

Preface

The book you are holding contains the original reports of some of the most explosive science of the twentieth century. Some explosions came literally, as a by-product of the discovery of nuclear fission. Others came in the thunderous debate that followed the announcement of the successful cloning of an adult sheep. But most of the chain reactions set off by the twenty-one discoveries presented here took the form of waves of revelation spreading through a community of scientists, providing impetus to further scientific or technological progress.

Textbooks present much of our understanding of the world as if it has always been known: the nuclei of atoms contain protons and neutrons; the structure of DNA is a double helix. But there was a time—not so long ago—when these basic facts were at the sharp edge of scientific discovery. What did it feel like to make such a discovery, or to read about it for the first time? As editors at the weekly science journal *Nature*, we have been among the first to know of world-changing discoveries (not that their impact was always immediately apparent). With this book, we hope to share that experience.

Here, a disclaimer is in order. This is not a collection of papers announcing the twenty-one most important scientific discoveries of the twentieth century—although, arguably, all of them would place in the top fifty. (Readers wishing to decide for themselves can find a wider selection in the chronology beginning on page xv.) For one thing, we restricted our choice to papers published in *Nature*. The reason is simply pragmatic. As editors at *Nature*, we are surrounded by our own journal's history—easily accessible in bound volumes that contain the weekly contents of

decade upon decade of scientific endeavor, all neatly packaged for publication. That history goes back to 4 November 1869, when the first issue appeared. But it was not until well into the following century that *Nature* really began to hit its stride as a vehicle for original research reports. Hence the choice of articles from the twentieth century: the first published in 1925, and the last in 1997. In all, twenty-two papers are included, because two announced a simultaneous finding.

So are these the most important papers published in *Nature* during the twentieth century? We would not make that claim either. A good case could be made for inclusion of the paper that cracked the nature of the genetic code, by which the letters of the DNA sequence are translated, by threes, into the building blocks of proteins. (A first draft of the complete human genome sequence escapes on a technicality, having been published in the twenty-first century.) Perhaps the invention of holography, or of monoclonal antibodies, both of which won Nobel prizes for their authors, should have been included. For editors of anthologies such as this, second-guessing comes with the territory. We hope readers will have fun picking holes in our choices.

Fortunately, however, we did not set ourselves the task of choosing *Nature's* "greatest" papers. What we do claim is that these are all papers that transformed their subject—even, in some cases, the world. Some did this by reporting the discovery of unexpected phenomena: the first pulsar, for example, or the "hole" in the ozone layer over Antarctica. Others, such as the explanation of magnetic stripes on the sea floor, provided a theoretical framework in which previously mysterious observations could be interpreted. Some gave the world a useful new technology, such as the laser. And still others reported the implementation of ingenious techniques that drove innovative science: DNA sequencing, and the "patch clamp" for recording electrical signals from individual cells.

Our selection method was thorough, but not exhaustive. One starting point was a list of "classic" papers started many years ago by *Nature's* editors, and extended as new candidates have cropped up in reference lists or award citations. Classic papers do keep coming to light, even from long ago. For example, it was only in 1998 that we rediscovered a flurry of seminal *Nature* papers on superfluidity that had been published sixty years previously, thanks to a commentary in *Nature* that recalled some of them.

We also picked the brains of our colleagues and advisers, in part to help improve the balance among different disciplines. In many cases the Nobel committee had done our work for us: twelve of the discoveries

presented here propelled their authors to Stockholm. But the Nobel Prize isn't the final arbiter of significance—not least because there is no Nobel for paleontology, geology, or observational astronomy, fields in which five of the remaining nine papers lie. Nevertheless, we are conscious of remaining gaps in the subject spread, for example in evolutionary biology, ecology, and mainstream chemistry.

A collection of papers on its own would be a poor thing—hence the specially commissioned explanatory essays that accompany each paper. We asked the authors of these essays, distinguished scientists and commentators in their own right, to place the discoveries in context by describing the state of knowledge at the time the paper was published, the immediate effect of the report of the discovery, and the abundance of science or technology that ensued. Each of the essayists has a close intellectual connection to the work in question, and many have a personal one as well. Remarkably, the eyewitness accounts extend even to some of the discoveries from the 1920s and '30s, reminding us of how far our understanding has come in the course of a lifetime.

The Nobel Prize-winning biologist Sir Peter Medawar once famously asked if the scientific paper is a fraud, as the conventional format for such papers, logically proceeding from facts to explanation, “misrepresents the processes of thought that accompanied or gave rise to the work.” In the same way, textbook accounts of the progress of science are too often forced to leave out the messy details of the human side of discovery. In asking our authors to cast their commentaries as narratives, our hope was that they would give a flavor of what it feels like to experience the thrill (or, often, endure the frustration) of pioneering science. And in asking them to write for the general reader, the intention was that in each case the significance of the work would be clear for such an audience, complementing the technicality of the original papers.

With the advances of the twentieth century, dilemmas over the practice of science itself and its applications have of course arisen. Exploring such issues is not the purpose of this book. Instead, we hope that this collection will illuminate how the best science is done and reported, and how its influence spreads, both immediately and in the longer term. You will see examples of the role of serendipity, and the importance of the prepared mind; the rewards that come from following up unexpected observations instead of ignoring them; and the benefits to be had from searching for needles in haystacks. You will see that no discovery, no matter how startlingly original, stands alone: each of the papers included here derives from previous work, and in turn provides support for what

follows. In that sense, they constitute bricks in an edifice. The edifice is subject to modification or even destruction in the light of later knowledge, but we suspect that these twenty-one bricks from the twentieth century will continue to provide durable components of science through the twenty-first century and beyond.

If further evidence is needed that science is a collective enterprise, one need only consider the supreme importance of the scientific paper in the lives of scientists: in a very real sense, a discovery does not exist until it has been published, and validated by one's peers. Electronic publication, which looks set to become the norm, is a change of medium from the printed format in which these papers first appeared. But it is unlikely to change that essential message.

Creating a book is also a collective enterprise. This book would not have happened without the vision and commitment of our colleague Richard Nathan at Macmillan and Christie Henry of the University of Chicago Press. Particular appreciation is also due to Radha Clelland for the graphics, Susan Boobis for the index, and A. A. Bene for help when it was most needed. Finally, our thanks in addition to other staff at the University of Chicago Press, especially Michael Koplow and Renate Gokl.