientific development and the dissemination of knowledge. This is especially relevant today, as public trust in science has declined. A 2023 survey revealed that trust in science for Americans dropped by as much as 14 percentage points compared to pre-pandemic levels. https://www.pewresearch.org/science/2023/11/14/americans-trust-in-scientists-positive-views-of-science-continue-to-decline/ The American Chemical Society hosted a webinar titled *How to Break Through to Reach Science Deniers*, offering insights into reversing this trend.

My lecture will explore whether the Right to Science, as articulated in General Comment 25, can help rebuild trust in science through its emphasis on development, conservation, and dissemination. A key takeaway from General Comment 25 is the importance of early science education, beginning in kindergarten. Addressing global challenges requires increased support for and engagement with science. The central question remains: Can the Right to Science help restore public trust and foster a more scientifically literate society?

Chemistry's role in building a fairer, safer, and more sustainable world

Dr. Helen Pain

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Public trust in science, and in chemistry, has never mattered more. From the materials we use to the medicines we take, chemistry underpins many of the solutions the world needs. But how the public sees chemistry affects everything from education and careers to public policy.

This talk explores the role of chemistry in society today, and the responsibility of the chemical sciences to serve the public good. Ethical questions increasingly shape both research and regulation, especially in areas such as chemicals policy and sustainability. Chemistry cannot be separated from the values of the society it serves.

The Royal Society of Chemistry is working to ensure that the benefits of chemistry are widely felt, and that the chemical sciences contribute meaningfully to the UN Sustainable Development Goals. This includes our work on chemicals regulation, support for ethical practice, and a commitment to global equity in science.

We are supporting greater participation from the Global South through initiatives such as the Pan Africa Chemistry Network and our programmes for early career researchers. More broadly, we are working to make chemistry more inclusive across many dimensions – including gender, ethnicity, disability, and socio-economic background – through research, partnerships, and direct action.

Chemistry can be a powerful force for positive change, if it is shaped with care, collaboration and conscience.

The Future of Science in the Digital Age

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Science is a universal human right, yet in the 21st century, the scientific enterprise—especially chemistry—is at a crossroads. While digital technologies, particularly Artificial Intelligence (AI), are opening new frontiers, science itself faces rising vulnerabilities: cyber threats, digital misinformation, suppression of knowledge, and increasing geopolitical pressures. These challenges demand a global conversation on how to both protect science and modernize it to meet the pace of societal and technological change.

Chemistry must evolve more rapidly to remain relevant in an increasingly interconnected and digital world. Today, AI presents a once-in-a-generation opportunity to revolutionize the way we design molecules, materials, and reactions—accelerating discovery and enabling new levels of predictive power. From autonomous laboratories to generative models for materials design, AI will be transforming chemistry into a data-driven, adaptive discipline capable of addressing urgent global needs in energy, sustainability, and health.

I will explore how we can harness AI to not only modernize chemistry but also democratize it—ensuring that the benefits of scientific progress are shared widely and equitably. At the same time, it is essential to approach the governance of AI with humility. While calls to regulate AI are growing, premature restrictions risk stifling innovation at a moment when its benefits are just beginning to emerge. We must remain vigilant about the ethical deployment of AI, but we must also protect the freedom of scientific inquiry and resist fear-driven approaches that could limit its transformative impact.

Ultimately, this is a call to safeguard science as a global public good while boldly upgrading our scientific institutions for the challenges ahead. The right to science must not only be defended—it must be realized in full, through intelligent stewardship, technological progress, and renewed commitment to openness, equality, and innovation.

The science, the interpretation or the integrity: where are we failing?

Prof. Elizabeth (Lisa) A. H. Hall

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The sociologist Robert Merton championed the need to defend science from anti-intellectualism and attacks on the integrity of scientists and the autonomy of science. He spoke of the 'scientific ethos', which is associated with reliable knowledge and advances being generated; Merton identified this as ***science being special***, setting it apart from other things. Has this separation and respect been lost?

Scientists have enjoyed freedom to explore beyond what is known and understood, in one of the most fulfilling and often self-determining careers available. However, this brings individual responsibility and accountability for research integrity and for maintaining and further building public trust in science. General communication of science outside the scientific community is evermore thwarted by misinformation, conspiracy theories and urban myth. At a time when we are overwhelmed with information, poor filtration between fact and fiction, inhibits the ability of the non-scientist (and even scientists!) to extract robust information and reach an unflawed conclusion. Thus, both public trust in science and their understanding of the limitations in the powers of the scientist to provide answers for everything, is restricted. Furthermore, while truth and integrity remain the cornerstones of the Scientist's creed, incidents of misconduct in the form of fraud, plagiarism, fabrication and falsification have brought distrust in science in the wider population.

Do we, as scientists, also have a greater responsibility to ensure reproducibility throughout our scientific outputs and should all our research be directed to cause fundamental change in the way we can live better lives, or intellectual change in the way we think? Is there a requirement to maximise the potential for beneficial application of the research we undertake? Does the "right to discovery" have an implicit freedom to explore, collaborate, discuss and present our findings without prejudice or barriers inhibited by political, legal or religious constraints? What are the limits of our responsibilities?

This presentation will consider cases where the science, the interpretation, the reproducibility or the integrity have impacted the trust in science, and ask: what we, as scientists should do differently.

Science, Worthy of Preserving, Protecting, and Defending

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There is a quote attributed to Albert Einstein, "The right to search for the truth implies also a duty; one must not conceal any part of what one has recognized to be the truth." This is often appropriately applied to our obligations as scientists in how we conduct our work in an ethical manner and with integrity. It may also be a useful reminder as we reflect on large questions surrounding the protection of science and the right to science.

It is fairly non-controversial to say that at least in specific cultural contexts the Scientific Revolution a few centuries ago was forged in the crucible of heresy. Over the course of several hundred years, it evolved, again within particular cultural contexts, to be viewed as almost an orthodoxy. It became what many believed to be the only path to knowing, to understanding, to truth.

If there are attacks on science to the point where science needs to be protected it is useful to ask, "Why?". If society needs to designate science as a right to be defended, again, it is useful to ask, "Why?".

- Why is science attacked?
- Do people or institutions feel threatened by science?
- What are the motivations to attack science?
- Does the conduct and culture of modern science warrant introspection?
- If there were a Golden Age of the embrace of science, what has changed from that time until now?

In other words, is it perhaps not enough to recognize that science is under attack, but rather to also reveal any uncomfortable truths we can reveal about why this may be the case. And, if through this process it informs our understanding of the problem, it may lead us to greater support for science in the future.

Building Trust in Science

Prof. Peter Mahaffy

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This presentation will focus on (a) increasing understanding by scientists of the public(s) who mistrust science and (b) ensuring that science is trustworthy and seen to be trustworthy.

I will draw out relevant key ideas and themes from several initiatives to which I have contributed:

1. **Scientist's Understanding of the Public.** Scientists have often implicitly used a deficit model of science communication to address the lack of information and misinformation by the public. How might new initiatives going forward benefit from findings of an IUPAC task group for Project 2004-047-1-050, which looked at the need for scientists to understand their public(s) in order to effectively communicate science to the public? (P. Mahaffy, *et. al.*, *Chemists and "The Public": IUPAC's Role in Achieving Mutual Understanding,* **Pure Appl. Chem.,** Vol. 80, No. 1, pp. 161–174, 2008, doi:10.1351/pac200880010161. And what is the role of systems thinking in dealing with misinformation in science?
2. **Ensuring that science is trustworthy through a strong and visible global commitment to the Responsible Practice of Science.** This theme is drawn out in a recent International Science Council publication ('The Contextualization Deficit: Reframing Trust in Science for Multilateral Policy.' The Centre for Science Futures, Paris. 2023) Examples will be drawn from:
    - **Principle of the Universality of Science.** As a charter member of the International Council of Science (ICSU) Committee on Freedom and the Responsibility in the Conduct of Science (CFRS), we contributed to the articulation of the need for symmetry between freedom to conduct science and the responsibilities that accompany that freedom. This led to a revision to ICSU's Statute 5, the Principle of the Universality of Science, which has served global science well.
    - **The Hague Ethical Guidelines.** To promote a culture of responsible conduct in the chemical sciences and guard against the misuses of chemistry, a group of chemical practitioners from around the world formulated a set of ethical guidelines informed by the Chemical Weapons Convention – The Hague Ethical Guidelines.
    - **IUPAC Guiding Principles for the Responsible Practice of Chemistry**. A 2-year initiative by an IUPAC CEDEI task force (Project # 2022-034-3-060) has articulated eight guiding principles for the responsible practice of chemistry, each of which consists of an overview, examples, future directions, and questions for discussion. The project culminates in their public launch of an IUPAC Guiding Principles for the Responsible Practice of Chemistry website at the 2025 World Chemistry Congress and IUPAC GA in Malaysia at the start of this WCLM.

The “Hydra's head” of attacks on science

Prof. David Winkler

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Attacks on science are not new but have reached a worrying level, especially over the past decade. Historically these have had a religious or philosophical basis, or a political one, with attacks from both left-wing and right-wing institutions. The accelerating pace of scientific discovery can also create issues that impact on quality, integrity, and accuracy. In particular, technologies such as the internet that have improved communication and enabled rapid electronic publishing of scientific research has also created pressures on scientific excellence. Simultaneous assaults on scientific credibility, acceptance, and support are a feature of the current situation, and are discussed briefly here.

The assault on scholarly publication from predatory journals and conferences dilutes the impact of good research, distorts the scholarly publication model, and throws doubt on the value and robustness of good science. Solution/mitigation not yet clear. Some bodies are tackling ethics in publishing e.g., Committee on Publication Ethics (COPE) (https://publicationethics.org). Issues with use of large language models (LLMs) for research data modelling and writing and reviewing scientific papers**.** A serious and growing problem due to poor/biased predictions from machine learning models trained on sparse, erroneous, or biased data or incorrectly trained or used. If models are used outside of their domains of applicability, they make confident but completely incorrect predictions (especially a problem with LLM hallucinations).

Rapid increase in journal numbers and higher workloads for scientists means less willingness to review papers, ‘good’ reviewers get too many requests. A flood of ‘low-quality’ AI-assisted papers is threatening to overwhelm journals and peer reviewers, preventing them from assessing more meaningful research. The pressure to publish can make people take shortcuts and publish before sufficient replicates have been done, and the huge pressure of work on good reviewers means that a lot of poor science gets published that should have been rejected. A new model based in preprints and continuous online reviews may help resolve this. Increasing anti science and anti-intellectual forces at play (especially in the US), and erosion of expert voices by influencers and bloggers with little or no training, has emerged strongly during COVID19. The solution or mitigation is not yet clear, more Marches for Science?

The reproducibility crisis appears to depend on the discipline – recent papers have focused on the social, psychological, and medical sciences as being particularly troubled by irreproducible research. Confirmation bias is a danger as some scientists 'fall in love' with their pet theory or hypothesis and look for data that confirms it while discounting that which disagrees with it. A 2016 survey by Nature on 1,576 researchers who took a brief online questionnaire on reproducibility found that more than 70% of researchers have tried and failed to reproduce another scientist's experiment results (including 87% of chemists, 77% of biologists, 69% of physicists and engineers, 67% of medical researchers, 64% of earth and environmental scientists, and 62% of all others), and more than half have failed to reproduce their own experiments. Registration of experiments could reduce bias and increase reproducibility.

Many universities offer options or courses in scientific ethics, but fewer include a compulsory unit on ethics and bias in research in any science-related undergraduate or postgraduate courses. This seems like a worthwhile initiative, especially given the potential for misuse of powerful disciplines like chemistry and biology. Formal codes of ethics have only been adopted by the American Chemical Society, American Institute of Chemists, the Royal Society of Chemistry, and the Organisation for the Prohibition of Chemical Weapons. There is a nascent initiative to establish a Global Code of Chemical Ethics led by the ACS. Some chemical institutes e.g., RACI, have a very general ‘code of conduct’.