Chemistry In Action!

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Team Chemistry: Oide partners with UL for workshops

Contents #127

Disclaimer

Contributions on any matter of interest to second-level chemistry teachers are welcome. Normally the results of research (chemical or educational) are **not** published, except in a general form or as a review. Articles should be submitted electronically (email or disc) to **peter.childs@ul.ie** together with a printed copy.

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Cover design: George Fitzgerald, Möbius Design, Limerick

Cover photo: The photo shows the OIDE chemistry team preparing for their national in-service programme at the University of Limerick on 25th and 26th September 2025, part of a collaborative partnership between EPI*STEM The National Centre for Science Education and the Bernal Institute with the OIDE team. (Photo: Epi*Stem, UL)

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Editorial #127

A radical change in the LC

In September 2025 seven new LC specifications were introduced, including Biology, Chemistry and Physics. These new courses represent a major change in the Leaving Certificate and possibly one of the most significant ever. The main innovation is the introduction of 40% for coursework, through an Additional Assessment Component (AAC) in all the new courses. There has been considerable controversy and disquiet about the new framework and the specifications, which have been rushed through by the Minister of Education and the NCCA, despite the strong and reasoned criticism of subject teachers, schools, unions and educators. The easiest way to deal with criticism is to ignore it. I fear that this change will turn out to be an educational disaster. Some of the reasons are given in the article below. The ISTA has been at the forefront in trying to influence the NCCA and the Minister to reconsider the rushed introduction and introduce the AAC on a phased basis. (See comment p. 15.)

One good thing has been that the sample papers in Biology, Chemistry and Physics, two in each subject at HL and OL, were produced and distributed before the new courses started. Congratulations to the SEC. Sample briefs for the research projects were also published at the start of the school year. At least teachers are more informed as to what is in store for them.

I was also pleased to see the activity in the ISTA's Chemistry WhatsApp group, as teachers prepared for the new school year and a new course, and shared ideas and requests with each other. This will prove to be a vital resource for science teachers. The publishers have also got their act together so that two textbooks are available for the new Chemistry course – a revised *Chemistry Live* by Declan Kennedy and Ryan Gallagher and a new book, *Cracking Chemistry* by Catherine Clayton, and congratulations to the authors. Each comes with printed and electronic resource materials and Chemistry teachers are well served. Chemistry teachers are also teaching the last cohort on the old specification in parallel with the new course which will not be examined until 2027.

LC Chemistry is holding its own and is taken by 16.4% of the cohort. 60% of the Chemistry numbers are now girls; Physics is still dominated by boys and Biology by girls (see p. 13).

We stand on the shoulders of giants

Irish science education and the ISTA have lost a stalwart supporter in Oliver Ryan, who died in June 2025. He was an essential fixture at the ISTA Annual Conference, and he was held in high esteem and affection by his past students from Galway and by everyone who encountered him professionally, in Ireland and abroad. He will be missed by all of us and especially by his family. Oliver was a great story-teller and raconteur and we will miss his anecdotes from a lifetime in Irish education at the ISTA conferences. Geraldine Moonie Simmie gives an appreciation of Oliver on p.4. This year chemical education also lost a stalwart in Bill Byers, who taught Chemistry at the University of Ulster for many years (see p. 5). He was active in promoting chemical education at third level.

Peter E. Childs
Hon. Editor 1980-

In this issue #127

This issue contains a wide range of articles and news about relevant conferences, past and future (p. 23). Several interesting books about science in Ireland with a historical focus are described on p. 42, including a history of 300 years of Chemistry at TCD. In the Education News and Views we summarise the 2025 LC Science results, *inter alia.*

Science education in Ireland lost a champion with the death of Oliver Ryan (p. 4), science education tutor at the University of Galway for many years. In this issue the life of Thomas Dillon is described, who was Professor of Chemistry in Galway for many years (p. 37). **What defines an Irish chemist?** Someone born in Ireland, educated in Ireland and who spent most of their career in Ireland clearly qualifies. We may also include people born outside Ireland but who spent most of their career in Ireland, for example Wesley Cocker of TCD. We should also consider people born in Ireland but who emigrated and spent their career outside Ireland, which would include Robert Boyle and Kathleen Lonsdale.

John Hayes (UCC) introduces the history of batteries on p. 32, based on a talk given at the 2024 ChemEd-Ireland conference.

This year marks the bicentenary of the discovery of benzene by Michael Faraday in 1825 (p. 49). Chemlingo looks at the language of aromatic chemistry (p. 50). Robert Boyle is well-known for his scientific research but less known for his interest in gemstones – Adrian Ryder fills us in on that (p. 55).

Teaching chemistry through Irish is a challenge mainly because of the lack of resources – two people discuss this problem on p. 29.

Apprenticeships are an alternative route to a chemistry-based career and IBEC has sponsored a scheme with several TUs (see p. 18). EPI*STEM in UL has a partnership with a local company SEROSEP (see p. 19).

Our world is literally built from minerals and the latest amazing mineral is bauxite (p.52). Ireland is a major processor of bauxite into alumina at Rusal AAL in Co. Limerick.

Peter Davern's quirky look at the elements considers gold in this issue (p.60). Sulfur dioxide and sulfites are considered on p. 58 as part of the Sulfur Story.

Finally, this year's Nobel Prize for Chemistry was awarded for the development of MOFs, versatile materials which can trap small molecules and have lots of potential uses (p. 34).

I hope you find something to interest you in this issue. If you want something covered in CinA! you can always email the editor.

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Unbeelievable?

"People have wracked their brains for an explanation of benzene and how the celebrated man, August Kekulé, managed to come up with the concept of the benzene theory. With regard to the last point especially, a friend of mine who is a farmer and has a lively interest in chemistry has asked me a question which I would like to share with you. My 'agricultural friend' apparently believes he has traced the origins of the benzene theory. 'Has Kekulé,' so ran the question, 'once been a bee-keeper? You certainly know that bees too build hexagons; they know well that they can store the greatest amount of honey that way with the least amount of wax. I always liked it,' my agricultural friend went on, 'When I received a new issue of the Berichte; admittedly, I don't read the articles, but I like the pictures very much. The patterns of benzene, naphthalene and especially anthracene are indeed wonderful. When I look at the pictures I always have to think of the honeycombs of my bee hives."

August Wilhelm Von Hofmann (1818-1892)

Remembering Oliver Ryan: Science Educator at the University of Galway

Geraldine Mooney Simmie
EPI*STEM, University of Limerick Geraldine.Mooney.Simmie@ul.ie

It is a great honour to be invited to write a few words in memory of Oliver Ryan who died peacefully earlier this summer (14 June 2025) surrounded by his loving family, his wife Jacqueline, daughter Fiona, son Ronan and grandchildren Charlie and Samuel. Oliver lived beside Lough Corrib in Moycullen in Galway and loved fishing as a pastime. A pastime that tells you everything about his deep and contemplative style. Oliver had a lifetime commitment to democratising scientific knowledge and to science education in Africa.

I have no doubt that you too have many fond memories of Oliver from his active involvement over the decades in the *Irish Science Teachers Association.* Oliver was an outstanding science teacher educator and held in play that wonderfully complex equilibrium between knowing the subject, knowing the student and their social contexts, and knowing the field of science education, with its foundational disciplines and access to powerful knowledge.

Oliver had a wonderful welcoming presence, he was open to dialogue, he was willing to give his undivided time and attention, he was willing to debate fresh ideas and was a constant support to all the science teachers in the greater Galway region. We held our ISTA Galway branch meeting in his prefabricated building, his Science Centre, for many years in the University of Galway. He was our anchor and provided us with a border-crossing school-university partnership long before that idea became popular in the education literature!

Like many of the educational philosophers in former and more recent times, Oliver believed in experiential learning and the role of experimentation as a gateway to learning science and to learning about the nature of science in the wider world. Oliver Ryan lived the commitment of the science teacher educator who knew the importance of the connective tissue for the science teacher and the science teacher educator, between science knowledge, science literacy, ethical sense and sensibilities, and the necessity for informed and wise sociopolitical decision making in relation to issues in the wider world.

Oliver would have felt right at home today in all the futures-oriented debates taking place at the recent ESERA [*European Science Education Research Association*] 2025 conference in Copenhagen, which looked at teaching young people science within an understanding that the contemporary journey of human change and development [the purpose of education] lies in the direction of the human-in-relation [to self/Self, to others/Others, to God/Spirit, to the environment/planet and to technology] rather than toward the desired SMART [*Self-regulating, Motivated. Adaptive, Responsible and Tech savvy]* individual that we have become more familiar with in the last decade.

Science Educator and Lecturer in the University of Galway

I first met Oliver Ryan as a student teacher when doing my *Higher Diploma in Education* in the University of Galway in 1979. I had just finished my honours degree in chemistry and mathematics. We were spoilt at that time with outstanding lecturers in the field of education. Oliver was our lecturer for science education. He focused on the necessity for a rich variety of pedagogical approaches to breathe life into the science curriculum for young people, to support and to provoke young people's interest in the topic and to connect the big ideas and concepts in the science topics to science-in-society and in ways that make a difference. What was wonderful about Oliver's lectures was his openness to creative and critical thinking, the importance of scepticism, and the thirst for knowledge and curiosity within the overarching aim always of making a difference in the wider world.

Making Science Videos for Chemistry Teachers

Some years into my science teaching career in Coláiste Iognáid S.J. in Galway, Oliver suggested that we might work together to make a few supportive videos for chemistry teachers in Ireland. I was more than up for the idea. That started a process with Oliver and his team [Jim Linehan and Jimmy Mc Grath], where we made two Organic Chemistry videos and one video for Junior Science. Like Oliver himself, I have many great stories of this adventure! I brought all the glassware home and put it through our washing machine so that it would look clean and shiny on camera. I also bought a packet of fake fingernails in Roches Stores! On one occasion, while over-spooning an older batch of dried calcium carbide, I blew the lid off the apparatus and almost blew a hole in the roof of the Science Centre! Oliver smiled and remained calm, we cleaned everything up and started filming again! We had great fun filming in Aillwee Caves in Ballyvaughan in my native County Clare at 6 o'clock in a bright summer morning before any tourists arrived! Here we wanted the science teachers and their students to see and to appreciate the science and the splendour of the mineral formations in the cave, the stalactites, growing from the ceiling and the stalagmites, growing from the floor, arising from dripping water over minerals, primarily calcium carbonate, over time.

I hope these few words give you a flavour of Oliver Ryan's great legacy to science teachers and science teacher educators in Ireland today. Oliver lived out in practice the relational and the holistic nature of science education. Oliver's connection between head and heart is his greatest legacy to chemistry teaching in Ireland today and a timely reminder to us all in this time of curriculum change, of the necessary equilibrium between knowledge of science and knowledge of students, ethics, and ecology for care-filled science education.

Professor Geraldine Mooney Simmie, Professor of STEM Education and Director of EPI·STEM The National Centre for STEM Education, School of Education, University of Limerick.
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Oliver's condolence book at rip.ie can be accessed at:
Condolence Book for Oliver Ryan (Moycullen, Galway) | rip.ie

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In Memoriam:
Dr Bill Byers 1943-2025

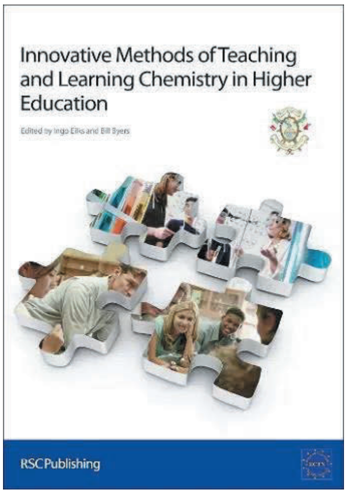
Our dear colleague Bill Byers passed awayon August 19th 2025. He had been suffering from cancer.

Bill was a valued member of our community. We shared many wonderful moments together at ECRICE and ECTN conferences and meetings. Personally, I had the privilege of working with him in ECTN working groups, as well as co-editing and co-authoring books and articles e.g. https://www.researchgate.net/.../311679695_Pre-service... or https://www.amazon.com/Innovative-Teaching.../dp/1847559581

His passing is a great loss to the chemistry education community, and he will be remembered with gratitude, respect, and affection.

At this very sad time, our sincere condolences and deepest sympathy go to Margaret.
https://www.researchgate.net/profile/William-Byers-5

Iwona Maciejowska, Krakow



Bill taught Chemistry in N. Ireland since 1970, first at Ulster Polytechnic and then the University of Ulster, retiring in 2008. He later moved back to England. In N. Ireland he was active in chemical education at third level and together we started the Irish Variety in Chemical Education conferences, which encouraged Irish third level chemists to talk about the teaching and learning of chemistry and to get involved in chemical education research. He was also active in the European Chemistry Thematic Network (ECTN) and was keen to promote North-South cooperation in chemical education in Ireland. He was a great enthusiast for chemistry and chemical education, was well regarded by his students, and we met at many European chemical education conferences over the years, and at ECTN meetings. His teaching was recognised by several awards:

- Distinguished Teaching Award (UU) 1996
- Distinguished Teaching Fellowship (UU) 2001
- RSC Silver Medal and Tertiary Education Award 2002

I am sad that he didn't have longer to enjoy his retirement in Windsor. My sympathy go to his wife Margaret and his family.

For a full CV see: Dr. Bill Byers: Chemistry Education CV/Resume

Peter Childs, Limerick

Education News and Views

This section is for news and views about chemical/science education in Ireland and abroad. If you have material of interest to Irish chemistry teachers, please send it in for consideration.

Junior Cert Results 2025

The 2025 JC results were issued on October 8th. There were 73,336 candidates, up from 72,833 in 2024. AS well as the demographic bulge going through second level, numbers have also been augmented by immigrants. A majority go on into senior cycle putting pressure on school places.

The SEC adjusted the grade boundaries this year in response to feedback that it was too difficult to get the highest grade (Distinction). A lighter curriculum and easier common papers would be expected to produce higher not lower top grades. This years grades are a better indication of student abilities.

8.6% got Distinctions (up from 3.6% in 2024), and the top band is now from 85-100 (not 90-100). 30.4% were awarded Higher Merit (up from 25.2% in 2024), with and adjusted band of 70-85. 33.7% were awarded Merit down from 44.5% in 20204, with an adjusted band of 55-70. Overall 72.7 got the top three grades. This was the 4th set of external JC exams since Covid.

There are still strong views amongst teachers about the new JC specifications and in Science, whether the course is a good foundation for the LC sciences. There was a large gap between the Junior and Senior cycles and this is now even larger.

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LC Results 2025

This year's LC results were artificially increased, as in previous years, but with a slow return to pre-pandemic standards. This eans that the 2025 results will be inflated compared to 2019 but less so than 2024. This inflation will affect this year's students seeking college places through the CAO in competition with students from previous years. It has meant again that some students with perfect marks cannot get their first choice due to a lottery for places, with demand exceeding supply. This could be avoided by using raw marks rather than grades to better discriminate between candidates.

Commenting on the efforts of the SEC to effect the gradual return to normal Leaving Certificate outcomes beginning in 2025 Ms Stewart (Chairperson of the State Examinations Commission) said:

"Following the marking of the examinations, the SEC has implemented a post-marking adjustment. This year's adjustment has been formulated so that the overall Leaving Certificate results in the aggregate are at a point broadly midway between the 2020 and 2021 levels, still well above the 2019 levels when examinations were last run as normal.

"While the level of the post-marking adjustment has been reduced compared to previous years, the 2025 adjustment has been calibrated to meet the Minister's commitments to a gradual return to normal while minimising the impact on candidates to the greatest possible degree."

52.4% of grades were inflated inn20205 compared to 68% in 2024. 11.7% were awarded H1s compared to 14.3% in 2024, but only 5-6% pre-pandemic. On average marks were increased by 6.8% compared to 7.5% in 2024. The 2025 LC class is competing for places with 19,782 former students, who would all have received inflated grades. The only fair way to solve this problem would have been a rapid return to pre-pandemic grading, as in the UK (see below), instead of prolonging the inequity.

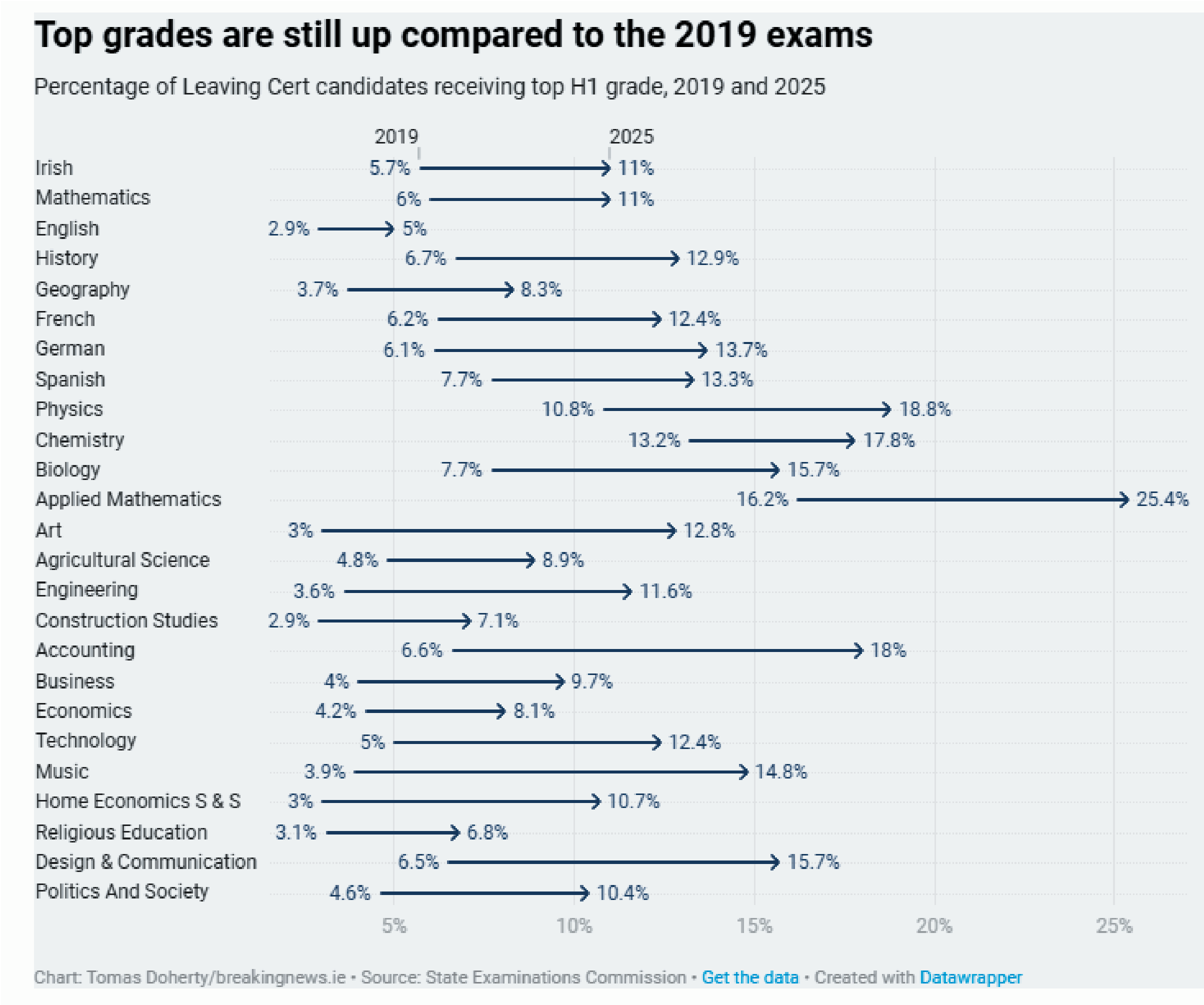

Figure 1: 2025 grades compared with 2019 grades
[Leaving Cert results: Three charts show how this year's grades are still above the norm]

A summary of the LC science results, which came out on August 22nd , is given in Table 1 and the % uptake shown in Figure 2.

Table 1: LC Science uptake for 2022-2025
(Total number of candidates: 2025 60,937, 2024 56,787, 2023 58,006; 2022, 58,056)

Subject	Year	HL(%)	OL(%)	Total	% LC cohort
Biology	**2025**	**30,650 (85.3)**	**5,283 (14.7)**	**35,933 ↑**	**59.0 ↑**
	2024	28,461 (85.7)	4,750 (14.3)	33,211	58.4
	2023	28,723 (83.0)	5,879 (17.0)	34,602	59.65
	2022	28,671 (84.1)	5,409 (15.9)	34,080	58.7
Chemistry	**2025**	**8,577 (85.8)**	**1,420 (14.2)**	**9,997 ↑**	**16.4 ↓**
	2024	7,939 (84.3)	1,478 (15.7)	9,417	16.6
	2023	8,068 (82.7)	1,682 (17.3)	9,750	16.8
	2022	8,481 (87.6)	1,198 (12.4)	9,679	16.7
Physics	**2025**	**6,592 (85.1)**	**1,154 (14.9)**	**7,746 ↑**	**12.7 ↓**
	2024	6,009 (82.2)	1,301 (17.8)	7,310	12.9
	2023	6,143 (81.6)	1,383 (18.4)	7,526	13.0
	2022	6,487 (83.5)	1,280 (16.5)	7,767	13.4
Ag. Science	**2025**	**6,237 (88.4)**	**821 (11.6)**	**7,058 ↑**	**11.6 ↑**
	2024	5,501 (85.7)	917 (14.3)	6,418	11.3
	2023	6,132 (82.2)	1,328 (17.8)	7,460	12.85
	2022	6,218 (83.9)	1,195 (16.1)	7,413	12.7
Phys.+Chem.	**2025**	**292 (82.0)**	**64 (18.0)**	**356 ↓**	**0.58 ↓**
	2024	309 (82.1)	67 (17.9)	376	0.65
	2023	344 (84.5)	63 (15.5)	407	0.7
	2022	369 (85.8)	61 (14.2)	430	0.75

Comments:

The uptake in 2025 was broadly similar to 2024. Total number of students was up but the % uptake by the sciences remained almost the same. Biology remains the dominant LC science subject, with just under 60% of the LC cohort taking it. This is followed by Chemistry, Physics and Ag. Science. Physics has clearly regained its place as the 3rd most popular science. All the sciences showed a small increase in numbers from 2024 to 2025 (except P+C). All the sciences have HL uptake of over 80%, even in Ag. Science, showing the relative lack of appeal to weaker students.

The graph below (Figure 1) shows fairly consistent uptake of the LC science subjects since 2010, although Biology continues to be far and away the most popular science subject.

While this is true in many countries, the disparity is greatest for Ireland where many more students take Biology than either Chemistry or Physics. The provision of a new LC Science subject following on from the JC Science course, would probably reduce this disparity.

The numbers of students taking all the sciences increased slightly, in line with the increase in candidates) and the % increased slightly for Biology and Ag. Science and decreased slightly for Chemistry and Physics.

If you combine the numbers taking the three main sciences (53,676), this indicates the scale of the problem to run individual research investigations for every student.

Grade inflation in the LC sciences

Table 2 shows the change in the % of students getting H1s from 2019 (pre-Covid) to 2025, showing the effect of grade inflation due to the disruption of teaching on state exams during the Covid pandemic and then the deliberate grade inflation by the SEC. Unlike the UK, Ireland has not reduced grade inflation, in fact it has deliberately retained it with a slow reduction back to pre-pandemic levels.

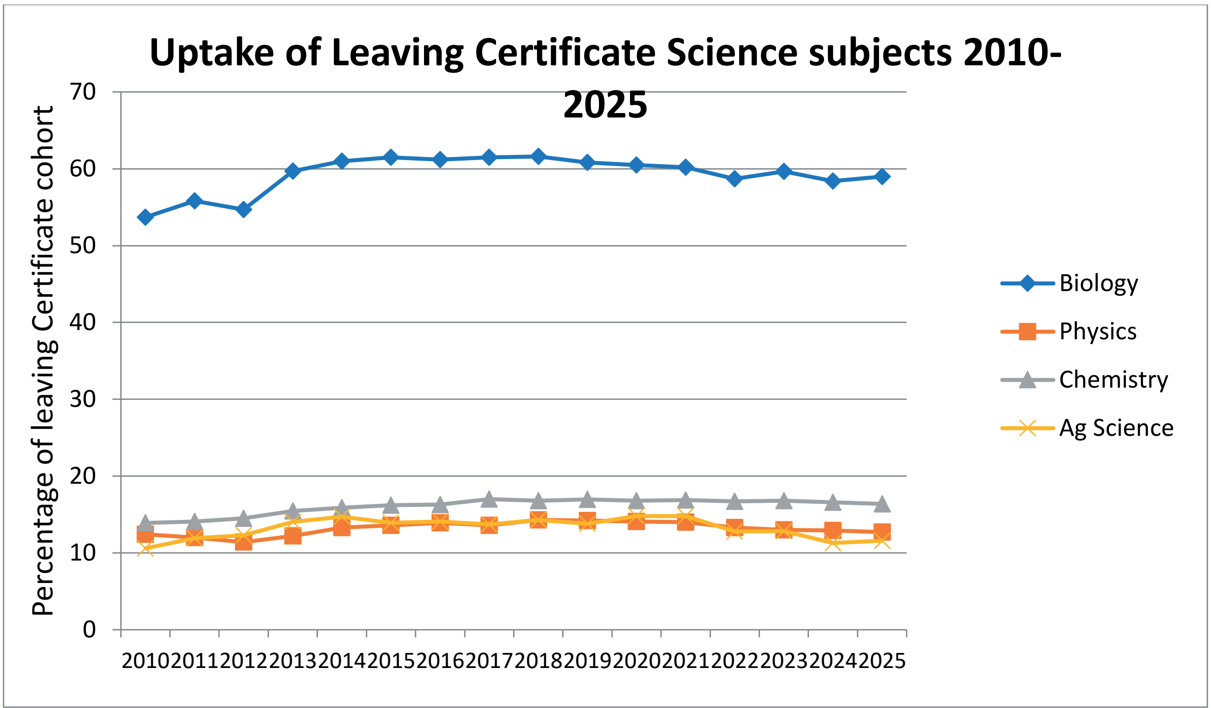

Figure 2: Percentage uptake of LC science subjects from 2010 to 2025

Table 2: Percentage of H1s from 2019 to 2025 in HL Maths and LC Sciences

Subject	2019	2020	2021	2022	2023	2024	2025
Maths	6.4	8.6	15.1	18.1	10.9	12.6	**11.0**
Biology	8.2	11.6	17.4	17.6	18.8	19.0	**15.7**
Chemistry	13.5	18.1	23.4	19.1	22.8	22.0	**17.8**
Physics	10.9	16.1	21.1	23.7	20.8	20.7	**18.8**
Ag. Science	5.0	9.5	11.3	5.8	12.4	13.6	**8.9**

Comments:

The 2024 % of H1s is slightly down for Maths, Biology and Ag. Science, and slightly down for Chemistry and Physics and Ag. Science. This is an artificial increase over 2019 as the SEC increased marks by an average of 6.8% as a ‘postmarking adjustment’. The adjustment was greater at the bottom of the scale than at the top, but still means almost double the % of H1s compared to 2019. The main thing to note is the significantly higher %s of H1s , meaning that the grading curve has been shewed artificially to the right, from 2020 to 2025, compared to 2019, the last ‘normal’ LC year. From 2020 onwards the grades have been inflated, first by using teacher assessments and then by maintaining these inflated grades, even when we have gone back to assessment by state examination.

This is reflected in the number of students now getting the maximum possible points, 625, including 25 bonus points for HL Maths (Table 3). Table 4 shows the distribution of CAO points from 2019 to 2025, showing the effect of inflation on the points used for third-level entry.

Note also the small increase in LC numbers from 2019 to 2025. Numbers taking the LC will continue to increase as the bulge (due to increased birth rate and immigration) enters senior cycle.

In Ireland there is a delay of 6 days between the release of the LC results and the first round CAO offers. In the UK the A level results came out on August 15th and students received notification of offers the same day. The LC results go from the SEC to the CAO before release day, so why cannot the offers and results come out together? The JC results are released weeks after the start of the new school year.

Table 3: Number of students with maximum CAO points (600-625)

	2019	2020	2021	2022	2023	2024	2025
Number (%)	781 (1.4%)	1,812 (3.1%)	3,330 (5.7%)	3,205 (5.5%)	2,800 (4.8%)	1,813 (3.2%)	737 (1.2%)

Table 4: Change in numbers in differ CAO bands 2019-2023 (% in brackets)
(Source: Central Applications Office (cao.ie))

Year/ Points	625	600-624	500-599	400-499	300-399	200-299	100-199	<100	Total
2019	207 (0.4)	574 (1.0)	6,684 (11.9)	13,489 (24.1)	14,266 (25.4)	10,732 (19.1)	6,557 (11.7)	3,562 (6.4)	56,011
2020	577 (1.0)	1,235 (2.1)	9,512 (16.5)	15,932 (27.7)	14,229 (24.7)	9,068 (15.8)	4,764 (8.3)	2,252 (3.9)	57,569
2021	1,342 (2.3)	1,988 (3.4)	12,133 (20.9)	16,189 (27.9)	12,865 (22.2)	7,544 (13.0)	3,623 (6.3)	2,268 (3.9)	57,952
2022	1,122 (1.9)	2,083 (3.6)	11,353 (19.6)	15,367 (26.5)	13,667 (23.5)	8,466 (14.6)	4,083 (7.0)	1,915 (3.3)	58,056
2023	952 (1.6)	1,848 (3.2)	11,378 (19.6)	15,852 (27.3)	13,902 (24.0)	8,233 (14.2)	4,022 (6.9)	1,819 (3.1)	58,006
2024	923 (1.6)	1,813 (3.2)	10,998 (19.3)	16,020 (28.2)	13,683 (24.1)	7,844 (13.8)	3,613 (6.4)	1,903 (3.4)	56,787
2025	737 (1.2)	1,651 (2.7)	11,311 (18.6)	17,188 (28.2)	15,168 (24.9)	8,850 (14.5)	3,998 (6.6)	2,034 (3.3)	60,937

Comments:
The size of the LC cohort has changed very little over the past 7 years. However, with the larger numbers taking the JC exams (over 73,000 this year), numbers taking the LC are also increase. The number of students with the maximum 625 points (inc. the Maths bonus) has jumped from 207 (0.4%) in 2019 to 737 (1.2%) in 2025, peaking at 1,342 (2.3%) in 2021. In addition, the % of students with more than 300 points (halfway up the CAO scale) has gone from 62.8% in 2019 to 75.6% in 2025. For reference in 2010 it was 56.1%. This represents a massive inflation of grades without any real change in the student population. In fact, as more students stay on at school and take the LC exams you would expect the grades to shift downwards not up. The same argument applies to third-level students, where a larger and academically more diverse population should result **in a lower %** getting 1st and 2.1 degrees, not more, as is the case. Grade inflation at third-level has been highlighted in both Ireland and the UK. The grade inflation of LC grades and the inflation of degrees devalues the qualifications and reduces their credibility and comparability with other countries. One immediate effect of having many more top grades, is that more students are qualified for the high-demand courses than there are places, and so places are allocated by lottery. Thus a student might

get a perfect score (625 points) and still not get their first choice.

This reminds one of the Dodo in Alice in Wonderland who said after the race, "*Everybody has won and all must have prizes.*" In fact, if everybody wins and gets a prize, then nobody wins, as winning is meaningless. We must remember, of course, that the Dodo is now extinct. If we reject the idea of meritocracy, rewards based on merit, what we will end up is mediocrity, a lowering of achievement. Unnecessary grade inflation helps nobody. It disadvantages current students who are competing against higher grades from previous years. It bunches good students together on the same number of CAO points so that more places have to be awarded by lottery instead of on merit.

The Minister of Education Norma Foley announced in April 2024 that from 2025 the LC grades will be gradually reduced back to pre-pandemic levels i.e. normality.

In April this year, the Minister announced that the phased return to normal results would start in 2025, with a modest and gradual reduction in the level of post marking adjustment applied to minimise the impact on students in so far as possible.

The return to normal will be done in stages over the coming years, in a phased and student-centred way. The adjustment next year will seek to bring the overall set of results on the aggregate to a point no lower than broadly midway between 2020 and 2021 levels.

The same adjustments to assessment components themselves, including Leaving Certificate examination papers – for example, greater choice - will also apply for next year's students.

The argument that grades must be elevated again this year to avoid disadvantaging the class of 2025, will also apply to subsequent years. In the UK the A-level grades have been returned to pre-pandemic level already (Figure 3), a much more sensible and realistic policy. The UK approach is shown in Figure 2 below showing the change in % getting A and A* from 2019 to 2025. The UK schools went through many of the same restrictions faced by Irish schools and have reduced the grade inflation since 2022. This surely is a better way to do it, so that current students are not disadvantaged against previous years.

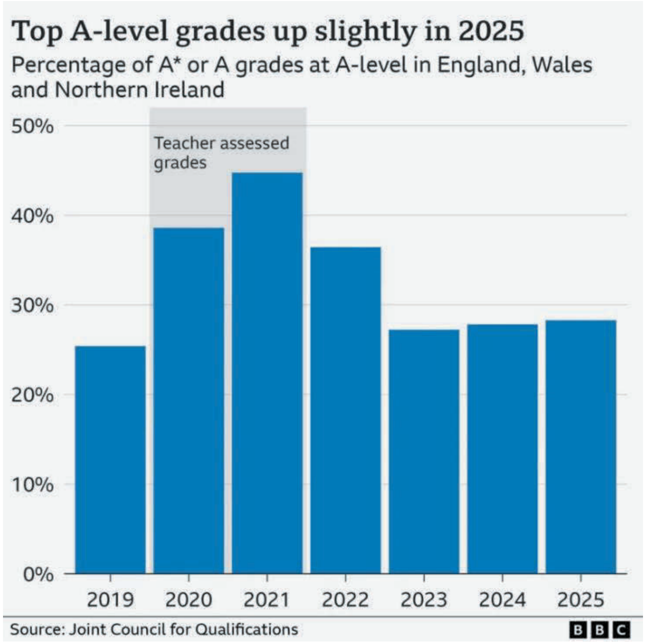

Figure 3: Top A level grades in the UK 2019-2025

Exam results: More students achieve top A-level grades - BBC News

2025 A level results

7 key trends in the 2025 A-level results data | Tes

Record numbers get into uni and other A-level results takeaways

The top A-level subject is Maths(104,580); all three sciences are in the top 10 – Biology (65,331, 3rd), Chemistry (59,050, 4th) and Physics(42,599, 7th).

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Gender breakdown of 2025 LC results (Source: SEC)

Table 4: Gender analysis of LC results in Maths and Sciences

Subject	No. boys (%)	%H1	No. girls (%)	%H1	Total (%)
Maths HL	11,816 (50.4%)	14.4	11,634 (49.6%)	7.6	23,450 (41.3%)
OL	16,414 (49.2%)	5.8	16,950 (50.8%)	6.3	33,364 (58.7%)
Σ Total	**28,230 (49.7%)**		**28,584 (50.3%)**		**56,814**
Biology HL	11,222 (36.6%)	13.8	19,428 (63.4)	16.8	30,650 (85.3)
OL	2,406 (45.5%)	1.6	2,877 (54.5%)	2.3	5,283 (14.7)
Σ Total	**13,628 (37.9%)**		**22,305 (62.1%)**		**35,933**
Chemistry HL	3,353	20.2	5,224	16.3	8,577 (85.8)
OL	654	3.2	766	4.0	1,420 (14.2)
Σ Total	**4,007 (40.1)**		**5,990 (59.9)**		**9.997**
Physics HL	4,639 (70.4%)	19.9	1,953 (29.6%)	16.3	6,592 (85.1)
OL	867 (75.1%)	4.8	287 (24.9%)	7.7	1,154 (14.9)
Σ Total	**5,506 (71.1%)**		**2,240 (28.9%)**		**7,746**
Ag Sci HL	3,450 (55.3%)	6.6	2,787 (44.7%)	11.8	6,237 (88.4)
OL	561 (68.3%)	0.4	260 (31.7%)	0.4	821 (11.6)
Σ Total	**4,011 (56.8%)**		**3,047 (43.2%)**		**7,058**

Comments:

The gender disparity between the sciences is see in Table 5 below.

Table 5: Gender ratios in LC sciences (Source: SEC)

Subject	Ratio B:G (HL+OL)	% Girls
Maths	0.99:1	50.3%
Biology	0.61:1	63.4%
Chemistry	0.67:1	59.9%
Physics	2.46:1	28.9%
Ag. Science	1.32:1	43.2%

The closest to gender parity is Maths at both levels, although boys get almost double the H1s. Essentially every student takes Maths, encouraged by the bonus marks, and 41.3% take the HL paper. In the sciences, where numbers are smaller, over 85% take the HL paper, including in Biology, by far and away the most popular science subject, and thus taken by a wider range of ability. Boys are a majority in both Physics and Ag. Science. The surprise is in Chemistry where girls now make up 59.9% of entries, not much behind Biology (62.1%). The number of girls taking Chemistry has gradually increased over the years. The % of H1s in Chemistry and Physics show that they are taken by high achieving students, even at OL level. Chemistry is useful for many third level courses especially in the health sciences.

It would be interesting to know if school type (mixed versus single sex) affects subject choice. The 2025 I Wish report below suggest that this is the case.

The Department of Education and Youth published in 2019 a document on STEM Education Policy, update in 2025. STEM Education Policy In 2022 a document on Gneder Balance in STEM Education was published. recommendations-on-gender-balance-in-stem-education.pdf

2025 I Wish Survey Report published

The I Wish Foundation has published its latest survey of student attitudes. 2025 IWish 2.3 Key findings from the 2025 I Wish Survey include:

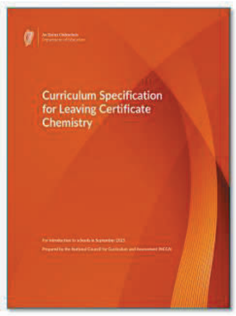
- 55 percent of girls in single-sex schools cite limited subject choice as a barrier to STEM, versus 37 percent in mixed schools.
- Access to applied STEM subjects remains low — only 5 percent reported having Construction Studies and 6 percent having Engineering, versus 84 percent and 74 percent in mixed schools.
- Main barriers: lack of information (64 percent), confidence (55 percent), female role models (50 percent), and subject choice (46 percent).
- Girls who play sports reported higher confidence in STEM subjects (53 percent vs 40 percent) and school life (61 percent vs 49 percent).

The I Wish Showcase 2026 is scheduled to take place on Thursday, **February 5, 2026**, at the RDS Main Arena in Ballsbridge, Dublin 4. This event is part of a nationwide initiative aimed at inspiring and motivating young women to pursue careers in Science, Technology, Engineering, and Mathematics (STEM). This is the 12th year of I Wish and it is aimed at Transition Year students, the key year for choosing LC subjects. Book Your Place Now I Wish 2026 – iWish

Senior Cycle Curriculum Reform: imaginative innovation or flawed fiasco?

Peter E. Childs

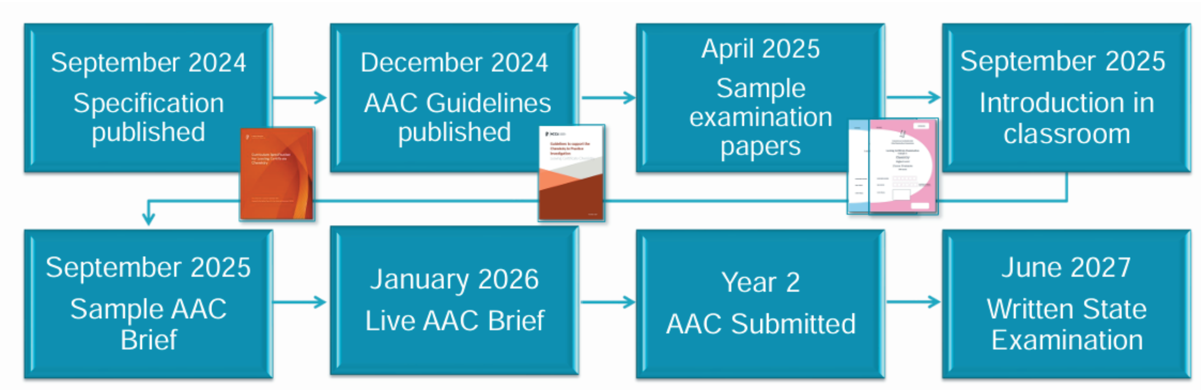
The new subject specifications and the new LC curriculum framework were introduced in schools in September 2025. (For the background to the LC development see Senior Cycle Redevelopment).



The revised LC Chemistry Subject Specification was released in August 2024 and is available online at SC-Chemistry-Specification-EN.**pdf**, although printed copies were not made available initially they have now been made available according to OIDE.

Sample papers (2 each for HL and OL) were distributed in April well before the introduction of the new courses (a first!) and in September the sample brief for Alternative Assessment Component: Chemistry in Practice Investigation, was posted. (The information for the Biology and Physics specifications were also released.) There is a lot for teachers to take on board with lengthy guidelines from the NCCA. The elephant in the room of course is AI and its ability to generate a convincing report without the student ever entering a laboratory or doing any research. A position paper on this is expected soon. A lot of weight is put on the teacher and the school to authenticate the student's work. The new LC science specifications (including Biology and Physics), as well as the other courses, involve a radical and untried change in the traditional courses, especially about assessment. Introducing an unvalidated and debatable coursework component worth 40% may yet turn out to be a disastrous educational experiment. A major objection is the over-weighting of a single coursework element, the AAC, worth 40%. This should be reduced to 20% to avoid imbalance between coursework and final exam-based assessment, or the AAC be broadened to include another type of coursework other than an individual research project. The AAC is an assessment basket with too many eggs.

OIDE have a useful summary of the development of the new LC Chemistry specification.
Final-29.04.25-Chemistry-Webinar-Presentation-1.pdf



Samples papers

Brief with links to sample exams and sample AAC brief.

https://www.examinations.ie/scr/

New LC science papers: 2 hrs 30 mins, 300 marks

HL papers have 36 pages, OL papers 32 pages.

LC Chemistry HL samp1e 1

EN-EX-59799328.pdf

LC Chemistry HL samp1e 2

EN-EX-94830138.pdf

LC Chemistry OL samp1e 1

EN-EX-4332566.pdf

LC Chemistry OL samp1e 2

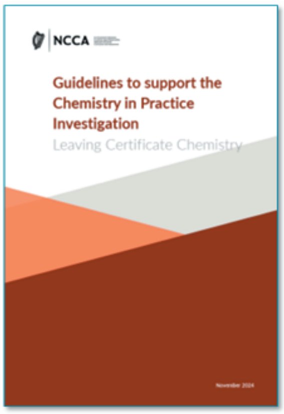
EN-EX-88047540.pdf

Sample AAC brief: Chemistry in Practice Investigation, HL and OL, 200 marks

The marks are allocated as follows:

1. **Title, introduction, background research, references 50 marks**
2. **Designing and planning, conducting the experiment 50 marks**
3. **Data and data analysis, conclusions 50 marks**
4. **Scientific literacy 50 marks**

EN-EX-16382013.pdf



The NCCA has also produced a detailed document on 'Guidelines to support the Chemistry in Practice Investigation: Leaving Certificate Chemistry'. AAC_Guidelines_Chemistry_Final.pdf

Opposition to the new curriculum

There has been strong criticism of the new LC curriculum model from subject associations (the ISTA has been particularly vocal), educationalists (like Professor Áine Hyland), university representatives on the Subject Development Groups, and the teacher unions. There were many detailed criticisms of the content and presentation of the new specifications, especially at the consultation meeting in 2024. Have all these comments, corrections and criticisms been taken on board? The overall impression is of a rushed process, without proper consultation involving listening and revising, and a major failure to pilot the new assessment component before its widespread introduction.

The science courses are a special problem because they involve three major subjects, Biology, Chemistry and Physics, using the same laboratory facilities and resources in schools in the same time period in the school calendar. Many students take 2 or more LC science subjects and their additional load will be particularly high, not to mention the extra load on their science teachers, who also often teach more than one science subject. The sensible suggestion from the ISTA to delay the introduction of the new courses was rejected. In April 2025 three representatives of the ISTA met with officials from the Department of Education to discuss the ISTA's concerns. In December 2024 the ISTA had sent a statement of their concerns to the Minister. (ISTA Statement on the Additional Assessment Components in Senior Cycle Biology, Chemistry and Physics – ISTA), with reasoned objections to the introduction of the new specification and the AAS component. The ISTA Council decided *"to formally dissociate from the Additional Assessment Components proposed in the revised Senior Cycle Biology, Chemistry and Physics specifications. This follows a similar decision made by the ASTI and IUA representatives on the Subject Development Groups for those subjects."*

These concerns were reiterated at the April meeting but were rejected. *"The key points raised included significant concerns around*

health & safety in the AACs, inadequate lab provision & resources, inadequate funding, the allocation of 40% to the AAC, the challenges AI creates, the impact on teacher workload, wellbeing and retention, the impact on student wellbeing and, crucially, their capacity to widen the social divide."
ISTA Proposes Postponement of Additional Assessment Components in Senior Cycle Sciences – ISTA

Teachers' Unions

Unfortunately, the two main teachers' unions in second level schools, the ASTI and TUI, did not come to an agreed position on the issue. The ASTI voted to oppose the changes and the TUI to accept them. This weakens the overall influence of the teachers' unions and opens the door to different practice, one example of which is the different use of Croke Park hours.

ASTI:

In June 2025 "*ASTI members have voted to reject proposals aimed at enabling Leaving Cert reforms, and have also endorsed industrial action.*
They voted by more than two thirds to reject the document, Senior Cycle Redevelopment – Implementation Support Measures.
With a turnout of 73%, 68% voted against the proposals and 32% voted in favour.
In a separate ballot, ASTI members voted by 67% to 33% in favour of industrial action, up to and including strike action, if necessary, in opposition to the accelerated implementation of the reforms.
Turnout in that vote was slightly lower at 70%."

TUI:

"In May 2025, TUI members voted in a national ballot by a margin of 73% to 27% to accept the Senior Cycle Redevelopment Implementation Support Measures document, negotiated with the Department of Education and Youth."
Layout 1

One conspicuous absence from this debate, apart from the representatives on the subject groups, is the views of third level institutions. Changes in the LC subjects directly affect the intake into third level courses. Will the 2025 batch of LC science students who enter third level in 2027 be better or worse prepared for third level courses? I suspect that the distorting effect of the 40% allocated to the AAC will weaken the content knowledge of students, which is now only worth 60% of the marks. Whether the AAC develops important transferable skills worth 40% remains to be seen. They will almost certainly learn how to use AI to game the system.

International experience

Many countries have tried to introduce coursework assessment into science courses at both junior and senior cycles. The experience has not always been positive and there has been a shift back towards final written assessment. Humphry Jones for the ISTA has written a helpful summary of a recent paper on the Scottish experience of practical in Advanced Higher Chemistry (New Study Highlights Issues with Practical Assessment in Scotland – ISTA) and you can access the full paper at Responses of teachers in Scotland to the reintroduction of the practical project in the advanced higher chemistry curriculum.

The practical assessment is worth 20% in Scotland (not 40%) and its implementation is supported by laboratory technicians (not generally available in Irish schools). Financing and provision of resources were major concerns in Scotland. Technician support was critical for project success. Health and safety were also a concern. The research highlighted the inequalities between schools, something that is even more pronounced in Ireland. The research did not address the impact of the project on academic outcomes. All these concerns would be even more important in Irish schools, and yet despite the obvious flaws, AACs worth 40% are being imposed without any trial or validation.

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Laboratory Apprenticeship Programme

Audrey Devlin
IBEC Audrey.Devlin@ibec.ie

The Laboratory Apprenticeship has recently welcomed its eighth intake of apprentices. We also congratulate 41 apprentices due to graduate in November, who will join the 76 previous alumni of the programme and celebrate their successful completion.

Developed by industry for industry, to address the skills gaps identified mainly at Technician and Analyst level, and launched in TU Dublin, Tallaght in 2018, the programme expanded to SETU Waterford in 2019 and MTU Cork in 2022. The programme has seen tremendous growth in previous years, with demand for the course nearly trebling between 2020 and 2025, with an average increase of 20% each year in the number of companies becoming involved.

A recent skills report carried out by the Expert Group on Future Skills Needs into the future needs for the BioPharmaChem industry (Skills for Biopharma - Future Skills Ireland) states that between 2016 and 2022 this sector has seen a 61% growth, with further growth expected in the coming years. The report further states that currently there is a lack of availability of higher technical qualifications (NFQ Level 6+) and employees with a Ready for Industry Skillset.

The Laboratory apprenticeships are closely aligned with the current needs of the BioPharmaChem sector, as well as the Medical Devices and Diagnostics, Food and Drink and Independent Testing laboratory sectors.

80% of employers who employ an apprentice agree they make their workplace more productive and are an exciting and proven way for employers to develop talent for their company and industry. Research also shows that apprenticeships offer myriad benefits to employers. By investing in talent development, employers gain a pipeline of loyal skilled workers, increase productivity and improve the bottom line. Apprenticeships can also help address the skills gap facing most companies, build alternative career paths, as well as provide greater opportunity to diversify their workforce.

Companies report that taking advantage of the apprenticeship programme to ‘fill the gaps’ in the laboratory created when graduates move upwards, allows the company to build a new talent pipeline. With two programmes to choose from - Level 6 Higher Certificate in Laboratory Technician, and Level 7 Ordinary Bachelors degree Laboratory Analyst - the apprenticeships combines practical hands-on work experience with excellent educational qualifications and ensures work-ready candidates graduate from the programme.

85% of the companies involved in the programme to date have rated the programme as very good to excellent in meeting their recruitment and retention needs. While 81% of apprentices have said they would recommend the programme to others.

According to one company: *"The laboratory apprenticeship has been a successful collaborative effort between industry and academia to meet the practical skillsets required in a GMP.”* While another states *"Amazing opportunity for both the apprentice and the company, the possibility to 'shape' the experience towards industry needs."*

The programme continues to go from strength to strength with 2025 our most successful intake yet in terms on apprentice numbers and companies involved.

To find out more about the Laboratory apprenticeship programme and the benefits the programme can bring to your company, please contact Audrey Devlin at Audrey.Devlin@ibec.ie

See also: for information and some videos are presented on the IBEC site: https://www.ibec.ie/connect-and-learn/industries/life-sciences-and-healthcare/laboratory-apprenticeship

There is an informative brochure which can be downloaded from https://cc.careersportal.ie/mce/plugins/filemanager/files/Lab%20App%20Candidate%20Mailer%202023%20Web%20(1).pdf

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EPI·STEM partnership with local enterprise: introducing SEROSEP

In this partnership project, EPI·STEM, The National Centre for STEM Education in the School of Education at the University of Limerick, links with local enterprises in the mid-west of Ireland to showcase their scientific knowledge and innovation, their enterprising spirit and the contributions they are making toward knowledge and sustainability in their local communities.

Here we will be taking you behind the scenes to SEROSEP, an Irish owned company with headquarters in Annacotty in County Limerick (see the link: https://www.serosep.com/). We are currently in the final stage of completion of this resource for schools. We have designed it for the attention of science and STEAM teachers and their pupils in schools in Ireland. In this article we give you, the chemistry teachers, a flavour of our EPI·STEM design. We share something about the company and how our proposed virtual tour of the company will help inspire a more informed connection to Science-in-Society and Science-in-Awareness, Advocacy & Action, especially in relation to the chemistry of water, the water cycle and the importance of environmental chemistry in testing the quality of water and waterways. This is a hot topic given the publication of the recent EPA report for water quality in Ireland 2019-2024 (EPA, 2025).

Our resource is designed as a research-led *Continuing Professional Development* (CPD) resource for teachers and their pupils and is aligned with the national curriculum in Ireland. It aims to connect science, and the nature of science to other literacies and to matters of ethics, aesthetics and sociopolitical issues. We know from the research literature that a broad-based STEAM education resource can help to democratize knowledge and to join theory to practice in inspiring, meaningful and motivating ways; ways that support young people in learning the knowledge, skills and values needed for a holistic and integrated curriculum and for generating and provoking awareness, advocacy and taking action in relation to personal and spiritual development, health, and the cultivation of wellbeing, and to making a difference in relation to the societal, political and environmental issues of the day. These professional and pedagogical approaches can bring the big ideas and concepts in science and chemistry down to earth, helping young people to make sense, to make meaning, and to make waves in relation to the highly scientific and technological world we live in today and care about.

About SEROSEP

Serosep | Laboratory Diagnostics

SEROSEP is a laboratory diagnostic specialist company owned by Dermot Scanlon and his wife Noreen Scanlon and was founded by them in 1997 first from their home in Limerick. Dermot completed a BSc in 1985 in Industrial Chemistry in UL. This gave Dermot not only the strong scientific foundation but also instilled in him the entrepreneurial spirit that would later define SEROSEP. What began as a small diagnostics distribution venture has since evolved into a world-renowned, global medical technology company, a MedTech, employing over 120 people, and supplying diagnostic solutions to more than 35 countries.

SEROSEP's journey as a highly successful indigenous business in Ireland is not only a testament to scientific innovation and diagnostic excellence, but also to the values instilled in its founders during their university education in the University of Limerick. As Dermot often reflects, real success is built on strong scientific rigour, enduring relationships, and a deep sense of responsibility - to employees, patients, and to society. The company is proud of its award-winning, family-friendly culture, wellness initiatives, recycling and green strategies, and strong community support, ranging from mental health services to international humanitarian aid that highlights a broad commitment to social responsibility. In 2021 SEROSEP won the prestigious "Irish Medtech Company of the Year" award, with it being noted that company's diagnostic test tools have "changed the way gastroenteritis is tested in clinical laboratories". An amazing feat for a self-funded, family-run business in Ireland.

Bio-medical and chemistry in action

SEROSEP specializes in high quality state-of-the-art molecular diagnostic kits and histopathology consumables. They have two products connected to aspects of Biology and the Biological World: EntericBio, for detection of gastrointestinal pathogens, and HistoPot, for safe biopsy sample handling, used in pathology labs worldwide.

A third product, SEROSEP's highly specialist diagnostic kit for Water, offers a relevant topic for Chemistry and the Chemical World. This diagnostic kit is used by specialist public bodies in Ireland and elsewhere who want to test the quality of water in different parts of the environment. The portable water testing kit by SEROSEP has ready-to-use reagents that can be brought to the testing site. The samples collected are then put through a highly specialist analyzer - a fully automated machine Colorimeter , which gives the accurate readout to the analyst.

This introduces that aspect of Chemistry called Environmental Chemistry. For example, Environmental Chemistry is a crucial sector in testing the quality of water in our natural waterways in Ireland, in rivers, lakes and in a variety of locations beside the seaside. The most recent EPA report finds that only 52% of our waterways are up to standard (EPA, 2025). This is a concerning finding in a country that prides itself on its natural beauty, on attracting tourists and on direct foreign investment on that basis. The solution will surely need to include the education of our young people in how to care for the environment properly, to know the science behind water contamination and human made pollution, and to develop a sense of the ecological and eco-justice obligations we all need to care for our waterways, as well as the increased level of public investment that will be needed to get our waterways back on track. In fact, from here onwards, projects about water and the scientific and sustainable care of our water and waterways could become valuable projects in future editions of the STRIPE YOUNG SCIENTIST EXHIBITION (see link: https://stripeyste.com/).

Alignment with the national curriculum in Chemistry

A glance at the new Chemistry specification for senior cycle (Department of Education, 2025) shows clearly the number of ways the chemical study of water, and the introduction to the Water Testing Kit made by SEROSEP, can breathe life into this new curriculum and help make it professionally and pedagogically interesting and meaningful for teaching young people science. The notion of high-quality clean drinking water and clean water in our rich variety of waterways (canals, rivers, lakes, seaside) connects in a very powerful way for a critical appreciation of Science-in-Society and Chemistry-in-Society

(Department of Education, 2025, page 33). It lays in front of us a topic that shows that human-made disasters can often be left unchecked and what needs to be done to solve such problems. This is a topic of ethical, sociocultural, economic and political importance to the future of Ireland, as a society, an economy and an environment.
The chemistry of water enters the new chemistry specification in ways that will help to spark the interest of senior chemistry teachers and pupils. Water acts as a lifeforce in relation to our daily need for clean drinking water to quench our thirst and for the continuation of life itself. Living and being beside water and human-made waterways can provide access to the aesthetics of immersive experiences, beauty, serenity and wellbeing in our daily lives. This ambition for personal development through science and scientific literacy connects directly to the senior cycle competence called 'cultivating wellbeing' (Department of Education, 2025, page7).

The senior cycle competences include 'thinking and problem-solving', and this clearly requires scientific knowledge and scientific literacy, working alongside an ethical and critical approach to problem solving for the greater good of society. This pedagogical strategy aligns with other key competences mentioned, such as 'being creative', 'working with others' and 'participating in society'. In the overview of Leaving Certificate Chemistry (Figure 3, page 11) there are four contextual strands identified in the unifying Nature of Science: the nature of matter, behaviour of matter, interactions of matter and matter in the world.

If we follow the story of water, and water testing in SEROSEP through the Nature of Science and then through each of the contextual strands, we arrive at a narrative for the chemistry of water that is most interesting and revealing. For the Nature of Science we learn about how chemists and scientists work in water testing, the scientific knowledge that they rely on, their curiosity and understanding of bias, their familiarity with the safety procedures they use, the observations they make, the approximations and judgements they make, how they justify their selections, how they form hypotheses and how they experiment and test these hypotheses and the conclusions they draw from their results. Pupils will learn that the experiments that scientists engage in might not always work as originally planned and as a result they need to revise their approach and select a different way forward. The students learn that science is conducted within a scientific community that relies on evidence, clear communication, peer review, and the importance of repeatability and reproducibility. Students need to grasp how science constantly evolves in history, and changes over time through new discoveries, new thinking and new models.

Students studying the water testing approach taken in SEROSEP can ask themselves how they might understand and investigate water in this regard, what abstractions, models and representation are necessary in relation to the learning outcomes (see pages 14 and 15) and how and in what ways the Water Testing Kit designed by SEROSEP can make a difference to Chemistry-in-Society and the learning outcomes mentioned on page 15, as follows:
1. How have scientists in SEROSEP made an impact on scientific innovation [i.e. discovery] in Ireland and how can their innovative water testing kit impact on society in Ireland?

2. How does the SEROSEP water testing kit contribute to appreciating the role of Chemistry-in-Society in Ireland, and what is its personal, social and global importance?

3. How might the SEROSEP water testing kit, testing the quality of water in Ireland's waterways play a part in ameliorating, mitigating and eliminating water pollution and supporting the necessary critical literacy and actions necessary for solving the problem (e.g. drawing from the EPA 2025 report) and for evaluating the media-based arguments for science and technology?

In a similar way, we are working our way through the four contextual strands. In relation to Section 4: Matter in the World, we see that water health gets pride of place in the section called Our Chemical Environment. We are interested in aligning our CPD resource with the areas for learning and the learning outcomes in this section. Here we encounter water as a finite resource, discuss the causes and the consequences of water contamination, connect to sewage, industrial and agricultural effluent, microplastics, heavy metals and acidification. This provides a wonderful opportunity to involve the young people in scientifically-informed debates about the current state of our waterways as indicated in the EPA report (2025), making sense of this report alongside their chemistry knowledge of water and suggest imaginative ways forward for Ireland to solve this contemporary issue of national importance.

References

Department of Education (2025). *Curriculum Specification for Leaving Certificate Chemistry*. Prepared by the National Council for Curriculum and Assessment (NCCA). https://www.curriculumonline.ie/getmedia/aa7e3dd7-c156-49d2-9b2e-51cbc49c9d7e/SC-Chemistry-Specification-EN.pdf

EPA (2025). *Water Quality in Ireland 2019-2024*. Environment Protection Agency.

https://www.epa.ie/publications/monitoring--assessment/freshwater--marine/EPA-Water-Quality-in-Ireland-2019-2024-Report.pdf

People involved:

Professor Geraldine Mooney Simmie (Director EPI·STEM), Dr. Michelle Starr (Research Liaison Officer), Martha Cosgrave (science teacher and a PhD student in STEAM Education), Samuel Brzyskiewiez (Research Coordinator EPI·STEM Academy of Stem Teachers) and Katelyn O’Neill (science teacher). Contact Helen Fitzgerald (Senior Executive Administrator) email: Helen.Fitzgerald@ul.ie

New Uisce Éireann National Water Laboratory in Limerick

In 2025 Uisce Éireann opened a new water laboratory in Limerick on the Ballysimon Road, which will be fully operational in 2026. The €60 million facility will be a centre of excellence for water testing.

The state-of-the-art National Laboratory, which is based in Ballysimon, Limerick, will lead to the recruitment of approximately 90 scientific and technical experts to operate the new National Laboratory, with education and research links to 3rd level institutions.

Once fully operational the new laboratory will process in the region of 250,000 water and wastewater samples from across the country and undertake 1.2 million tests annually in addition to testing river and lake water quality.

Scientific and Technical Service Programme | National Projects |

Chemical Education Conferences 2025-2026

2025 Events

Green and Sustainable Chemistry, TUDublin, April 7-8, 2025

On April 7th and 8th 2025, TU Dublin were delighted to welcome Dr John Warner to the School of Chemical and BioPharmaceutical Sciences TU Dublin. Over two days, nearly 200 people joined us to explore the future of green and sustainable chemistry.

A recording of his public lecture presentation can be viewed here; Making the World Better with Chemistry Dr John Warner public lecture recording.

In two engaging and truly inspirational seminars, Dr Warner shared his professional journey and the thinking that shaped the 12 Principles of Green Chemistry. His ability to solve complex problems by combining scientific knowledge and a deep respect for nature's own solutions – asking how we might work with nature rather than against it – is a perspective that is both thought-provoking and essential for rethinking the future direction of chemical research and education.

He spoke about the central roles of creativity and collaboration, as well as the responsibility to design and make products with intention – keeping in mind a material's full lifecycle, potential for reuse, and long-term environmental impact. This is the approach that should underpin all of our activities as chemists.

What stood out in particular – aside from his impressive scientific achievements – was his commitment to making green and sustainable chemistry foundational to chemistry education. Through his role as the co-founder of Beyond Benign—Green Chemistry for a Sustainable Future, Dr Warner is helping to advance this agenda globally, so that future graduates are equipped with the tools to tackle the world's most pressing environmental challenges. His message was clear: As educators, we have a moral and ethical responsibility to ensure our graduates can contribute to and can shape a more sustainable future.

Dr. Warner's visit was a timely reminder that sustainable thinking should be at the heart of how we approach science – guided by curiosity, creativity, and a deep respect for the world around us. Our School is proud to be one of just over 225 universities worldwide who have signed Beyond Benign's Green Chemistry Commitment – a key step in ensuring that sustainability becomes the cornerstone of future chemistry education in TU Dublin.

Our thanks to the Sustainability Education team, particularly Brian Gormley, for supporting these seminars. Many thanks also to TU Dublin colleagues, Dr Sarah Rawe, Dr Patrice Behan and Dr Eoin Mc Gillicuddy, whose invaluable contributions helped to make this event a success.

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14th BASF Summer School, UCC, Cork, June 18, 2025

This summer saw the 14th Annual BASF Summer School run in UCC together with Oide. The programme is given below and covered a wide range of topics relevant to LC Chemistry and Transition Year. The ppts of the talks are available at: https://padlet.com/jct2/14th-basf-oide-summer-school-2025-kn9qk9bkdqv1dk1c

Declan Kennedy and his team in Cork are to be congratulated on another successful conference.

14th Annual BASF- Oide Summer School for Chemistry Teachers

Great ideas and teaching resources for teachers of Leaving Certificate and Transition Year Chemistry.

Eureka Centre, Kane Building, University College Cork.
Weds 18th June 2025.

This summer school involves a partnership between BASF, Oide, UCC, RSC and the Cork branch of the ISTA. The aim of the summer school is to give chemistry teachers the opportunity to enhance their knowledge and understanding of key areas of the Leaving Certificate Chemistry syllabus, to update their laboratory practical skills and to get lots of good teaching ideas for teaching Leaving Certificate Chemistry and Transition Year Chemistry

PROGRAMME:

9.00 – 9.30	Registration. Tea / Coffee in Room G2 Kane Building, UCC.
9.30 – 10.15	*Nanotechnology in the new Leaving Certificate curriculum* – Prof. Justin Holmes UCC
10.15 – 11.00	*Resources for the New LC Chemistry Specification and launch of his recent book Onscreen Chemistry* – Dr John O'Donoghue RSC
11.00 – 11.30	Tea / Coffee.
11.30 – 12.15.	*Fuel Cells and batteries in the new Chemistry curriculum* – Dr John Hayes and Jack Connolly, UCC.
12.15 – 13.00	*The use of wireless sensor technology in teaching the new Chemistry specification* – Dr Patrick O'Donnell, Scoil Phobail, Rathmore, Co. Kerry and John Phelan, Lennox.
13.00 – 14.00	Group photo and Lunch in UCC staff dining room.
14.15 – 15.00	*Using Forensic Science to enhance the teaching of topics in the new Leaving Certificate Chemistry curriculum* – David O'Connell, Ecole Jeannine Manuel, Paris.
15.00 – 15.45	*Surfactants, soap and sanitation in the new specification* – Dr Fiona Desmond, formerly of SEC, College of Commerce and UCC.
15.45 – 16.30	*Simulations, stimuli and models in the Leaving Certificate Chemistry Specification* – Oide Chemistry Team
16.30	Presentation of Certificates of Attendance and raffle for Molymod kits

To register for a place on this event please click: https://oide.ie/apply-book-now/teachers/

Eurovariety, Krakow, Poland, July 2-4, 2025

https://eurovariety2025.confer.uj.edu.pl/

The 11th European Variety in University Chemistry Education conference took place from 2–4 July 2025 at the Faculty of Chemistry, Jagiellonian University in Kraków. It brought together 115 participants from 29 countries across Europe and beyond (including Australia, Brazil, Ghana, Israel, and the USA), united by a shared commitment to modern, engaging, and effective chemistry education at the university level and in lifelong learning.

The Eurovariety conferecnes are organised by the Division of Chemical Education of EuCheMS.

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ViCEPHEC25 – Variety in Chemistry Education / Physics

Higher Education Conference, August 28-29, 2025
University of Liverpool

ViCEPHEC 2025 is the leading annual conference for third level chemistry and physics educators in the UK and Ireland, bringing together lecturers, researchers, and educators to share best practices, innovative teaching ideas, and educational research in chemistry higher education.

IVICE is held every 2-3 years in TU Dublin for Irish third level chemical educators and the next one will be in April 2026.

*****

44th ChemEd-Ireland

October 18th

TUD, Grangegorman

This year's ChemEd-Ireland was held on Saturday October 18th on the new Grangegorman Campus of TU Dublin, organised by Dr Claire McDonnell and colleagues. Attendance was ~50 and the ppts will be made available and we hope to print the talks in the Proceedings in the Spring 2026 issue.

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ChemEd-Ireland conferences

The ChemEd-Ireland conferences were started in 1982 by Dr Peter Childs in Thomond College of Education (TCE), later at the University of Limerick. They ran for 25 years in Limerick and since then have rotated around several Irish institutions, who have activity in chemical education, either in producing science teachers or in research into the teaching and learning of Chemistry. They alternate between a Dublin venue and a venue outside Dublin. In Dublin it has been hosted by DCU, TUD (formerly DIT) and TCD; outside Dublin by UL, UCC, and TUS (formerly LIT). ChemEd-Ireland is a one-day conference for Chemistry teachers, is dedicated to improving the teaching and learning of Chemistry by equipping and informing teachers. The Proceedings are normally published in the Spring issue of *Chemistry in Action!* This provides a permanent archive and widens the impact of the talks by reaching more Chemistry teachers. Attendance ranges from ~50 to ~150 (the UCC effect!). It is a great opportunity for Chemistry teachers to meet, share ideas and learn new things. It is also good value for money: at the start it was £15 inc. lung and now it is €30 inc. lunch, thanks to sponsorship from various sources to defray the costs.

In 2026 the conference will be on October 24th in UL and in 2027 in DCU.

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2026 Events

2026 looks like being an exciting year for chemical/science education events. For Ireland the big one is the joint ICASE/ISTA conference in June. Internationally ECRICE and ICCE are combining together in Turkey in July. ChemEd-Ireland comes back to UL in October. Details of 2026 conferences are given below.

ASE Annual Conference, University of Nottingham, January 8-10, 2026

[ASE Annual Conference 2026 Programme Highlights | www.ase.org.uk]

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8th ICASE World STE Conference, UCC, Cork, June 22-25, 2026

www.icaseonline.net/icase2026

(jointly with ISTA annual conference)

Registrations: www.icaseonline.ie

Full package: €350, reduced package €200.

This conference is being organised jointly with the ISTA whose annual conference will be part of the ICASE conference.

Some of the speaker highlights include:

- **Áine Hyland**, Emeritus Professor of Education, University College Cork
- **Stuart Farmer**, Learning and Skills Manager, Institute of Physics Scotland
- **Donna Governor,** NSTA President Elect 2025-26, Associate Professor, Science Education Program Coordinator, Department of Middle, Secondary, and Science Education, University of North Georgia
- **Manabu Sumida,** Professor, Faculty of Education, Ehime University Bunkyo-cho, Matsuyama City, Japan
- **Michael Reiss,** Professor, Institute of Education, University College London
- **Miles Berry,** Froebel College, University of Roehampton
- **Jonathan Osborne**, Kamalchari Professor of Science Education, Emeritus, Stanford University
- **Matthew Thomas,** UNESCO Lead on Teacher Education and Professional Development

Conference Themes:

- Sustainable Development – Climate change
- Artificial Intelligence in Education
- Curriculum Development – Teaching, Learning and Assessment
- International trends in science education – PISA
- Initial Teacher Education (Teacher Training)and Continuing Professional Development for Science Teachers
- Industry-Education links – careers in science
- Laboratory Practical Work
- Technology in Science Education
- Science on Stage
- Marine Education – the United Nations Decade of Ocean Science for Sustainable Development
- The role of ICASE in promoting Science, Technology and Society (symposium)

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10th EuChemS Chemistry Congress (ECC10)

Antwerp, July 12-16, 2026

10th EuChemS Chemistry Congress (ECC10) - IUPAC | International Union of Pure and Applied Chemistry

The EuChemS Chemistry Congresses are the pinnacle chemistry congresses in Europe. It unites the chemical community (from young scientists to leading experts) and fosters interdisciplinary interactions among them. The congress is a truly inspiring and instructive and inclusive experience for young researchers (like PhD students) as it includes a full parallel program by the European Young Chemists' Network, focusing on topics like the development of soft skills, career development, grant writing, while also including the European Young Chemists' Awards.

ECC10 – the 10th EuChemS Chemistry Congress is the biennial congress of the European Chemical Society. It aims to showcase cutting-edge research in all domains of chemistry, foster interdisciplinary interaction and collaboration, and support young scientists. The 2026 edition in Antwerp focuses on eight thematic areas, including sustainability, AI in chemistry, and societal impact—topics of high relevance today. The scientific program is designed to be inclusive, forward-looking, and impactful, with contributions from leading experts. The venue also reflects a commitment to sustainability and education.

Contact: Ir. Thomas Vranken
ECC10 Co-Chair & KVCV Secretary-

General
thomas.vranken@kvcv.be

The 9th conference was held in Dublin in 2024.

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28th ICCE & 17th ECRICE, Erzurum, Türkiye, July 13-17, 2026

Chemical Education in the Age of Artificial Intelligence

www.iccecrice2026.org/

Chemistry education is a field concerned with teaching and learning of chemistry. The content of Chemistry education research (CER) ranges from understanding the history and philosophy of chemistry, which guides on us how chemistry knowledge was developed, to the application of emerging technologies and tools for more effective teaching and learning of chemistry. CER has grown as a field substantially over the past 60 years but is still a relatively young subdiscipline of chemistry. Although substantial progress has been made in identifying evidence-based strategies to support the teaching and learning of chemistry, we have yet to realize widespread systemic change regarding how chemistry is taught at the secondary school and tertiary levels. Connecting chemistry educators at the secondary education level with chemistry education researchers in academia has never been more vitally needed, and yet these groups are still frustratingly divided.

Welcome Message from Chair of ICCECRICE 2026

Dear Colleagues

On behalf of the organizing committee of the 28th IUPAC International Conference on Chemistry Education & 17th EuChemS European Conference of Research in Chemical Education (ICCECRICE 2026), it is my great pleasure to invite you to participate in ICCECRICE 2026 from July 13-17, 2026, in Erzurum, Türkiye – The peak of Anatolia.

Integrating technology into chemistry teaching and learning is a transformative approach that empowers students and educators alike, creating a dynamic learning environment that fosters curiosity, critical thinking, and a deeper appreciation for the wonders of chemistry. Therefore, the theme of the conference is planned as "*Chemistry Education in the Age of Artificial Intelligence*".

Prof. Mustafa Sözbilir
Chair, ICCECRICE 2026

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2026 BCCE, University of Wisconsin-Madison, USA, July 26-30, 2026

https://conferences.union.wisc.edu/bcce2026/

The Biennial Conference on Chemical Education (BCCE) is a meeting sponsored by the Division of Chemical Education (DivCHED) of the American Chemical Society (ACS). The conference welcomes chemistry educators from around the globe and who operate in all education sectors (academia/government/industry) and levels (primary, secondary, two-year and four-year undergraduate, and graduate/postdoctoral).

The BCCE helps chemistry educators make connections with colleagues and friends who are dedicated to the teaching and learning of chemistry. The conference provides educators with opportunities for interacting with colleagues in formal and informal settings and can be an excellent source for ideas, inspiration, and materials for those both new to chemistry education and those who have years of experience.

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13ISMC26

The 13th International Symposium on Microscale Chemistry

July 8-10 2026

The 13th ISMC will be a conference for school teachers of chemistry, school science technicians, academics, and educational professionals from the UK and overseas with the aim of promoting Microscale and Small-Scale Techniques (MaSSTs) in chemistry education.

The venue will be St Paul's School, Lonsdale Road, London, SW13 9JT, UK.

Themes

1. Developing new equipment and procedures for micro- and small-scale chemistry while maintaining the same level of rigour as traditional methods.
2. Developing protocols to correct students' misconceptions that hinder their understanding of chemistry.
3. Developing dual coding and integrated instructions which reduce overloading of working memory and enable students to follow procedures efficiently.
4. Ensuring that students have the materials and equipment necessary to complete practical work despite the decrease in specialist space (laboratories) and increasing expense of chemicals and equipment.
5. Relating procedures to the recent experiences of students, their future employment, and addressing global concerns encapsulated in the United Nations Sustainable Development Goals (UNSDGs), particularly Goal 4: "Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all".
6. Providing a safe and secure environment for teachers, students, and other laboratory personnel.
7. Including MaSSTs in STEM projects.
8. Creating experiences and specialised equipment to make practical chemistry in schools highly inclusive, including for those with additional needs.
9. Employing contemporary presentation techniques with visualisers, mobile phones, and USB microscopes to ensure that groups of students can observe chemical activity on such a small scale.
10. Ensuring that exam boards, school administrators, university outreach teams, tutors, and textbook authors are informed about MaSSTs and their educational and environmental credentials.

If you are interested in updates about 13ISMC26, please join our mailing list below and bookmark this website, which will be updated as further details become available.

If you are interested in getting involved please contact Matthew Smith and Bob Worley at 13ismc26@gmail.com.

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45th ChemEd-Ireland,

UL, Limerick,

October 24th 2026

Sarah.Hayes@ul.ie and Geraldine.mooney.simmie@ul.ie

*****

Dúshlán na Gaeilge – The challenge of teaching Science through Irish:1

Eoin McNamara
Department of Chemical Sciences, University of Limerick eoin.mcnamara@ul.ie

As a Gaeilgeoir, I've had the pleasure and the challenge of learning and teaching science through the medium of Irish. The title of this piece, *Dúshlán na Gaeilge,* is a unique grammatical example of *an tuiseal ginideach* that comes into play when using the language. Grammar is integral to the use and understanding of a language, whether that be Gaeilge or the language of science. Our role as teachers often involves helping students to partake and live with these languages. In this piece, I wish to outline some of the challenges science education faces through Irish, the rewards it can provide and my hopes for the development of educational supports and resources.

Science as Gaeilge can often feel artificial, despite the Irish language being full of beautiful, well-articulated words and phrases that draw from our long heritage of story-telling and scribing. However, scientific vocabulary is often translated with an anglicised slant that can feel at odds with the structure, tone and timbre of Irish. One can probably guess what *núicléas*, *einsím* and *clóraifill* translate to and are prime examples of the *"Béarlachas"* that crop up in science. Intrinsically complex concepts like the mole or the firing of a neuron really stretch and stress the language, to the point where teachers may revert to explaining the concept in English and then translating it afterwards. This leads to a student having to know how to conceptualise phenomena in both languages, how to translate between them and all under the duress of an exam setting. For students who wish to avail of the bonus Irish marks, the pressure is high, but if they are scientifically able enough, this extra reward is often not worthwhile due to the sliding scale awarded.

Resources for teaching *as Gaeilge* are fewer and often less-supported than their English counterparts. I typically see teachers distribute their own, translated notes to students and use an English textbook for reference and working materials. Not to disparage the works of creators, but informational videos *as Gaeilge* are rare and again, often the works of individual teachers. This reinforces the notion that the language of science is English, yet, we need only look at the prevalence of Latin, German, Egyptian and Chinese texts throughout history to know that science is itself a universal language.

These challenges are complex and not easily surmounted by an individual science teacher, however, I feel there is great potential and value in the work being done by *múinteoirí* around the country. Sharing resources through open forums and other gatherings can help alleviate the burdens associated with teaching science for new and seasoned teachers. With the growing rollout of digital technologies and AI competencies, we should encourage our students to design models, videos and other resources so that we can see science through their eyes and that they can take ownership of their language and understanding. Gaeilge should not be something prescribed like some medicinal dose, it should be enjoyed and used and lived with as any other language. From a government perspective, promoting resources and avenues for students and teachers to share and evolve the language can help remedy many of the challenges I outlined earlier. An increased focus on delivering resources and catching *eolaíocht as Gaeilge* up to date organically and professionally can help reduce the barriers to education as Gaeilge and to give platforms to the talent already at play.

Biography

Scríofa ag Eoin Mc Namara, a biology and chemistry teacher and technical officer from the Chemical Sciences Department at the University of Limerick. Having completed my school years as a Gaelcholáiste student, I was imprinted with the importance and value of the Irish language in my formative years. When I graduated and began to teach during the Covid-19 pandemic, I worked in a few English and Irish speaking schools before finding myself at UL. I work with teachers in science magic workshops and with

OIDE in their chemistry training days when I'm not working with undergraduate or PME students and like to keep abreast of the rewarding and challenging world of science education.

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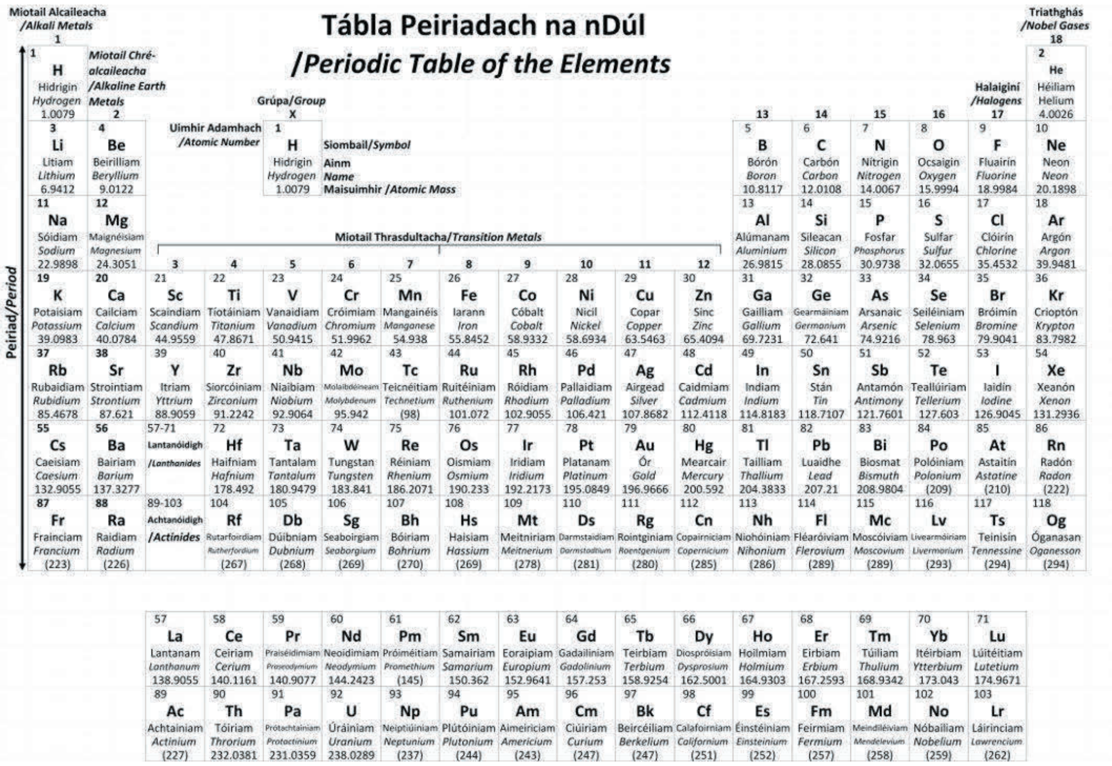

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The challenges and problems of teaching chemistry through Irish: 2

Síle Ní Thuathail
Coláiste Chroí Mhuire, An Spidéal sile.nithuathail@gmail.com

I wanted to let you know some of the challenges I face in my gaelscoil. We are a gaeilscoil in An Spidéal, operating under the scéim aitheantas and as such every resource we use to teach must be through the medium of Irish.

I started in my school 3 years ago and I was using the *Chemistry Live* textbook by Declan Kennedy. I have spent the last 3 years translating the book, the labs and all worksheets aligned with that particular textbook. Now we have moved onto the new course and I am having to start again as we changed to the *Cracking Chemistry* textbook. I spend hours every evening (no exaggeration) translating all of the powerpoints, worksheets, and lab worksheets to Irish. It is incredibly time consuming and frustrating that there is no textbook available in Irish and the *Ceimic Firicí* booklet that was once available has been out of print for the past three years and is impossible to find. I often use COGG An Tairseach, which has some fantastic resources, but it's simply not enough. I already feel burnt out and it's still only September.

In addition due to the post 2011 cutbacks we are operating in a two tier system where some teachers are being paid for this translation work while others, including myself ,are not as we were unlucky to graduate after 2012. I worry that after two years translating this course, there will be a newer updated version of the book released and I will have to again translate updated notes to align with the new textbook or specification, if and when that gets updated.

I get envious of all of the resources available on Teachers pay Teachers (Teaching Resources & Lesson Plans | TPT) as some are incredible but unfortunately I cannot use them as they are pdf's and not editable and even if they were editable, I simply don't have the time to translate them. This is my 13th year teaching and my third year teaching as gaeilge and I cannot emphasise enough the amount of time I am spending translating instead of using that time to prep engaging lessons for my students.

If I had to summarise the major challenges I face they would be:

- No textbook available in Irish for Chemistry.
- Very limited resources available through Irish for Chemistry, such as activities, lesson plans etc.
- When a textbook is made available in Irish, usually the workbook and lab book are not translated and you are forced to translate those workbooks and worksheets, which is even more time consuming than translating the textbook as diagrams with English labels can be difficult to edit. Sometimes I wish they would just translate the lab books and workbooks as a priority over the textbook.
- The terminology varies greatly across textbooks and exam papers. This is a challenge for our students as they sometimes don't know which term to use, and they worry about losing marks on exam papers. We need consistency here.
- The lovely posters that are sent by book suppliers or government organisations are usually available only in English.
- You spend a few years translating a book and then a newer version of the book is released in English and you have to go and start again.
- For example, with science in the junior cert, our kids are often forced to keep using the older version of a book despite a newer one being available in English, as the Irish one doesn't get translated.
- The powerpoints, videos, worksheets, workbooks, lab-books etc are usually not available in Irish. If they translate anything it is usually just the textbook.
- Many teachers (including myself) are reluctant to share resources as I fear that my grammar/terminology is incorrect. It would be brilliant if there was somewhere you could upload your lesson resources and someone with a degree in Irish translation could edit it and post it for others to use. Forgive me if this is already available. I haven't come across it.

Thank you very much for giving me and other teachers the opportunity to express the areas that are proving difficult and challenging. I really enjoy teaching through Irish and it's great that the students get to learn Chemistry bilingually. I just wish the students learning through Irish had access to the same resources that students learning through the medium of English have. They certainly in my opinion earn every one of their bonus points.

The sites that I find useful are:
https://www.tairseachcogg.ie/
Leabhar Oibre Chemistry Live ó Cogg
ISTA is a great website for resources and I am grateful for them for setting up the Whatsapp ISTA for teachers to share resources etc., both through Irish and English.

All of the other websites I use are through English and I translate whatever is useful to use in my lessons.

Biography:

Síle Ní Thuathail, múinteoir eolaíochta, Coláiste Chroí Mhuire, An Spidéal, Co. Na Gaillimhe.

□

The Early History of Batteries

John Hayes
Dept. of Electrical and Electronic Engineering, UCC
john.hayes@ucc.ie

The development of battery technology dates back a number of centuries. The experiments of Italian **Luigi Galvani** (1737-1798) at the University of Bologna demonstrated the impact of electricity on animal muscles and spurred much debate, argument, and experiment. The invention of the first practical electrochemical battery is credited to his friend and fellow Italian **Alessandro Volta** (1745-1827). Volta built on Galvani's experiments with his own interpretation, and invented the voltaic pile, or the electric column as he termed it, in 1799. He constructed his battery using alternating disks of zinc and copper, separated by layers of cloth or cardboard soaked in salt water (See Figure 1). This was the first practical battery and was a seminal invention. The measure and unit of electric potential are **voltage** and the **volt**, respectively, and are named in his honour. Volta was famously honoured by Napoleon for his achievements in 1801, as shown in Figure 2.

Figure 1: Voltaic pile (Tempio Voltiano, Como, Italy)

Figure 2: Bertini's painting of Volta demonstrating his battery to Napoleon (Tempio Voltiano, Como, Italy)
https://www.visitcomo.eu/en/discover/museums/tempio_voltiano/

A version of the Voltaic Pile is shown in Figure 3. This cell uses sulphuric acid, with symbol H_2SO_4, rather than brine, as the electrolyte. The electrode on the right is a sheet of copper, which acts as the cathode and is the positive terminal. The electrode on the left is a sheet of zinc, which acts as the anode and is the negative terminal. This approach is popular in school laboratories as the cell results in the very visual outgassing of hydrogen bubbles.

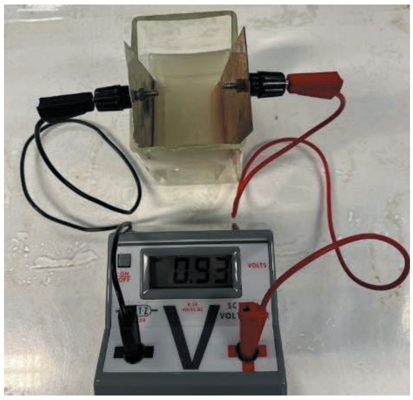


Figure 3: Simplified version of Voltaic Pile with sulphuric acid as the electrolyte.

A voltaic cell is composed of two **half cells**. One half-cell is the site of the oxidation reaction and the other half cell is the site of the reduction reaction.

An electric **battery** comprises one or more of these electrochemical cells and produces dc current by the conversion of chemical energy into electrical energy. The Voltaic pile is a practical example of a battery with the stacking of individual cells.

A simple sketch of the cell in the Voltaic pile is as shown in Figure 4. The half-cell voltage is generated as the solid zinc (Zn) releases electrons and dissolves as positively-charged Zn^{++} ions into the sulphuric acid. Interestingly, in this voltaic pile-type battery, the copper electrode does not contribute a half-cell voltage, but rather acts as a current-conducting catalyst conducting the electrons into the electrolyte. This is unlike the electrochemical behaviour of other commonly-used or commonly-referenced cells, such as the Daniel cell or the modern lithium-ion cell, as in these cells the anode does contribute a significant half-cell voltage. Simplified equations are shown in **Error! Reference source not found.**1.

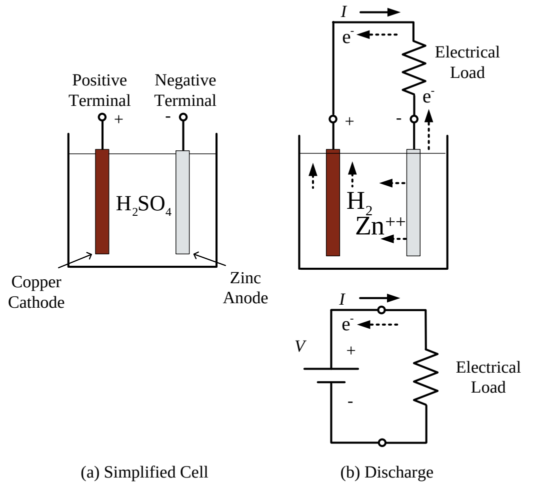


Figure 4: Simplified version of Voltaic Pile with sulphuric acid as the electrolyte.

Table 1: Discharge of Voltaic Pile zinc-copper cell.

Chemistry	Electrode	Reaction	Equation
Pile Discharge	Cathode	Reduction	$2H^+ + 2e^- \rightarrow H_2$
	Anode	Oxidation	$Zn \rightarrow Zn^{++} + 2e^-$
	Cell		$Zn + 2H^+ \rightarrow Zn^{++} + H_2$

Potential Difference, also known as voltage, is the potential energy per unit charge between two points, or in the case of a battery, between the two electrodes. It is measured using the units of the volt, with symbol V. Thus, one volt (V) equals the unit of energy, the joule (J), divided by the unit of charge, the coulomb (C).

$$\text{Potential difference} = \text{voltage} = \frac{\text{energy}}{\text{charge}},\ V = \frac{E}{Q},\ \ 1\text{V} = \frac{1\text{J}}{1\text{C}}$$

Using this definition, we can see that an electron at the anode has a high potential energy, similar to the water at the top of a waterfall, and the ability to do work, when compared to an electron at the cathode, similar to the water at the bottom of the waterfall, which has a low or zero potential energy.

The **Daniell** cell was subsequently invented by Englishman John Daniell (1790-1845). His key invention was to greatly improve on the voltaic pile by eliminating the outgassing of hydrogen.

The **lead-acid** cell was invented by French scientist **Gaston Planté** (1834-1889). This battery continues as the auxiliary or starter battery on many cars today, well into the 21st century. The lead-acid battery features a lead anode and a lead-dioxide cathode with sulphuric acid as the electrolyte. The lead-acid battery was the first rechargeable battery. Fellow Frenchman **George-Lionel Leclanché** (1839-1882) invented the Leclanché cell in 1866. This cell was the first modern primary battery and featured a zinc anode, a manganese oxide-carbon cathode and an aqueous ammonium chloride electrolyte. Many modern dry cell technologies are still based on this original technology. A **dry cell** is so termed because the electrolyte is a paste rather than a liquid. Our basic primary batteries (AAA, AA, etc.) are dry cells.

Nickel-based batteries were a topic of experimentation in the late 1800s. In 1883 we had the famous and fun quote from **Thomas Edison** (1847-1931) reflecting his frustration with the development of battery technology.
"***The storage battery is, in my opinion, a catchpenny, a sensation, a mechanism for swindling the public by stock companies. The storage battery is one of those peculiar things which appeals to the imagination, and no more perfect thing could be desired by stock swindlers than that very self-same thing. ... Just as soon as a man gets working on the secondary battery it brings out his latent capacity for lying. ... Scientifically, storage is all right, but, commercially, as absolute a failure as one can imagine."*** Thomas Edison 1883.

Swede **Waldemar Jungner** (1869-1924) is credited with inventing the first nickel-cadmium (NiCad) rechargeable battery in 1899, just a few years before **Edison** patented a nickel-iron (NiFe) battery in the USA. Nickel-metal hydride (NiMH) batteries were later to emerge from the nickel-metal family of batteries. Cadmium is the element below zinc in the Periodic Table.

Many billions of battery cells based on the technologies discussed in this section were to provide electrical storage for mobile and stationary applications for much of the 20th century and into the 21st century. A new technology set based on lithium was to emerge in the late 20th century.

Biography

Dr. John Hayes is a senior lecturer in Electrical and Electronic Engineering at University College Cork. John specializes in electrical power and electric vehicles. He is the lead author of Electric Powertrain: Energy Systems, Power Electronics and Drives for Hybrid, Electric and Fuel Cell Vehicles, published in English by John Wiley & Sons in 2018, and in Chinese by China Machine Press in 2021.

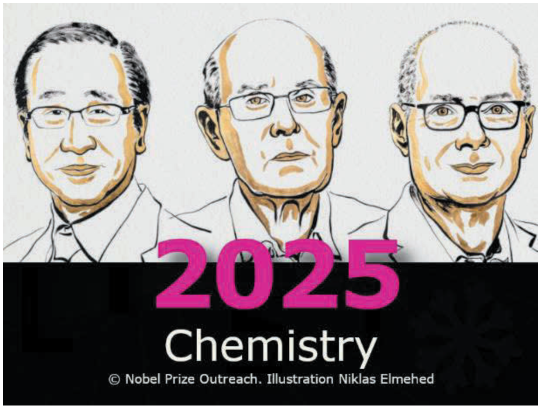
Dr John Hayes gave this talk at the 2024 ChemEd-Ireland conference in UCC in October 2024. It didn't come in time for the Proceedings. Part 2 will be published in a future edition.
To be continued!

□

2025 Nobel Prize in Chemistry for MOFs

[Nobel Prize in Chemistry 2025 - NobelPrize.org]

The Royal Swedish Academy of Sciences on 8 October 2025 decided to award the Nobel Prize in Chemistry 2025 to **Susumu Kitagawa,** Kyoto University, Japan, **Richard Robson**, University of Melbourne, Australia and **Omar M. Yaghi,** University of California, Berkeley, USA ***"for the development of metal–organic frameworks".***



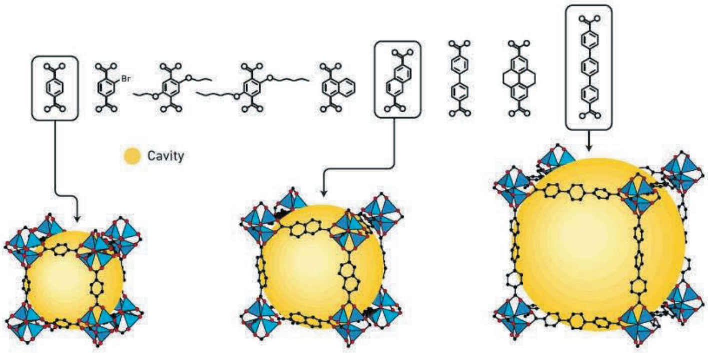
Their molecular architecture contains rooms for chemistry

The Nobel Prize laureates in chemistry 2025 have created molecular constructions with large spaces through which gases and other chemicals can flow. These constructions, *metal–organic frameworks*, can be used to harvest water from desert air, capture carbon dioxide, store toxic gases or catalyse chemical reactions.

Susumu Kitagawa, **Richard Robson** and **Omar Yaghi** are awarded the Nobel Prize in Chemistry 2025. They have developed a new form of molecular architecture. In their constructions, metal ions function as cornerstones that are linked by long organic (carbon-based) molecules. Together, the metal ions and molecules are organised to form crystals that contain large cavities. These porous materials are called metal–organic frameworks (MOF). By varying the building blocks used in the MOFs, chemists can design them to capture and store specific substances. MOFs can also drive chemical reactions or conduct electricity.

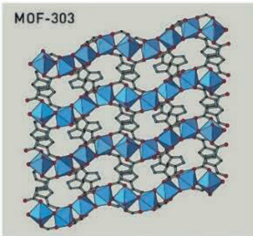
"Metal–organic frameworks have enormous potential, bringing previously unforeseen opportunities for custom-made materials with new functions," says Heiner Linke, Chair of the Nobel Committee for Chemistry.

It all started in 1989, when Richard Robson tested utilising the inherent properties of atoms in a new way. He combined positively charged copper ions with a four-armed molecule; this had a chemical group that was attracted to copper ions at the end of each arm.

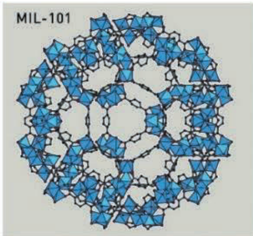


When they were combined, they bonded to form a well-ordered, spacious crystal. It was like a diamond filled with innumerable cavities.

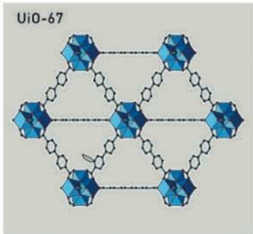
Robson immediately recognised the potential of his molecular construction, but it was unstable and collapsed easily. However, Susumu Kitagawa and Omar Yaghi provided this building method with a firm foundation; between 1992 and 2003 they made, separately, a series of revolutionary discoveries. Kitagawa showed that gases can flow in and out of the constructions and predicted that MOFs could be made flexible. Yaghi created a very stable MOF and showed that it can be modified using rational design, giving it new and desirable properties.



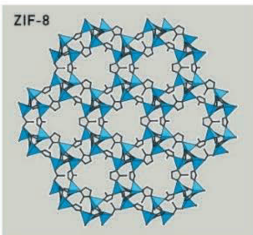
MOF-303 can capture water vapour from desert air during the night. When the sun heats up the material in the morning, potable water is released.



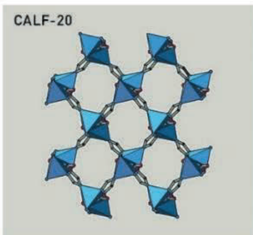
MIL-101 has gigantic cavities. It has been used to catalyse the decomposition of crude oil and antibiotics in polluted water. It can also be used to store large quantities of hydrogen or carbon dioxide.



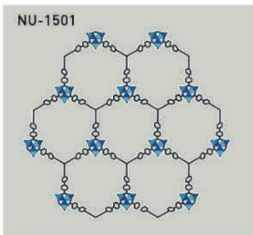
UiO-67 can absorb PFAS from water, which makes it a promising material for water treatment and the removal of pollutants.



ZIF-8 has been used experimentally for mining rare-earth elements from wastewater.



CALF-20 has an exceptional capacity to absorb carbon dioxide. It is being tested in a factory in Canada.



NU-1501 has been optimised to store and release hydrogen at normal pressure. Hydrogen can be used to fuel vehicles, but in ordinary high-pressure tanks the gas is extremely explosive.

Following the laureates' groundbreaking discoveries, chemists have built tens of thousands of different MOFs. Some of these may contribute to solving some of humankind's greatest challenges, with applications that include separating PFAS from water, breaking down traces of pharmaceuticals in the environment, capturing carbon dioxide or harvesting water from desert air.

□

Famous Irish Chemists #4

Thomas Patrick Dillon (15/1/1884-11/12/1971) – revolutionary chemist

Peter E. Childs
Peter.childs@ul.ie

Introduction

Professor Thomas Patrick Dillon

On 2nd October 2019 NUI Galway (now University of Galway) hosted a meeting on Carbohydrate Chemistry to mark the centenary of the appointment of Thomas Dillon as Professor of Chemistry at University College Galway. (For the programme see symposium-programme_full.pdf.) Dillon established a strong research school in Carbohydrate Chemistry in Galway, and one part of his research looked at alginates in seaweed. He spent time in jail in Gloucester for supporting Irish republican candidates, for speaking publicly against Conscription, just prior to joining the staff in Galway. Thomas Dillon played an important role in establishing the profession of Chemistry in the new Irish State, and in making Galway an important centre of chemical teaching and research, where he led the Department of Chemistry for 35 years. Honor O Brolchain, author and family historian, said of her grandfather:

"Referred to as 'remarkable' by diverse people, he was the kind of man you could, and would, ask to do anything, and he did – running an organisation, setting up a canteen, starting an Aid Fund and, in the case of Galway, enhancing and expanding a Chemistry Department, while fending off the violent extremes of the Black-and-Tans, and representing the University in 1935 in a debate on the uniting of Ireland. He was an interesting, complex and generous man." September - University of Galway

Early years and education

Thomas Patrick Dillon was born 15/1/1884 in Enniscrone, Co. Sligo. He was the first of 5 children (4 boys and 1 girl) of John Dillon, and engineer, and Elizabeth née Sullivan. His father's family included Catholic politicians and lawyers, including John Blake Dillon, John Dillon and Lord Mayor and Parnell's solicitor, Valentine Dillon.

His grandfather was William K. Sullivan a Chemist and Fenian who, with his friend, William Kane, started the sugar beet cultivation in Ireland, believing that the country should work on its own resources. They also started the first College of Science with its site on St. Stephen's Green, Dublin. Both men were subsequently Presidents of Queens College, Cork (UCC).

Thomas Dillon's family moved to Ballina, Co. Mayo, where his father built the water works. Dillon was educated at St. Nathy's, Ballaghadereen and Clongowes Wood College, Dublin. Clearly a bright student, he won a scholarship at the age of 16 to study medicine at Queen's College Cork (QCC, now University College Cork, UCC).

The students were encouraged to go to lectures in different disciplines and when Dillon went to a Science lecture by an inspiring lecturer, a student of the great Justus von Liebig, he changed his mind and gave himself wholly to Chemistry. A fortuitous move for Irish Chemistry.

He switched courses to science and took a BA in Chemistry and Physics in 1904. He then went to the Royal College of Science in Dublin and gained an MA in Chemistry in 1908 and was then appointed an assistant to Professor Hugh Ryan of the Catholic University. Dillon also taught part-time at the Catholic University School, Dublin and Loreto Convent School, Dalkey. In 1908 when the National University of Ireland (NUI) was established, he moved with Professor Ryan to University College Dublin (UCD). In 1912 he was awarded the first D.Sc. degree awarded by the NUI. The University of Dublin (TCD) gave him an honorary doctorate in 1954. His chemistry tree (Chemistry Tree - Thomas Patrick Dillon Family Tree) shows his scientific ancestry: through Hugh Ryan he was connected to Alfred Senier in Galway and Herman Fischer in Berlin, and from them into the mainstream of European chemistry.

While in prison for his revolutionary activities, his wife, Geraldine Plunkett, applied for the post of Professor of Chemistry in Galway, UCG on his behalf, and she collected references from appropriate sources. He was appointed Professor of Chemistry in March 1919 and stayed there until retirement.

Thomas Dillon with his wife Geraldine

Thomas and Geraldine had 5 children: 3 daughters and 2 sons. One daughter, Éilis Dillon (1920-1994) became a well-known novelist, and Michael Dillon (1922-1992) an agricultural journalist. These two children and his wife have entries in the *Dictionary of Irish Biography*. Geraldine Plunkett Dillon had her memoirs, *All in the blood*, published posthumously in 2006, edited by Honor O Brolchain, 20 years after her death.

His revolutionary activities

In 1912 when working with Professor Hugh Ryan at UCD, Dillon met Geraldine Plunkett, one of his Chemistry students, who started but didn't complete a medical degree, and they were married on Easter Sunday 1916. They watched the start of the Easter Rising from their honeymoon hotel window. Through Geraldine, Dillon met her brother Joseph Mary Plunkett and later joined the Irish Volunteers and was the Chemical Adviser for the 1916 Rising, where he helped make grenades and bombs. Later he served on the executive council of Sinn Féin. This political involvement and his anti-conscription work led to his arrest in May 1918 and imprisonment in Gloucester. Dillon tells of his arrest (Dillon, 1960).

"I had become involved in revolutionary politics of the day and was a member of the Sinn Fein Executive, of which I had been for a time secretary. One May night of that year

[1918], I was served by the Chief Secretary for Ireland, Mr. Shortt, with a notice, which, in my case he did not take the trouble to sign, that, whereas I was suspected of behaving, or being about to behave in a manner prejudicial to the defence of the realm, he therefore ordered that I was to be detained during His Majesty's (or somebody's) pleasure. In the small hours of the morning, I found myself on a sloop of the British Navy in Kingstown (as it then as) Harbour with a goodly company. We were soon on our way to English gaols, where those of us who did not escape or die in the 'flu epidemic remained until the end of the following March."
(Dillon, T.P., (1960), 'Early days of the New University College, Dublin', *University Review*, 2(3), Autumn-Winter 1960, pp. 23-32)

He took the opportunity in prison to learn Irish and chess! The Spanish Flu was raging in Europe at the time and it badly infected the prisoners. Geraldine travelled to Gloucester and helped get her sick husband released back to Ireland. She also helped him get appointed to the professorship in Galway by collecting references. Some members of the appointment committee were suspicious of him, and in the end, he was appointed by just 1 vote. He replaced Alfred Senier, who had died in 1918, and Dillon turned out to be an inspired choice. He was the fifth Professor of Chemistry in Galway.
(http://www.advertiser.ie/Galway/article/84681/the-professor-in-his-wifes-overcoat)

Dillon continued to be active in republican politics, and he and his wife took an active part in the war of independence and several times Dillon was on the run from the authorities. Geraldine was briefly jailed and their house searched.

Chemical education in Galway

Professor Thomas P. Dillon teaching in, University College Galway (UCG) Photo: Honor O Brolchain

Dillon was an enthusiastic and successful teacher of chemistry. The photo above shows him at the chemistry demonstration bench in a lecture theatre. It is clear from this that he did demonstrations in lectures. I wonder if there are any accounts from his students of his lectures? He encouraged the teaching of Chemistry in Irish, and parts of the Chemistry course were taught in Irish. Dillon initially wasn't fluent himself in Irish, though he became so, and the lectures were given by Vincent Barry and Prionsias Ó Colla. He and Vincent Barry wrote the first Chemistry textbook in Irish, but no longer in print. There is still no Chemistry textbook in Irish for Leaving Certificate Chemistry students. The emphasis on Irish gradually declined and the first course is now not taught in Irish, although there is an elective module in 3rd year (LN2210 Scileanna Gaeilge don Eolaíochta 1.) Chemistry flourished in Galway under Dillon's direction and student numbers rose from 70 in 1919 to 300 in 1953, when he retired.

Chemical research

"Dillon's foresight in trying to develop useful products from carbohydrates is just as relevant, if not even more relevant today. Aside from the relevance to health, carbohydrates are highly renewable carbon stores and will certainly have roles to play in generating chemical feedstocks for making drugs or for the production of smart materials in future years. This is potentially very important for the future of the West of Ireland given our proximity to the sea and importance of agriculture to the region."
Paul Murphy, Established Professor of Chemistry of University of Galway's School of Chemistry [September - University of Galway]

Dillon developed an international reputation for his work on the structures of carbohydrates, especially those in seaweed. In the 19th and early 20th century the seaweed industry was important along the west and north-west coasts of Ireland. Initially as a source of soda, then as the only source of iodine and finally as a source of alginates. Dillon worked on various chemicals found in Irish seaweeds and published many papers from 1928 onwards, establishing a School of Carbohydrate Chemistry, which continued after his retirement, and continues to this day. He was also interested in the commercial exploitation of seaweeds as a source of chemicals and in 1939 he took out two patents on making paper and fertiliser from seaweed. A government-funded unit was set up in the University to research the economic uses of seaweed. The University of Galway is still an important centre for seaweed research ([The Seaweed Site :: information on marine macroalgae]), a legacy of Dillon's pioneering work.

Dillon was keen to promote science-based industries in Ireland using Ireland's natural resources, like seaweed. An article on his retirement noted:
"His pioneering work contributed in no small measure to the establishment of a flourishing seaweed industry in the world, and it is fitting that some of his former pupils are leaders of the industry in Norway and America. A large number of his former students to be found in the new industries, research institutes and educational establishments of Ireland, is an indication of his contrition to the development of the country."
('University College Galway', *University Review*, **1**(2), Autumn 1954, 70-72)

Ireland's first two female professors of Chemistry both came from Dillon's Department in Galway, one of whom was Eva Philbin (UCD), and the other was Elizabeth Lee (Galway). A third female Professor, also a student of Dillon's, was Ethna Gaffney, first female Professor in the Royal College of Surgeons in 1967.

In an article published in 1930 Dillon makes a case for reviving the seaweed industry to produce not just iodine, but also potash as a fertiliser. Interestingly, the Irish government did try to restart the Irish iodine industry in 1929-30 with a new factory in Galway, but it soon fizzled out due to the collapse of the global iodine trade.
"I have pointed out above that under present conditions an Irish iodine industry could not be of very large dimensions, and while I have suggested the possibility, of a new growth due to the use of iodine in agriculture, it is evident that such a growth, if it comes, may be very slow. On the other hand the seaweed

industry, while it may not be capable of bringing a great fortune to any individual capitalist, means much to the impoverished districts along our west coast, and hence one would like to see it based on something larger and more stable than the iodine market. For that reason 1 have endeavoured to show that there is a prima facie case for a technical investigation of the possibility of obtaining potash from our seaweed. It will doubtless be asked, if such a thing is possible, why is no other country doing it The answer is that in no other country do the same circumstances occur: a large population living in a state of semi-starvation on an impoverished coast, the necessity of preserving that population not only for humanitarian but for national reasons, and the occurrence of an enormous quantity of seaweed thrown up annually on these shores. If we have not the intelligence to solve this problem for ourselves, no other country will do it for us."

(Dillon, T.D., (1930), 'Iodine and Potash from Irish Seaweed', *Studies: An Irish Quarterly Review* , June 1930, 19(74), pp. 267-278)

Professional activities

Dillon played an active role in the promoting and establishing the profession of Chemistry in Ireland. He was a founder member of the Chemical Association of Ireland (1922-1936) and its successor the Irish Chemical Association (1936-1950), the forerunners of the Institute of Chemistry of Ireland, (ICI), the professional body for Irish chemists. Dillon was President of the Institute from 1954-1956. He was elected to the Royal Irish Academy in 1941 and was vice-President in 1957.

Conclusion

Thomas Dillon played an important role in the development of Chemistry in the newly independent Irish state. He was Professor of Chemistry for 35 years in Galway and helped establish a thriving Chemistry Department, in teaching and research, which continues to this day. It nearly didn't happen. He could have died of flu in an English prison, and without his wife's lobbying he probably wouldn't have been appointed as Galway's 5th Professor of Chemistry. He also pioneered the teaching of Chemistry through Irish and helped produce the first Chemistry textbook in Irish. He promoted the importance of Chemistry as a career choice for Irish students and advocated the greater development of science-based industry in Ireland. In an article on 'Chemistry in the service man' he said:

"In our blindness to the relation of science to industry we are following an old and outworn English tradition…It has been said that it takes sixty years for a new idea to penetrate from the Continent to England, and another hundred for the same idea to cross to Ireland. Let us pray that in the case of science, in the interest of the future prosperity of the country, the period of crossing may be much shortened."

(Dillon, T.P., (1939),'Chemistry in the service of man', *Studies: An Irish Quarterly Review*, March 1939, 28(109), pp. 49-62)

In 2025 we can see the legacy of this emphasis on science-based industry by Dillon in the vibrant Irish Pharma firms and MedTech industries, which now underpin the Irish economy.

Sources

In addition to the references in the text:

Lunney, L. & Leaney, E. (2009). "Dillon, Thomas Patrick". In McGuire, James; Quinn, James (eds.). *Dictionary of Irish Biography*. Cambridge: Cambridge University Press.
Dillon, Thomas Patrick | Dictionary of Irish Biography

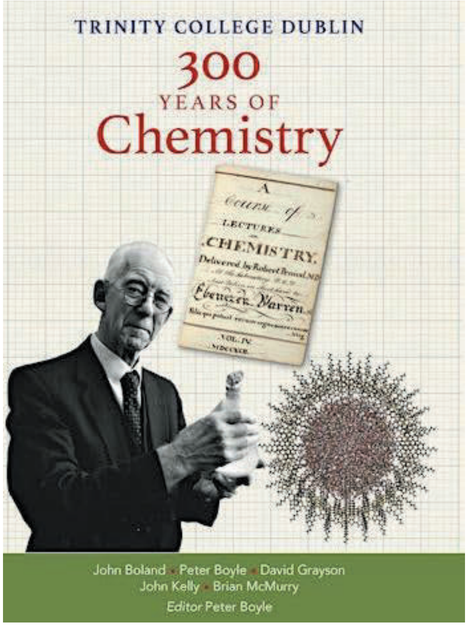
Essentially duplicated in his Wikipedia entry.
Thomas Dillon (chemist) - Wikipedia

Acknowledgements

Thanks to Honor O Brolchain for commenting and adding to the article and to Professor Paul Murphy of UG for his input.

□

BOOK REVIEWS



***Trinity College Dublin: 300 years of chemistry*, Dublin: Hinds, 2025, ed. Peter Boyle**
ISBN-13 978-1-909442-09-2

Trinity College Dublin (TCD) is the top-rated Irish university and its chemistry department is the top-rated chemistry department in Ireland, in the top 100 in the world. This is an achievement for a small country like Ireland, and for a small university in international terms. TCD can also claim to be one of the oldest chemistry departments in the world, having appointed a Professor of Chemistry in 1711. The tercentenary of this in 2011 and this book commemorates the 300 years of chemistry in Dublin. The book is dedicated to Dr Mary Carson, the first woman lecturer in the Department, who worked at TCD from 1967 to her retirement in 2000. She died in 2019 and left a legacy to the department which helped fund this book. Chemistry at TCD has a long and distinguished history and this detailed and profusely illustrated book is a worthy tribute to mark its long history. It consists of six chapters, each covering a period of its history and authored by past staff members. Sadly, Brian McMurry did not live to see its publication. The chapters are as follows:

1. Chemistry, the handmaid of medicine 1711-1844 (Peter Boyle)
2. A new era 1844-1903 (Peter Boyle)
3. Young and Werner 1903-1947 (Brian McMurry)
4. The Cocker years 1947-1978 (David Grayson)
5. The department in transition 1978-2000 (John Kelly)
6. The new millennium 2001-2022 (John Boland)

Chemistry started off in TCD as an adjunct to medicine and all the early professors were doctors, until 1844, from which date it was headed by qualified chemists. Its history as a centre of chemical excellence, in teaching and research, can be summed up as BC – Before Cocker – and AC – after Cocker. Wesley Cocker was a Lancastrian, (1908-2007), and was recruited as Professor of Chemistry in 1947, in the aftermath of WW2. (Figure 1) Previously he was a lecturer in Chemistry at King's College, Newcastle on Tyne. He remained as head of department until he retired in 1978. Figure 1 shows the chemistry staff in 1978. Most of these have now retired or died and will be familiar to many TCD chemistry graduates.

Figure 1: Professor Cocker at his laboratory bench

Figure 2 The chemistry staff at TCD in 1978, the year of Professor Cocker's retirement. (Fig. 5.1, p. 182 in the book)
Front row: L to R George A. Lonergan, W.J. (Bill) Davis, T. Brian H. McMurry, Wesley Cocker, David C. Pepper, E.R. (Eddie) Stuart, Peter H. Boyle
Back row: L to R John M. Kelly, G. Roy Brown, Mary S. Carson, D.A. (Tony) Morton-Blake, David H. Grayson, David J. Cardin, Christine J. Cardin, Kevin J. Crowley

When Wesley Cocker took over there were 4 members of staff and the department was mainly concerned with service teaching, with little or no research, and poor physical facilities. It is not too much to say that Professor Cocker transformed the department and laid the foundation for its future growth and commitment to top-level research. He started the process to turn the department into am modern, research-focused centre with an international reputation. An appendix lists the PhDs awarded from 1950 to 2021: in 1950 there was 1 PhD; in 2021, 25. Initially most PhDs were in organic chemistry but now they reflect a wide range of modern topics in all branches of chemistry. Chemistry moderatorship rose from 6 in 1978 to 18 in 2000, though these numbers are now greatly increased with the addition of other chemistry-based degrees. Professor Cocker continued to be active in research and publication long after his retirement. He is commemorated by the Cocker Prize (1950-), funded by his relative Sr William Cocker who ran a chemical company; the Cocker Teaching Laboratory (1996); the SOCI Welsey Cocker Award (2008-); and the TCD Cocker Lecture (2021-). Professor Cocker wrote his own detailed account of chemistry at TCD in an article when he retired (Cocker, 1978).

Scientific research in Ireland was poorly funded until 2000 but since then the vastly increased support for Irish universities, for their facilities, equipment and student scholarships, has transformed the research scene in Ireland. A rising tide lifts all boats, and all the Irish

Chemistry departments have benefited from the increased funding, probably TCD and UCD most of all. Ireland's international reputation as a location for biopharma companies, providing well-paid jobs for chemistry graduates, has also helped to promote the training of chemists and chemical research. For a small country Ireland is punching well above its weight, thanks to support from SFI and the EC. The number of chemistry staff in TCD has grown from 4 in 1947, to 14 in 1978, to 24 today, with a concomitant growth in the number of research students. The last two chapters give a good overview of the development of research in the Department, especially since 2000. It is noteworthy that the majority of staff seems to have been imported, recruited from many countries, and this is also reflected in the composition of the postgraduate students. The chemistry department has long since expanded out from the 1887 building (Figure 3), familiar to generations of chemistry students, and its staff are now located in six different sites. TCD chemistry graduates have gone on to distinguished careers in academia, industry, business and teaching.

Figure 3: The old chemistry building TCD

This book will be of particular interest to TCD chemistry graduates and postgraduates and present and past staff. It should also be of interest to anyone interested in the history of chemistry in Ireland and TCD's important role in that history. It is well worth reading and is a bargain at €30. It is worth reading for the wealth of photos it contains. Randal Henly has written an interesting article online about his time at TCD. Popular (Henly, 2023). One of the staff, Dr. Roy Brown, was a great friend of the ISTA and a frequent speaker to chemistry teachers. He taught chemistry to premed students from 1962 to his retirement in 1995. In more recent years the Chemistry department has hosted the RSC Education Officer, and Dr. John O'Donoghue has made TCD an important centre for chemical education and outreach. It is clear from the final chapter that the Chemistry Department at TCD has a bright future in chemical education and research, building on its 300 year history.

References

Cocker, W., (1978), 'A history of the university chemical laboratory, Trinity College, Dublin, 1711-1946,' *Hermathena*, CXXIV, pp 58-76

Henly, R., (2023), 'Memories of my undergraduate years, 1958-1962, Ttinity News, Nov. 2023 Online at [Randal Henly, Author at Trinity News] Accessed 23/7/25

The book is available from:

Hinds Publishing Ltd, 13 Carlisle Avenue, Donnybrook, Dublin 4, Ireland
Phone +353 1 667 4864 or within Ireland 01 667 4864
Mobile +353 87 114 5537 or within Ireland 087 114 5537
ross.hinds@hinds.ie
The price is 30 euro and is post free for Irish addresses.
P. E. Childs

A history of the Irish pharmaceutical industry: making medicines for the world,

Pat McCarthy, 2021, Dublin: Four Courts Press
ISBN 978-1-84682-979-6

(Published at €35 but available from the Four Courts Press, and other outlets, at €17.50.)

I have thought for some years that someone needed to write a book about the modern Irish chemical industry. I gave a talk at an ICI symposium and wrote an article on 'The early chemical industry and industrialists in Ireland' in 1998 but this did not cover the modern industry. This is often dated from 1971 when the American company Pfizer opened a citric acid plant at Ringaskiddy, so that the modern Irish biopharma industry is around 55 years old. The growth of the pharma (now biopharma) industry in Ireland has been a great success story. There are three main area of high-tech industry in Ireland: biopharmaceuticals (biopharma), medical technology (medtech) and information technology (software and hardware, IT). Of these, the biopharma sector is the oldest and largest in terms of export volume, and together these industries kept Ireland afloat economically through the 2008 recession and Covid. Without them our economy would have crashed and burned. Their importance can't be overstated and many of the world's largest biopharma companies have plants in Ireland and many of the world's biggest selling drugs are made in Ireland.

I only came across this book by accident as I missed its publication and Pat McCarthy has done a fine job in describing the rise of the industry. It should be compulsory reading for all chemistry undergraduates and third level staff. Chemistry teachers will benefit by reading it to give them the ammunition to present the value of taking Chemistry and at school and pursuing a chemistry degree. This book tells the story of the industry up to 2020, just at the start of Covid, and its author worked for many years in the Irish pharmaceutical industry. There are many reasons why companies, especially American companies, locate in Ireland: low corporation tax (even now it has gone up from 12.5 to 15%); access to the European market especially the EC; an English-speaking workforce; a well-qualified and highly skilled pool of labour; access to the EC labour market as well; a clean environment. Of these, the quality of the workforce is crucial and this means that the chemical education pipeline from secondary school, especially LC chemistry, to undergraduate courses to PhDs is vital. Ireland has the second highest proportion of third level qualifications in Europe. The quality of the educational system is a key factor in attracting inward investment, and this means that supporting chemical education at school and university is important. Unless enough students take chemistry at school, then at third level (levels 6 to 8) and into chemistry graduate school (Masters and PhDs), then Ireland will not be able to sustain the still-growing chemical industry. Since 2020 the government support for research through SFI and other bodies has helped increase the output of highly-qualified PhDs. Many of these postgraduates have gone on to work in Ireland, many of them rising to the top in their companies and many moving into senior positions abroad. Ireland has been punching well above its weight in scientific research, with internationally recognised centres of excellence in chemical research.

The biopharma industry is one of Ireland's great success stories, producing many highly-paid jobs and showing remarkable stability over the years. Its future growth is threatened by Irelands poor record in developing infrastructure (water, electricity, transport, housing) and currently, the threat from Trump of increased tariffs; reduced support for third level education.

Pharmaceutical exports have grown from €51.7 million in 1973 to €87.7 billion in 2019; from 4.7% in 1973 to 57.5% of manufactured exports in 2019; from an employment of less than 2,000 in 1973 to 35,372 in 2019. The situation has even improved since 2019. Most of the growth has been in multinationals but there has also been a healthy growth in indigenous pharma companies, supplying generics, in supporting companies (for example in engineering) and in spin-off companies from Irish universities.

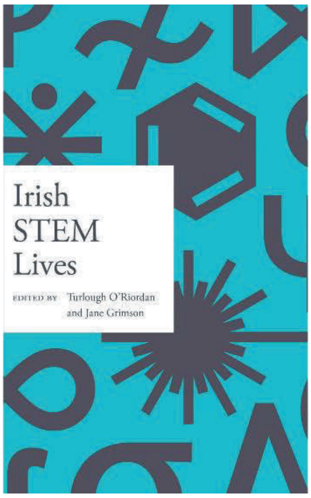
The slide from the IDA below gives an idea of the health of the biopharma industry in Ireland. Plants are spread around Ireland but they are concentrated in Cork and the greater Dublin area.

References

Childs, P.E., (1998), 'The early chemical industry and industrialists in Ireland', *Irish Chemical News*, **XII**(1), 18-25, Summer 1998

You can access a lecture on this topic by Pat McCarthy at [Bing Videos].

P. E. Childs □



Irish Stem Lives
Ed. Turlough O'Riordan, Jane Grimson
RIA 2025
https://shop.ria.ie/products/irish-stem-lives
€15 from RIA or in bookshops.
shop.ria.ie/products/irish-stem-lives

The Royal Irish Academy is delighted to announce the upcoming publication of *Irish STEM Lives.* The latest in the *Dictionary of Irish Biography's* (DIB) ongoing *Lives* series is available for preorder at the RIA online shop and will be published on 24 September 2025. The publication will be followed by a launch event held at The Royal Irish Academy on 8 October 2025.

Edited by Turlough O'Riordan and Jane Grimson, *Irish STEM Lives* retraces the extraordinary work and contributions of natural philosophers, mathematicians, engineers, particle physicists, code breakers and many more, through a selection of forty-six exceptional pioneers from the DIB. This book will take the reader on a journey across artificial intelligence, climate change, food safety, transport and communication, touching all the fields of STEM (science, technology, engineering and mathematics) that are integral to modern society.

A notable theme of the book is the evolution of the pursuit of knowledge over the past four centuries, covering relevant breakthrough events in STEM history, such as the development of the 'scientific method' in the circle surrounding Robert Boyle and the large-scale particle physics experiments undertaken by John Stewart Bell and Anne Kernan at CERN.

Another major theme is the representation of diversity within STEM fields in Ireland. Women in STEM are often overlooked and barely mentioned, relegated to the margins of textbooks despite their crucial contributions to scientific and technological advancements. *Irish STEM*

Lives brings their stories to the forefront: from Mary Ward to Anne Kernan, these women played an essential role in shaping the landscape of science and technology.

To honour their invaluable contributions and acknowledge their efforts, the only pictures included in the book are those of female STEM practitioners. This decision was made to challenge the conventional norms of STEM representation. The absence of male figures in the visual elements serves as a reminder that scientific progress is not an endeavour exclusive to men and that women have been, and continue to be, fundamental in driving innovation and discovery, which the editors discuss in their introduction as they delve into the issues impacting women in STEM historically.

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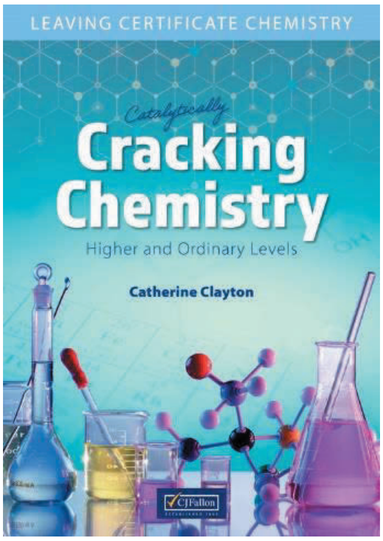
New LC Chemistry Textbooks

Chemistry teachers are well resourced for the new Chemistry specification by the availability of two textbooks: an old favourite, ***Chemistry Live*** by Declan Kennedy and Ryan Gallagher, now in its 3rd edition, and a new offering ***Cracking Chemistry*** by Catherine Clayton. Each comes with a package of resources and are available electronically. Teachers had to make up their minds which book to recommend for the free books scheme before really seeing the books and before the start of the new school year. I am sure most teachers will use both books but will have to choose one for the students. It'll be interesting to see how this works out in practice and how the market divides up. The authors are to be congratulated in getting them out in time for the start of the new course.

There has been an interesting thread of discussion about the books and their resources on the ISTA's Chemistry WhatsApp group. Every chemistry teacher should join the ISTA and this group as it is full of good advice and shared experience.



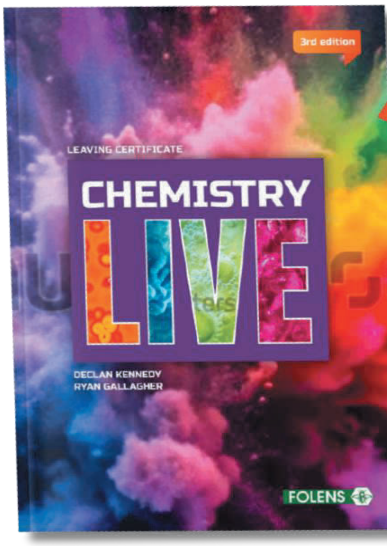
Cracking Chemistry
Catherine Clayton
CJ Fallon 2025
Price: €39.95
ISBN: 9780714431871

***Cracking Chemistry* is a complete package fulfilling all the requirements of the new Leaving Certificate Chemistry specification.**

This engaging textbook covers all five key strands of the new course: the nature of science; the nature of matter; the behaviour of matter; the interactions of matter; and matter in our world.

Click here to view Sample Chapters

Catherine Clayton is an experienced Science and Chemistry teacher, currently teaching at St Louis High School, Dublin. She completed her undergraduate degree at Trinity College Dublin and USCB (University of California Santa Barbara), followed by a Masters in Education at University College Dublin. Follow her on Instagram: @CrackingChemistry.



Chemistry Live **3rd Edition**
Declan Kennedy and Ryan Gallagher

Folens €44.90
Student resources include an Assessment and Exam Guide.
[**Chemistry Live 3rd Edition Digital Resources – Folens: Primary & Post-Primary Teaching Programmes**]

This is a new, revised edition of a classic text and teachers are familiar with it and its resources. Declan Kennedy is well-known as a successful textbook author and he is joined for this new text by Ryan Gallagher, who has replaced Declan as Science Education tutor at UCC.

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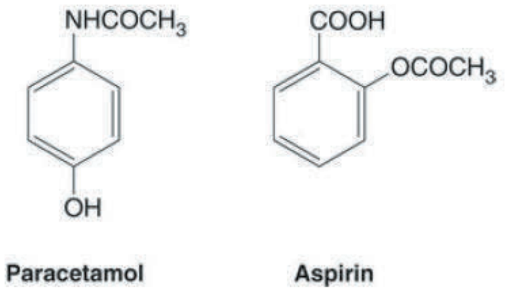
200th anniversary of discovery of benzene

Benzene is in many ways the archetypal molecule and symbol of chemistry. 2025 marks the 200th anniversary of the discovery of benzene by Michael Faraday at the Royal Institution in London. Gas for lighting houses in the early 19th century was made either from heating coal (coal or town gas) or by heating whale oil (illuminating gas). The whale oil was heated to turn it into gas it and then compressed into cylinders for distribution. One of the manufacturers, David Gordon, found a liquid residue was formed on compression to make his 'portable gas' and he sent a sample to Michael Faraday (via Michael's brother Robert), to see if Faraday could find out what it was (Kaiser, 1968 describes this in detail). The liquid was an impure mixture and it took Faraday two years to separate, purify and analyse the sweet-smelling product he finally obtained. He used the atomic weight (mass) of carbon as 6 and hydrogen as 1 and so he gave it the formula C_2H and called it bicarburet of hydrogen. It should have been CH and we now know the formula is C_6H_6, with a 1:1 ratio of C:H. The distinctive sweet smell gave the name aromatics to benzene and its derivatives. The naming of benzene is described in the following *Chemlingo: Aromatic Chemistry*.

This was an important discovery of a new and unusual class of carbon compounds. It later became known as benzene, after the German *benzin*, when it was made from benzoic acid, itself obtained from gum benzoin.

Benzene didn't behave like other hydrocarbons and chemists didn't know what its correct structural formula was. Friedrich August Kekulé has a brainwave in 1865, supposedly as a result of a dream where snakes swallowed their tails, and proposed a radical idea that the benzene molecule was a flat ring. Chemists found this idea hard to swallow and there was no direct evidence for its structure. Its formula showed it to be unsaturated (containing double bonds) but it didn't behave chemically like other unsaturated compounds, like the alkenes.

Aromatics, made first from coal and then from oil, became the mainstay of the organic chemical industry, as well as being used in liquid fuels. The first synthetic dye, mauveine, made by William Perkin was derived from aniline, $C_6H_5NH_2$, a benzene derivative and this launched the synthetic dyestuff industry. Many (if not the majority of) pharmaceuticals contain benzene rings, like aspirin and paracetamol.



Chemists had accepted the symmetry of the benzene ring and the fact that it contained double and single bonds, but they had no direct evidence of its planarity. Irish-born crystallographer Kathleen Lonsdale solved the problem in 1929, while working at the University of Leeds. She solved the crystal structures of hexamethylbenzene and hexachlorobenzene, crystals given to her by Professor Christopher Ingold, a famous organic chemist. She showed by analysing their X-ray diffraction patterns that were both flat molecules, and were symmetrical, with equal C-C bond lengths. This in turn led later to the idea of resonance and delocalised electrons in aromatic rings to explain the unusual properties of benzene. Ingold said afterwards: *"The calculations must have been dreadful, but one paper like this brings more certainty into organic chemistry than generations of activity by us professionals."* Kekulé turned out to be right and the structure provided clues to the chemical stability and unusual chemistry of benzene. Unlike other unsaturated hydrocarbons, like ethene, benzene undergoes substitution reactions rather than addition reactions, as substitution preserves the stable benzene ring.

References

Kaiser, R., (1968), 'Bicarburet of Hydrogen". Reappraisal of the Discovery of Benzene in 1825 with the Analytical Methods of 1968', *Angew. Chem.* internat. Edit., 7 (5), pp. 345-350

["Bicarburet of Hydrogen". Reappraisal of the Discovery of Benzene in 1825 with the Analytical Methods of 1968]

Lonsdale, K., (1929), 'The Structure of the Benzene Ring in $C_6(CH_3)_6$', Proc. Royal Society A, 123(792), 494-515

[The structure of the benzene ring in C6 (CH3)6]

Lonsdale, Kathleen. 1928. The structure of the benzene ring. Nature 122: 810.

Lonsdale, Kathleen. 1929. The structure of the benzene ring in $C_6(CH_3)_6$. Proceedings of the Royal Society of London A 123: 494–515.

"The above reasoning, in fact, supplies a definite proof,, from an X ray point of view, that the chemist's conception of the benzene ring is a true representation of the facts."

(Lonsdale, 1929, p. 503)

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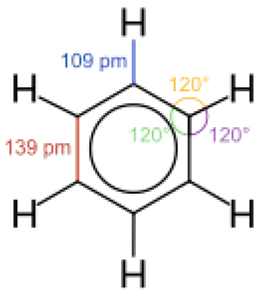
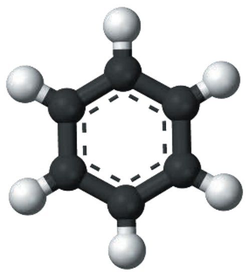
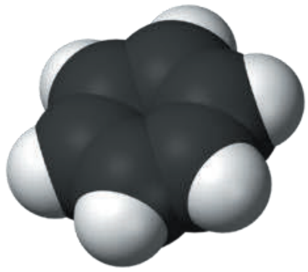
Chemlingo: Sweet smells - aromatic chemistry

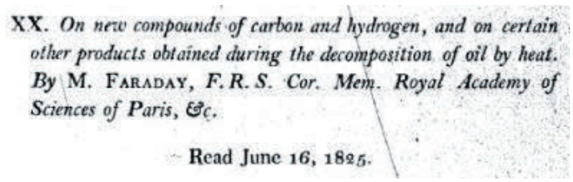
Peter E. Childs







2025 marks the 200th anniversary of the discovery of benzene by Michael Faraday (Faraday, 1825)


XX. *On new compounds of carbon and hydrogen, and on certain other products obtained during the decomposition of oil by heat.* By M. FARADAY, *F.R.S. Cor. Mem. Royal Academy of Sciences of Paris, &c.*

Read June 16, 1825.

In many ways benzene is the archetypal chemical: when anyone wants to illustrate chemistry, they often use a benzene ring. It is a widely recognised symbol and icon of chemistry. Benzene has a pleasant smell or aroma, familiar to my generation for its widespread use in chemistry laboratories. We used in cleaning glassware and even washing our hands! (It's use is now restricted due to its carcinogenicity, but older chemists actually live long!) The smell gave its name to the class of compounds derived from benzene and containing one or more benzene rings: aromatic compounds.

The other main class of organic compounds, aliphatic compounds, contain chains of carbon atoms. This name derives from Greek *áleiphar* meaning oil or ointment, since many of the organic compounds discovered were oils. It was first used in German (*aliphatisch*) and its first English use was in *Nature* in 1882. Alicyclic compounds are rings of carbon atoms but without aromatic character.

E. Mitscherlich in 1835 made benzene from benzoic acid (from gum benzoin) and he called it benzin (German), which became benzine in English and later in 1872 benzene, to show its relationship to unsaturated hydrocarbons. Petrol is called

Benzin in Germany. Faraday's name bicarburet of hydrogen didn't stick; he thought the formula was C_2H because he used 6 as the atomic mass of carbon not 12. Benzole, a mixture of aromatics, was made by distilling coal and was used as petrol and Benzole was a famous brand petrol name.

Its ring structure was famously proposed by August Kekulé, supposedly after a dream of snakes biting their tails. The early chemists could not confirm this hypothesis until Kathleen Lonsdale used the new technique of X-ray crystallography in 1929 to demonstrate conclusively that the benzene structure was a flat ring, in its compound C_6Cl_6.

The benzyl radical is $C_6H_5CH_2$-, not C_6H_5- as might be expected, which is known as phenyl. Thus phenol is C_6H_5OH. Phenyl comes from French *phényle*, derived from the root of *phaínō*, "to shine", from benzene's discovery in illuminating gas. Phenyl chloride, C_6H_5Cl, is named systematically as chlorobenzene. The benzyl radical is derived from toluene, by losing H from the methyl group; as is the tolyl group which is toluene with a substituent at the ortho, meta or para positions. The benzoyl radical is C_6H_5CO- derived from benzoic acid. These names are confusing for beginners, and it is really because benzene was misnamed originally.

On the 2nd July 2025 the Royal Institution of London, where Faraday made his discovery, had an evening discourse on 'Celebrating 200 years of benzene – from whale oil to aromaticity' given by Judy Wu. The centenary was also commemorated in 1925 at the Royal Institution (Wilson, 2013). To mark 200 years of the RI Discourses, started by Faraday, the RI has made Kathleen Lonsdale's 1970 Discourse available online.

References

Faraday, M. (1825). "On new compounds of carbon and hydrogen, and on certain other products obtained during the decomposition of oil by heat". *Philosophical Transactions of the Royal Society*. 115: 440–466. doi:10.1098/rstl.1825.0022. JSTOR 107752.

Wilson, J. (2012). Celebrating Michael Faraday's Discovery of Benzene. *Ambix*, *59*(3), 241–265. https://doi.org/10.1179/174582312X13457672281821

Resources

Video on the history of benzene: The fascinating 200-year history of benzene, https://youtu.be/NmzMoE3LQHM

RI Discourse by Kathleen Discourse, 1970 https://youtu.be/tzlA1aSNlWg

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Amazing Minerals: #5 Bauxite

Can anything good come out of the poor, red tropical soils of Africa? Through the miracle of chemical transformation, those red soils can be turned into gleaming aluminium metal. A major constituent of such soils is bauxite, a produce of heavily weathered soils.

Bauxite is a mixed mineral of aluminium oxide and iron oxide, which is the main source of aluminium. It is a weathered rock, where soluble minerals have been leached out over millennia, leaving behind the insoluble aluminium and iron (II) oxides. Bauxites are red due to the iron content. Generically bauxite is a laterite and is very common in tropic countries, where weathering is common. This is why African soils are red.

The main aluminium minerals in bauxite are: gibbsite ($Al(OH)_3$), boehmite ($AlO(OH)$), and diaspore ($AlO(OH)$).

Figure 1: A typical bauxite ore, the source of aluminium metal

Bauxite is the main source of aluminum. It is a mixture of various minerals of iron and aluminum. The aluminum content generally varies between 30% and 60%. Iron is found between 5% and 30%. These ratios determine the quality of bauxite. Bauxites also vary in colour depending on the iron content. In 1821, the French geologist Pierre Berthier discovered bauxite near the village of Les Baux in Provence, southern France, hence its name. Bauxite is also the major source of gallium, an important element for the electronics industry.

Top 5 Bauxite Producers in 2023 (Top Bauxite Producing Countries: Global Mining Leaders)

- **Australia:** Produced 98 million metric tons in 2023, holding reserves totalling approximately 3.5 billion metric tons.
- **Guinea:** Produced about 97 million metric tons, boasting the largest reserves globally at approximately 7.4 billion metric tons.
- **China:** Generated around 93 million metric tons in the same year, despite significantly lower reserves of 710 million metric tons.
- **Brazil:** Produced 31 million metric tons, supported by large reserves of around 2.7 billion metric tons dispersed mostly in Brazil's Amazon region.
- **India:** With production at 23 million metric tons and reserves of about 650 million metric tons, India remains vital as a regional hub for bauxite.

Ireland and the bauxite story

Ireland is by no stretch of the imagination a tropical country. But small deposits of bauxite exist in N. Ireland, and it was mined commercially during WW2. The deposits are not large enough or rich enough to make them worth mining now, when there are large resources in West Africa.

a. Clinty Chemicals, N. Ireland

Figure 2: Clinty Quarry, near Ballymena, Co.Antrim: bauxite workings.
Clinty Quarry - Mineralogy

Clinty Quarry, located 4 km north of Ballymena town centre, is a working basalt quarry operated by Robert Stevenson and Brothers Ltd. Also on the site is an industrial plant owned by Clinty Chemicals that produces ferrous aluminium sulphate solution (FAS) using lateritic bauxite from the quarry. Clinty Chemicals Ltd. market FAS as a flocculating agent and water purifier. When added to water it forms a floc, which carries down suspended organic matter, and when it settles can be filtered off. It is an important step in purifying drinking water.

From 1894 to 1940 there was an alumina refinery using local bauxite at Larne in N. Ireland. You can read the story here: *Larne: from Genesis to Dismantling of an Early Alumina Industry (1894-present day)* Dr Thierry Renaux.
Larne: from Genesis to Dismantling of an Early Alumina Industry (1894-present day) – HSTM Network Ireland

Figure 3: Handling of alumina bags in the kiln hall at Larne (undated) © BACo Photo Collection, Larne Museum and Arts Centre

b. Aughinish Alumina (AAL) /Rusal

Since 1983 AAL/Rusal has been an important chemical industry in Ireland, processing imported bauxite into pure alumina, Al_2O_3, which is shipped to aluminium smelters abroad for conversion into aluminium. Figure shows a flow diagram for the process.

You can read a history of the plant at The Largest Industrial Investment in Ireland’s History: The Aughinish Alumina Refinery in a Globalised Aluminium Economy – HSTM Network Ireland

The Bayer process

The Bayer Process uses the amphoteric character of aluminium oxide/hydroxide to separate aluminium from iron and other impurities. The aluminium compounds dissolve in hot concentrated sodium hydroxide solution, leaving insoluble materials, including iron oxides, behind. They can be filtered off and then the aluminium hydroxide precipitated out, heated to drive off water, leaving pure alumina (aluminium oxide), the raw material for aluminium production. Figure ** shows a simple flow diagram of the process. The sodium aluminate solution is recycled to maximise alumina yield and this also concentrates impurities like gallium and vanadium, which can be valuable by-products.

$$\mathbf{Al(OH)_3 + NaOH \rightarrow NaAlO_2 + 2\ H_2O}$$

On seeding and precipitation, this reaction is reversed.

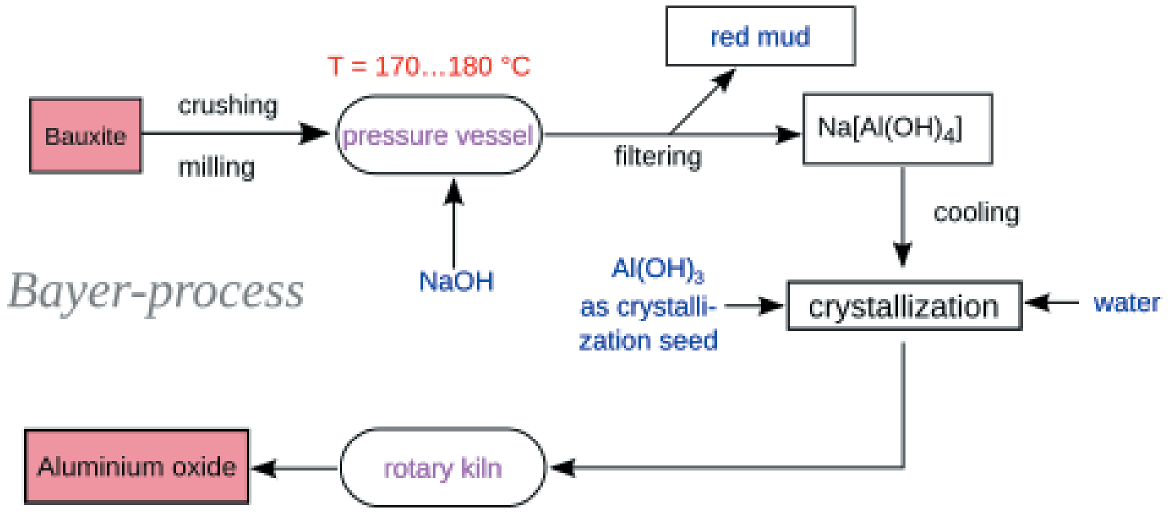

Figure 4: The Bayer Process for refining bauxite to alumina
[Bayer process - Wikipedia]

It takes from 4-6 t of bauxite (depending on its composition) to produce ~2 t of alumina, which in turn when smelted gives 1 t aluminium metal. AAL uses ~2 million t of alumina a year, which needs 2-3 x this amount of bauxite. The solid waste, known as red mud, is disposed of in tailings ponds.

The importance of bauxite

Bauxite is the source of primary aluminium and aluminium is one of the most important metals, second only to iron. Around 72 Mt of aluminium is produced each year and it would be hard to imagine modern life without it – from aluminium foil and drink cans, to aircraft fuselages and train bodies. Its production is highly energy intensive as it is extracted using high temperature electrolysis, and so secondary (recycled) aluminium is important as it requires much less energy to produce than primary aluminium.

It's hard to imagine the modern world without aluminium and bauxite is now an essential mineral.

Chemists you should know: #15

Robert Boyle and the beginning of modern gemmology

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We are, in this age, somewhat spoilt with the apparatus readily available for the determination of the composition of gemstones. Up to the 17th century no scientific method was available for the determination of the composition of a gemstone and the various variations in a gem's colour led to the name of the country or area being prefixed to stones of the different shades of colour observed. It may be said that the development of modern-day chemistry in the 19th century was promoted by the demand to know the make-up of the various classes of gemstones.

In this essay we look at the state of information concerning the formation and properties of gemstones at the beginning of modern times viz. the 17th century.

The first book on gemstones in English appeared in 1652 and was written by Thomas Nicols of Cambridge, England. Prior to this, European books on the subject were written in Latin. His book was called *Lapidary* or the History of Precious Stones. He used Anselimius Boétius de Boodt' s method for categorising gemstones. De Boodt (1550-1632) was Flemish and the method is given in his *Gemmerium et lapidium historia* of 1609.

According to Nicols:
Stones or Gemms are either Small or Great.
Small ones are either Rare or Common.
The Rare and excellent ones are either Hard or Soft.
The Small hard ones are either Fair or of an evil colour.
The Fair ones are either Wholly shadowed as the Turkey Stone (Now called Turquoise) or Partly shadowed as the Sardonyx, the Astroites (a red-spotted Jasper) and the Opales.
Again the Fair ones are transparent either with Colour or without Colour.
The Fair ones transparent with colour are the Jacinth, Beryll, Ruby, Prassius, Rubicell, Chrysoprass, Spinell, Granat, Amandine, Chrysolite, Ballasse, Carbuncle, Sapphire, Emerault, Gemma Solis, Almadine.
Fair ones without colour are diamonds.

(The fair stones listed above are as follows in today's world…Zircon, Beryl, Ruby, Prase, Reddish-yellow Ruby, Chrysoprase, Spinel, Garnet, Andradite, Chrysoberyl, Pale red to Violet Ruby, Any rounded red stone, Sapphire, Emerald, Star opal, Almandine.

From the above it is seen that the division of gemstones into categories is based on the colour of the stone. The carbuncle, Nicols maintains, is a ruby or other red stone of weight two Scruples or more. (A scruple being 1.296 gm or about 6.5 carats in today's measurements).

Mention is made of hard and soft stones and a list, from hardest to softest, is given by Nicols as follows: Adamant, Topaz, Oriental Chryssolite, Sapphire, Granate, Jacinth, Smiris, Jasper, Achate, Basaltes and Opalus the softest, with no mention given as how the hardness was determined.

(Nicols' list corresponds to the modern-day stones as follows: Diamond, Topaz, Chrysoberyl, Garnet, Zircon, Emery (an impure form of Corundum), Jasper, Agate, Basalt and Opal. The hardness of these on the Mohs scale (1812) is as follows - 10, 8, 8.5, 6.5 to 7.5, 6.5 to 7.5, 8, 6.5 to 7, 7, 6 and 5.5 to 6.5.)

The photo below shows a selection of "Fair ones without colour" from the author's collection.

The stones are, from L to R: 5.65ct Goshenite Beryl, 0.05ct Spinel, 0.95ct Diamond, 4.6ct Topaz and 2.85ct Sapphire.

Prior to Nicols, a supernatural force was credited for the formation of gemstones and supernatural aspects such as healing and divination were ascribed to the various gemstones. Nicols is perhaps the first to reject a supernatural force for the formation of gemstones, but wonders whether the Sun might be a factor, as most of the gemstones known come from places near to the equator. He also surmised that the gemstones, while still in a molten or soft state, were affected by nearby metals which gave rise to the various colours shown. He does not reject out of hand the healing properties of gemstones but is sceptical of the claims made for their usage as medicines.

In 1669 Nicolas Steno (11/1/1638 – 5/12/1686), a Dane (name latinised from the Danish Niels Steensen), in his book *De solido intra solidum naturaliter content* was the first to note that the angles between corresponding faces of a crystal of calcite is the same for all specimens of the same mineral and his findings were the basis for future crystal determination. However, the notion did not gain universal recognition until the Abbé René Just Haüy (1743 – 1822) produced some one hundred papers establishing the general crystal systems as accepted today. Steno also states that transparent gems have been liquid substances at one time, being imbued with mineral tinctures that con-coagulated with them and the various qualities of the gems are probably derived from this.

This leads us on to Robert Boyle (25/1/1627 – 31/12/1691).

Boyle is a previous subject of this author in *Chemistry in Action*, issue No. 72, Spring 1994, pps. 31 – 35, where his life is detailed.

In 1672 he writes an Essay about "the origine and virtues of gems" from which various quotes are taken in this article.

"I propose .... First, that many of these gems, and medical stones, either were once fluid bodies, as the transparent ones; or in part made up of such substances as were once fluid; and secondly, that many of the real virtues of such stones may be probably deriv'd from the mixture of metalline and other mineral substances, which (though unsuspectedly;) are usually incorporated with them:" p.5

Boyle is aware of Steno's work and agreed with him *"That divers kinds of them (crystals of gemstone) have geometrical and determinate shapes, though it be not vulgarly observ'd, because we are wont to see them when they are cut."* p.9

The degree of hardness of rubies and saphires is oftentimes so equal, that I knew an expert English Jeweller, who for that only reason (for he knew not whence the difference of colours might proceed) took rubies and saphires to be of the same kind of stone. p.34

"sort of pale amethysts, that some call white amethysts; ... and was like that sort of gem so hard, that I could readily cut glass with it.2 p.47

"so diamonds are the hardest, and heaviest of all stones." p.52

Boyle demands that only what one perceives from one's own direct experimentation and observation, or at least from those of a trustworthy person who reports on their own such experimentation or observation, be acceptable as truth. He says, on page 3 of the preface to his "*The Sceptical Chymist*, 1661".. *"yet I must for truth sake, and the reader's, warn him not to be forward to believe chymical experiments when they are set down only by way of prescriptions, and not of relations; that is, unless he that delivers them mentions doing it upon his own particular knowledge, or upon the relative of some credible person, avowing it upon his own experience."*

In his 1672 work Boyle goes on to promote this experimental basis in the following two extracts …

"For not only some of the writers of natural magick, but men of note, who should be more cautious and sober, have delivered in their writings many things concerning Gems, which are so unfit to be credited, and some of them perhaps so impossible to be true, that I hope the believers of them will among the votaries to Philosophy be as great rarities, as Gems themselves are among stones." P.3 "And those that can admit such unlikely fables will be as

much despis'd by the Judicious, as Jewels can be priz.d by the rich." P.3

"I should, at least in some measure, prove a benefactor to what is perhaps preferable even to lucky conjectures themselves, the natural and experimental history of such noble subjects as Gems." (The Preface)

Boyle rejected the widely held notion that diamond is not only the hardest but also the heaviest of the gemstones. (Note heaviness and specific gravity are much taken as being the same.) He goes on to ask that people should use specific gravity in the determination of the identity of a particular gem. He instances an author (unnamed) of a small (untitled) volume in French for holding the view on Diamond as follows.. "*He must excuse me if I declare, that what he asserts agrees not with my experience, who having try'd the weight of an uncut diamond hydrostatically, having taken such a course to estimate the specific gravity, as I find not to have been taken by any other, and which you will easily grant to be more exact than any other of the known ways can be*." (p.52)

Boyle's experience would have shown him that, of the gemstones known at the time, the Ruby, Sapphire, Zircon, Garnets and Spinel, all have a specific gravity greater than Diamond.

Interestingly Boyle suggests that rock crystal, due to its obvious purity and ready availability, could be taken as the standard for comparison of specific gravity. Indeed, such a crystal either in the rough or cut can be used with great advantage to cut out the need to have absolutely pure water in determination of specific gravity even today.

[The mathematics are as follows… S.G. (Gem X) = (Mass (Gem X) / apparent loss of Mass (Gem X) in water) * S.G. of the water used.

S.G. (Rock Crystal) = (Mass (Rock Crystal)/apparent loss of Mass (Rock Crystal) in water) * S.G. of the water used.

Dividing the S.G. (Gem X) by the S.G. (Rock crystal) removes the S.G. of the water used leaving the following …

S.G. (Gem X) / S.G. (Rock crystal) = (Mass (Gem X) / apparent loss of mass of Gem X in water) / (Mass (Rock Crystal) / apparent loss of mass of Rock Crystal in water)

Having previously found the S.G. of the Rock Crystal by detailed experiment or, taking the standard vale of 2.65 for the S.G. of Rock Crystal, the specific gravity of our gem is now found without recourse to knowing the specific gravity of the water (pure or adulterated) used.]

In short:

1. **Find mass of gemstone in air - M1**
2. **Find apparent loss in water - M2**
3. **Find mass of a quartz stone in air - M3**
4. **Find apparent loss of mass of the stone in water -M4**
5. **The specific gravity is given by ((M1/M2)/(M3/M4))* 2.65**

29.55ct Test Quartz stone used by author.

In the second half of his essay Boyle deals with the possibility of gems having curative powers, of which, while sceptical, he does allow that perhaps minuscule particles of such stones may, by ingestion directly into the body or by infusion in water, alcohol etc. release some of the metallic particles within the stone, which on drinking the infusion may be of benefit in treating an illness. This same effect he allows may also be had by wearing the gemstone next to the skin.

"For my part, I never saw any great feats perform'd by those hard and costly stones, (as diamonds, rubies, sapphires,) that are wont to be worn in rings. …… I find no impossibility that at least some costly and less hard, (though indeed more valuable) Gems, may have considerable operations upon humane bodies, some few of which I have had opportunity to be convince'd of I will not indiscriminately reject all the medicinal virtues, that tradition and the writers about precious stones have ascribed to those noble minerals: contenting my self to declare in a word, that suspecting most of them to be fabulous, my conjectures aim only at giving one of the causes of those virtues ascrib'd to Gems which experience warrants to be real and true." p.4,5.

He accepts that a Regulus (bullet pill) of antimony (p.109) taken orally passes through the gut to be washed and reused as an emetic and vermifuge without observable change of weight. (A regulus of antimony is a partially purified form of the element containing between 0.4% to 1% of impurities, mainly arsenic but also sulphur, zinc and iron.)

He also notes that water boiled with mercury will kill worms in the body again with no apparent loss of weight.

Boyle's emphasis on the use of experimental data instead of word of mouth and tradition so influenced the later generations of scientists that he has been been honoured as the Father of Chemistry today.

□

The sulfur story: devil's gold or essential element?

6. Sulfur dioxide and sulfites

When sulfur is burned in air, sulfur dioxide (SO_2) is produced, with a characteristic smell. It is a reducing agent and dissolves in water to give sulphurous (sulfuric (IV)) acid, H_2SO_3. This is a weak acid (unlike sulfuric acid) and produces a series of sulfite salts. Sulfur dioxide was a major contributor to acid rain, due to the burning of sulfur-containing fossil fuels or metal smelting. In the atmosphere, sulfur dioxide dissolved in water and was oxidised to sulfuric acid, a strong acid. Acid rain was a major problem in the 1980s.

Campden tablets

Figure 1: Campden tablets

If you make wine, you'll be familiar with Campden tablets, tablets of sodium metabisulfite, $Na_2S_2O_5$. These are used as a disinfectant and small amounts of sulfites are added to wine to prevent oxidation and spoilage. Some people are allergic to sulfites and so their presence is listed on wine bottles.

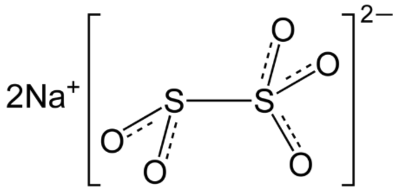
The name Campden tablet comes from the town of Chipping Campden in Gloucestershire, England, where the original solution was developed in the 1920s by the Fruit and Vegetable Preserving Research Station, now Campden BRI. The idea was then taken up by the Boots Co., which developed the tablet. [Campden tablet - Wikipedia]

Sodium metabisulfite is made by bubbling SO_2 gas into sodium hydroxide solution, which forms sodium sulfite. Adding more SO_2 produces $Na_2S_2O_5$.

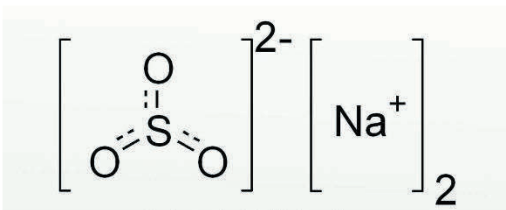
$$\mathbf{SO_2 + 2NaOH \rightarrow Na_2SO_3 + H_2O}$$

$$\mathbf{SO_2 + Na_2SO_3 \rightarrow Na_2S_2O_5}$$

It illustrates the tendency of sulfur to form oxoacids with S-O bonds and S-S bonds. Sodium metabisulfite is also familiar to home photographers as a reducing agent used in developing film (known as hypo), which gives a distinctive smell to the darkroom.



Sodium metabisulfite



Sodium sulfite

Figure 2: Structures of sodium metabisulfite and sodium sulfite

Papermaking

[Sulfite process - Wikipedia]

The sulfite process was one of the major papermaking processes. The sulfite process produces wood pulp that is almost pure cellulose fibres by treating wood chips with solutions of sulfite and bisulfite ions. These chemicals cleave the bonds between the cellulose and lignin components of the lignocellulose. The lignin forms soluble lignosulfonates, which are soluble and can be removed by filtration. The Kraft process, which produces stronger fibres, has largely taken over from the sulfite process.

Acid rain/acid precipitation

Sulfur and nitrogen oxides from volcanoes, metal smelting and burning fossil fuels produce acids in the atmosphere which are precipitated as rain and snow, lowering the pH of lakes and rivers and damaging crops, corroding metals and eroding stonework. Strict emission standards have recduced the amount of sulfur dioxide being produced (see Figure below) so that acid rain is no longer a significant problem in Europe and America, but is still a problem in developing countries with laxer environmental standards.

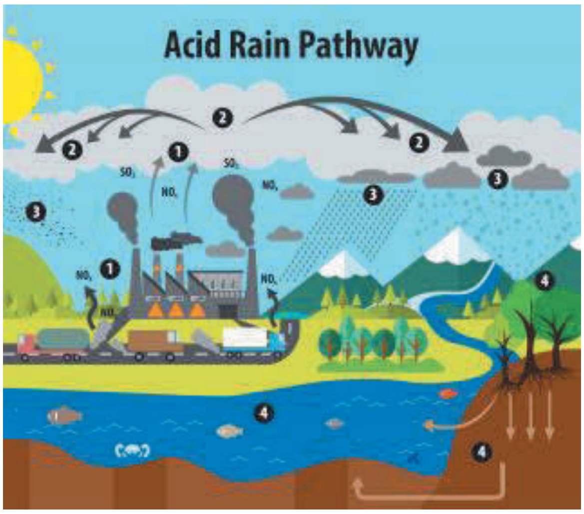


Figure 3: This image illustrates the pathway for acid rain in our environment: (1) Emissions of SO2 and NOx are released into the air, where (2) the pollutants are transformed into acid particles that may be transported long distances. (3) These acid particles then fall to the earth as wet and dry deposition (dust, rain, snow, etc.) and (4) may cause harmful effects on soil, forests, streams, and lakes.

[What is Acid Rain? | US EPA]

The global reduction in SO2 emissions is one of the environmental success stories of the late 20th century (Figure 4).

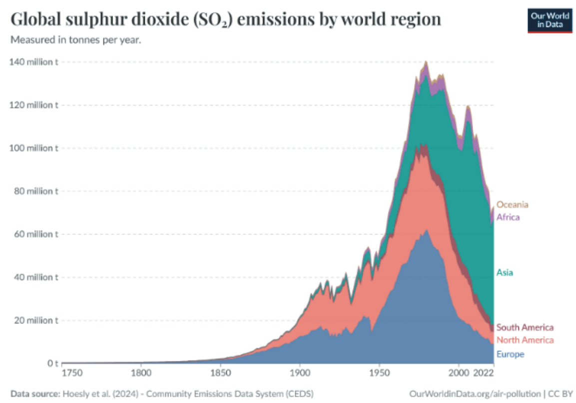


Figure 4: Global SO_2 emissions 1750 to 2022

Preservatives

Sulfites and sulfur dioxide are widely used as food preservatives as at low levels they kill bacteria. They also react with oxygen and prevent oxidation and discolouration of foods. They are used in wine, dried fruits and some canned goods. About 1 person in a 100 is allergic to sulfites and they must avoid them. The table below shows some concentrations of sulfites in foodstuffs. When exposed to the air these levels will tend to fall. Organic wine doesn't contain sulfites. Their preesence must be declared on the label.

□

Quirky Elemental Facts in Rhyme

Peter Davern Peter.davern@ul.ie

Gold, Au

Untouched by time, soft lustrous gold retains its rich allure,
This Coinage King's enthralling bling your status will ensure.
Just twenty meters "cubed" all in . . .
. . . to bend 'n' stretch and spread so thin;
In catalysts and dental crowns and contacts that endure.

Untouched by time, soft lustrous gold retains its rich allure, This Coinage King's enthralling bling your status will ensure.

From ancient times to the present, arguably no other element has held humanity more in its thrall than the soft, lustrous, richly alluring, and bright-yellow metal, gold. Much of gold's captivating appeal (whether in nuggets, ingots, bars, coins, ornaments, artifacts, or jewellery items) lies in the permanence of its warm, untarnished appearance, which shines through undiminished, regardless of its age. This unchanging quality is due to gold's inertness in the presence of air, water, alkalis, and most acids, and accounts for the pristine condition (some 3,000 years after it was fashioned) of King Tutankhamun's golden death mask and other such archaeological treasures.

As the undisputed king of the coinage metals, gold sits deep in group 11 on the periodic table. From there it keeps a watchful eye on the lesser coinage denominations, silver and copper, located directly above it. For all the reasons mentioned, gold provides a high status to all those who possess it, whether they squirrel it away as bullion in bank vaults or wear it ostentatiously in the very best of jewellery.

Just twenty meters "cubed" all in . . . . . . to bend 'n' stretch and spread so thin;

Gold is quite a rare metal (it's only the 73rd most abundant element in Earth's crust.), a fact that enhances its value and universal appeal. Some have estimated that all the gold ever mined would fit inside a cube only 20 m on edge.

Of all the elements, gold is the most ductile (capable of being stretched into a fine wire) and the most malleable (capable of being manipulated and flattened into a thin sheet). A single gram of gold can be beaten to an ultra-thin sheet of gold leaf with dimensions 1 m × 1 m.

In catalysts and dental crowns and contacts that endure.

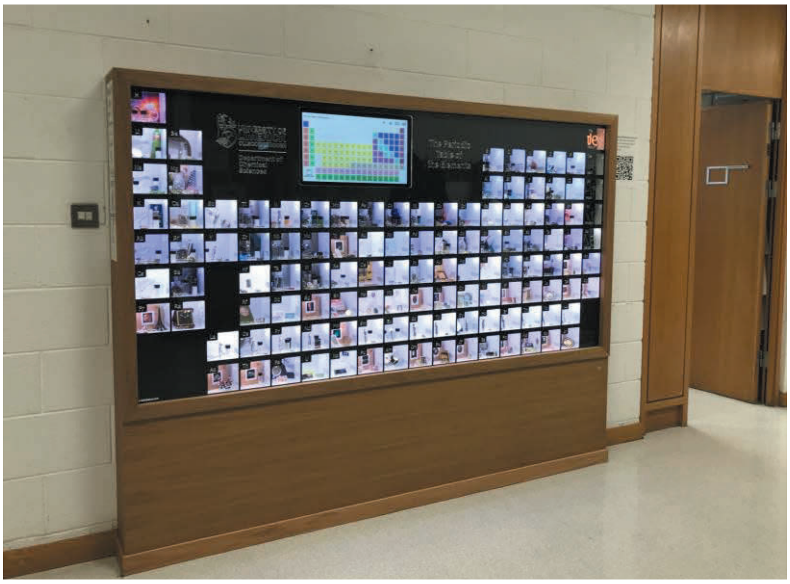
Gold has more recently been utilized as an industrial catalyst. For example, gold is used in the oxidation of toxic carbon monoxide (CO) to less harmful carbon dioxide (CO_2) and in the synthesis of vinyl acetate—a key raw material in the production of polyvinyl acetate (PVA) glues, resins, and paints.

Each year, around 60 metric tons of the approximately 2,300 metric tons of gold produced globally end up in people's mouths as dental crowns, fillings, and gold teeth!

Gold has excellent electrical conductivity and corrosion resistance. It's applied in the electronics industry as an enduring, conductive, microfine, protective coating on electrical contacts, connectors, and printed circuit boards.

Are you interested in the chemical elements and their uses? Might you be passing through Limerick at any stage?

If so, then email peter.davern@ul.ie to arrange a <u>free</u> 'guided tour' for you and/or your students of the large-scale, interactive periodic table display in the Chemical Sciences Department at the University of Limerick.



Diary

2026

ASE Annual Conference, University of Nottingham, January 8-10, 2026
ASE Annual Conference 2026 Programme Highlights | www.ase.org.uk

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8th ICASE World STE Conference, UCC, Cork, June 22-25, 2026
www.icaseonline.net/icase2026

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10th EuChemS Chemistry Congress (ECC10), Antwerp, July 12-16, 2026
10th EuChemS Chemistry Congress (ECC10) - IUPAC | International Union of Pure and Applied Chemistry

*****

28th ICCE & 17th ECRICE, Erzurum, Türkiye, July 13-17, 2026

Chemical Education in the Age of Artificial Intelligence
www.iccecrice2026.org/

*****

2026 BCCE, University of Wisconsin-Madison, USA, July 26-30, 2026

*****

13ISMC26 The 13th International Symposium on Microscale Chemistry July 8-10 2026

*****

45th ChemEd-Ireland, UL, Limerick, October 24th 2026
Sarah.hayes@ul.ie and Geraldine.mooney.simmie@ul.ie

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Critical minerals
Amazing minerals: Limestone
Proceedings ChemEd-Ireland 2025
The sulfur story: Sodium thiosulfate

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