

# Crystal Vision

Dorothy Hodgkin & the Nobel Prize



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*“Few were her equal in generosity of spirit, breadth of mind, cultivated humaneness, or gift for giving. She should be remembered not only for a lifetime’s succession of brilliantly achieved structures. While those who knew her, experienced her quiet and modest and extremely powerful influence, learned from her more than the positioning of atoms in the three-dimensional molecule, she will be remembered not only with respect, and reverence, and gratitude, but more than anything else, with love. Let that be her lasting memorial.”*

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Anne Sayre, in the Autumn 1995 Newsletter of the American Crystallographic Association

# Letter from the Principal

Dr Alice Prochaska, Somerville College

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Many remarkable woman scientists have passed through Somerville, but few rival Dorothy Hodgkin, whose path-breaking work in crystallography showed a mind not only attuned to high science but one also able to envision a crystal structure from the pattern made by its X-ray diffraction. Her ability to 'see' molecules such as cholesterol, penicillin, vitamin B and insulin transformed her field.

2014 sees the fiftieth anniversary of Professor Hodgkin's Nobel prize. It is also the International Year of Crystallography, marking the 100th anniversary of Max von Laue's Nobel Prize for Physics, awarded for his discovery that X-rays could be diffracted by crystals. That discovery underpinned Dorothy Hodgkin's work. We are proud that Somerville supported her at a time when there was widespread opposition to married women pursuing academic careers. In turn she herself actively supported women academics, giving funds from her Nobel Prize to the establishment of Somerville's nursery.

Sir William Bragg, (also a Nobel prize winner and one of Hodgkin's great influences) once said: "The important thing in science is not so much to obtain new facts as to discover new ways of thinking about them." Developing new ways of thinking is a Somerville tradition, and Dorothy Hodgkin always encouraged vision and originality in her students. To commemorate her work as both scientist and tutor, we plan a fundraising project later this year to support continued work in her field. Meanwhile, I hope the vignettes presented here will deepen many people's interest in a remarkable scientist and Somervillian, one whose legacy time has not effaced.

# Dorothy Hodgkin

## The Scientist

Dr Margaret Adams, Dorothy Hodgkin and E.P. Abraham  
Cephalosporin Fellow and Tutor in Chemistry, Somerville College

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The Nobel Prize in Chemistry 1964 was awarded to Dorothy Crowfoot Hodgkin “for her determinations by X-ray techniques of the structures of important biochemical substances”. The award was made exactly 50 years after the prize for physics was given to Max von Laue for “his discovery of the diffraction of X-rays by crystals”. Dorothy’s prize represented the way the method had come of age over that 50 years and was given for a series of results of extreme importance, always at (or many believed just beyond) the upper limit of solubility.

Her research from the outset was inspired by a question she asked herself as an undergraduate. Fascinated by the ingenuity of chemists who were determining molecular structure by considering the results of chemical reactions, she wondered... “Would it not be better if one could really ‘see’ whether molecules as complicated as the sterols, or strychnine were just as experiment suggested?”

X-ray diffraction patterns from crystals could be predicted if the position of the atoms were known. “Seeing” molecules using x-ray diffraction depended on being able to do the inverse experiment. This inversion is not trivial and solving crystal structures requires insight and significant calculation to provide the information missing from the diffraction pattern. While in the 21st century computing power is great enough for direct structure determinations to be done of very



Vitamin B<sub>12</sub> crystals © Sidney Moulds/Science Photo Library

large molecules, 60 years ago, many calculations had to be done by hand, and even 50 years ago a calculation on a molecule the size of vitamin B<sub>12</sub> would take several hours on the only Oxford computer (which probably had less power and memory than a smart phone).

Ingenuity, care and accuracy, a series of parallel methods and experiments, collaborators and funding were all required. The elegance and persistence shown in the experiments which elucidated the structure of penicillin and of vitamin B<sub>12</sub>, both with trans-Atlantic collaboration and the first achieved during the Second World War, are apparent in Dorothy's Nobel Prize lecture. Both structures showed fascinating chemical features: penicillin's 4-membered  $\beta$ -lactam ring and the corrin

ring of vitamin B<sub>12</sub> in which one of the coordination sites for the cobalt has a 5-membered ring while the other three are 6-membered. While her co-workers were gifted and hard-working, Dorothy's amazing ability to visualise in three dimensions was a key factor in these important results.

Insulin was, perhaps, one of Dorothy's first loves; the 1935 paper describing an X-ray pattern for insulin crystals came at a point when there was not yet certainty that a protein even had a single chemical formula. The final solution of the structure came some five years later than the Nobel Prize and led to a range of further important discoveries about the nature of this protein hormone.

Dorothy was not only an outstanding scientist, but a teacher who led by example as much as by lecturing to her students. Three of Somerville's Honorary Fellows are her former students, or research students, and went on to distinguished careers in crystallography. Many others of us continued to work in the area inspired by the example. I recall, as a student, being asked by the then College Principal if I was going to be a 'real' Somerville chemist and to work with Dorothy, such was the importance of her work.



# Watching her heirs

Dame Kay Davies, Dr Lee's Professor of Anatomy, Oxford;  
alumna and Honorary Fellow of Somerville College

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I remember giving my first research lecture in the small lecture room on the ground floor of the Biochemistry Tower in South Parks Road. I was communicating our first results on the development of diagnosis of the muscle wasting disease, Duchenne muscular dystrophy. I was therefore very surprised when Dorothy Hodgkin arrived in her wheelchair at the back of the lecture theatre.

She had a broad interest in science and was keen to support young scientists, particularly Somervillians. Indeed, this was very typical of Dorothy Hodgkin throughout her life. She was not only passionate about her own science but also cared about her students and their careers. In fact, her students were like an extended family. She often invited them back to her house for a meal and maintained contact with many of them long after they had left. Margaret Thatcher was one of her Chemistry Part II students and she stayed in touch with Dorothy throughout her career, even travelling to Oxford when she was Prime Minister to talk about science and education. Indeed, Lady Thatcher hung a portrait of her former tutor on the wall of Number 10, Downing Street.

Hodgkin's role also extended to international relationships as she assisted many female students from abroad in settling down to life in Oxford, particularly students from India, China and Brazil. Dorothy Hodgkin was the perfect inspiration and role model and she leaves a legacy of numerous highly successful females.

# Nobel prize for



PROFESSOR HODGKIN

# British wife

By JAMES LEWTHWAITE

**A** CABLE was sent yesterday to tell Professor Dorothy Crowfoot Hodgkin, Oxford scientist and mother of three, that she has been awarded the 1964 Nobel prize for chemistry. It is worth more than £18,750.



## Nobel prize for a wife from Oxford

**A HOUSEWIFE** and mother of three yesterday won the Nobel prize for chemistry. The award is worth £18,750.

Professor Dorothy Crowfoot Hodgkin, 46, of the first high school in Oxford, was a housewife and only the sixth woman in the world to do so.

A scientist who has worked with her since 1952.

"Everyone in science will be absolutely delighted. She is a very gentle character — but all at all a hard worker."

"It is a great honour to receive the prize and I am proud to be a British citizen."

By Science Reporter  
**ARTHUR SMITH**

### Study

She has worked with the British physicist Sir John Cockcroft and a team of American scientists at the Cavendish Laboratory, Cambridge, since 1952. She has also worked with the American physicist Dr. Linus Pauling at the California Institute of Technology, Pasadena, since 1955. She has also worked with the American physicist Dr. Robert R. Wilson at the Brookhaven National Laboratory, Upton, New York, since 1957.





# Seeing through Dorothy's eyes

Kate Hodgkin, Dorothy's granddaughter

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As a small child it was clear to me that Dorothy's mind was always occupied. When I left university with a history degree, and with no idea what to do next, she stepped in, offering me a small income to sort out the room full of papers in the white house that was then the Chemical Crystallography Department in Parks Road. I was a young woman with a path to choose in the world; this was something that spoke to her and she wanted to help, which also meant a bit of gentle steering towards serious pursuits. So I spent nine months living in Oxford, cycling to her lab, sitting on the floor of her office and sorting through a lifetime of papers.

I understood almost nothing of the scientific side of what I read, though some of the phrases, like "tobacco mosaic virus", had an odd charm and, of course, the papers concerned with her life as a peace activist were more familiar to me. But I came to recognise the names and handwriting styles of those she worked with most closely and to see these names through her eyes, in some way: the early Somerville friends who remained important to her, the formidable earlier generations of crystallographers, her many partners in science and in peace campaigns. She would come in from time to time to sit at her desk leafing through my pile of queries and murmuring in gentle pleasure as some happy memory presented itself in the form of a long-ago letter.

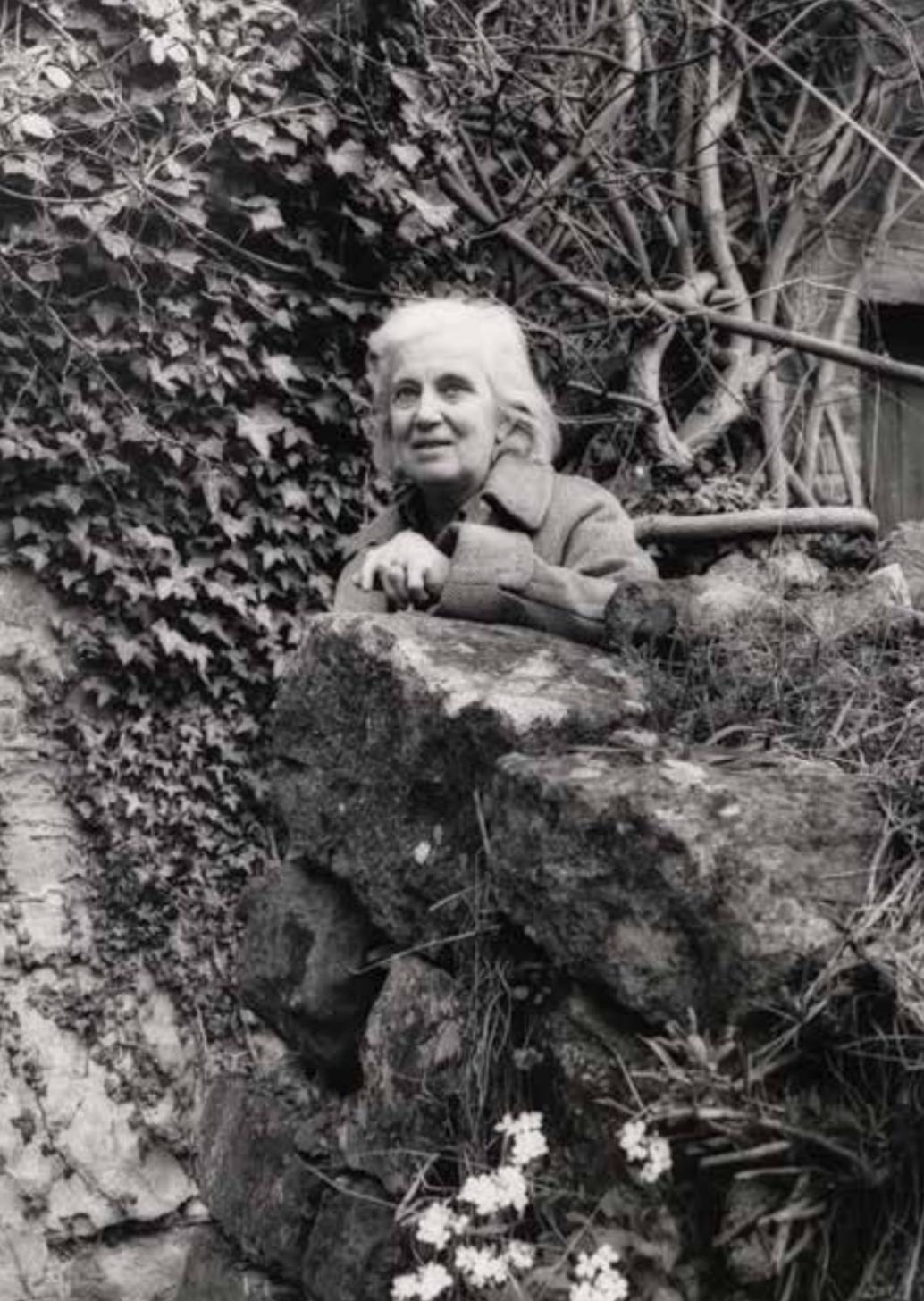
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*“To live simply, and do serious things...”*

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And I would see, in the warm and enthusiastic messages from around the globe, the network of close friendships and alliances that sustained her work; how she was helped by many, how many she helped, how much affection and mutual admiration went to the making up of her circle, both in her scientific and her campaigning work. I saw this more immediately in her later, frailer years, when I would occasionally escort her on international trips. Her pleasure in communication, in ideas and in shared memory remained strong, as she and her friends grew old and slowed down.

During those quiet months with her papers I imagined how good it would be to live like that, working collaboratively across the world, wholly focused on one's life's work. Choosing, in Dorothy's words, to live simply, and do serious things.



# Excerpt from Dorothy Hodgkin's Nobel banquet speech

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*Hodgkin was engaged internationally in promoting both social equality and pacifism. This led to her presidency of the 'Pugwash Conferences on Science and World Affairs', an international association of scientists and public figures committed to reducing the risk of armed conflict. It was the offspring of a joint declaration signed by Bertrand Russell and Albert Einstein in 1955.*

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We knew, when we came here as Laureates from our different countries, that we should greatly enjoy meeting one another and talking together about scientific problems in our international language. I do not think that any of us had realized how much more this festival might mean both to you in Sweden and to the whole world. I was chosen to reply to you this evening as the one woman of our group, a position which I hope very much will not be so very uncommon in future that it will call for any comment or distinctions of this kind, as more and more women carry out research in the same way as men. But I might have been chosen for you for other reasons to reply to your speech, as a country woman of Tom Paine who wrote an early book of the rights of man, from whom the declaration of human rights which you mentioned today derives.

*Stockholm, 10 December, 1964*





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