science and wouldn't understand it anyway. They do understand the science stories that do get into the mass media: if this were not so, the science stories would not appear there at all. But this does not mean that science reporting must be sensational. Members of Mechanics' Institutes in the nineteenth century responded with enthusiasm to the journalistic essays of Faraday. Readers of the tabloid press were enthusiastic about science reporting by J.B.S. Haldane in the 1920s. So, there is a strong case for science journalism at this very popular level to be accurate, enlightening and responsible. What constraints stand in the way?

For the mass circulation newspapers the constraints are that the news item must arouse immediate interest, it must be grasped at first reading, and it must have an element of novelty. (How close to the bone was the analogy of Jules de Goncourt!) If papers don't sell they go out of business. Released from these three constraints they would not sell.

For television news, as contrasted with sustained scientific programmes such as *The Ascent of Man* and *Life on Earth*, there are similar constraints. A Select Committee report (on hazardous wastes, for instance) is published on a Tuesday. It is, let us say, 150 pages long. On Tuesday evening it will have to be reported "on the box", with a verdict on its merits or (preferably) its deficiencies, mustered that afternoon over the telephone. In Britain some of the sustained programmes are splendid. This is possible (as June Goodfield explains) because the producer is "totally responsible for the content and impact of the work". He doesn't have someone else in the hierarchy breathing down his neck all the time. In America it is otherwise; there "the long arm of sponsorship" reaches down even to the details of the production. Even public television, where there have been some successes, seems constrained to plug the wonders of science rather than the experience of doing science and the effects science is having on the way people live.

The scientist, too, works under constraints that block his contacts with the public. His peers, higher in the pecking order of distinction, are breathing down his neck: too much (or, just as bad, too successful) popularization, and the whisper "not altogether sound, you know" echoes in the academic groves. News is enlivened by human interest, so the media like a little autobiography to be brought into a science story (hence the success of James Watson's *The Double Helix*). But it is the aim of scientists at work to be self-effacing; they never publish their false starts, their failures, their own reactions to the research they do: all these are filtered out before the paper is sent to the learned journal to be published. The chief constraint is the necessity imposed by the conventions of scientific research — not to reach premature conclusions, not to

advance to a position from which you may one day have to retreat, and never, never, in reporting research, to extrapolate beyond your data to broad speculations. If your research does have social consequences, discussion of these has to be put into different journals addressed to a different readership. This is one of the difficulties science reporters have to contend with.

June Goodfield illustrates the difficulties in the way of bringing journalists and scientists on to the same wavelength by four examples. There was the scramble of reporters to make a sensation out of the affair of Summerlin's painted mouse. In their haste to get a story out, all but one of them got the story wrong. Only one journalist, Gail McBride of the *Journal of the American Medical Association*, took the trouble to understand the whole story, and (of course) by the time she published, four months after the event, it was no longer news. Then there was the worldwide, and at times hysterical, publicity following the Asilomar conference on recombinant DNA. There was an even more hysterical exhibition over Rorvik's false claim about a cloned man, exposing the venality of a publisher who contrived to create a best-seller out of the phoney book. And there was the example of investigative journalism at its best: the sustained campaign to expose the cover-up over thalidomide.

With great skill June Goodfield attempts a summing-up. Both scientist and journalist begin on common ground: it is their business to discover and to publish the truth. Neither profession has an explicit code of ethics, nor a controlling body which (like the General Medical Council) can deprive a practitioner of his right to practise. In science, peer opinion provides a crude, but on the whole effective, mode of control. Shoddy work is not condemned in bitchy articles, such as Leavis wrote about Snow; it simply sinks without trace.

In journalism the implicit code of ethics is weakened by a pervading hypocrisy. It is a scoop to publish a secret government document illegally obtained; it is also a scoop to expose someone outside the profession who has obtained a secret document for his own ends. A contractor who bribes a politician is fair game for publicity, but not a journalist who bribes a witness. June Goodfield wants journalists to tighten their code of ethics but she would like them also to assume some responsibility to act as critics of the ethical implications of science. The need for this arises because scientists do not have a cloud of critics hovering round them, as novelists and dramatists have, and they deliberately dissociate their work from its ethical overtones.

As for the scientists, she wants them to take the trouble to sympathize with the constraints under which journalists have to work, to be less arrogant and more co-

operative, to realize that journalists are an essential channel of communication between themselves and the public on whom they depend for a livelihood. She wants devices for disseminating information in suitable form to the media. She wants the interpretation and communication of science to be taken more seriously as disciplines in universities, so that a student could find training for science-writing.

Her main suggestion is that there should be critics in science who play roles like those played by critics in music, literature and the arts, critics "in the accepted, old-fashioned meaning of the term". This is the one point in June Goodfield's essay with which I disagree; for two reasons. First, the achievements of science are published normally as papers in journals, not as books. (For books there is a mild critical apparatus already, e.g. in the review columns of *Nature* and other science magazines.) Second, the scientific content of research papers is effectively criticized by the use made of the papers by other scientists. Research of high quality is quoted. Research of poor quality is disregarded. So I see no merit in having professional science critics. If all critics were like Walter Lippmann or Edmund Wilson or Donald Tovey, that would be fine. But critics now abound like carrion flies, swarming over the work of people engaged in the desperately difficult professions of literature and art, dismissing, with a patronizing drawl, such as one hears on some radio programmes, creative work they would be quite incapable of doing themselves. God preserve us from critics like that in science. Nor will they be needed while there are scientists about who have June Goodfield's brilliant capacity to work at the interface between science and the humanities. □

Lord Ashby is Chancellor of Queen's University, Belfast, and a Fellow of Clare College, Cambridge.

The measure of man

P.B. Medawar

A History of the Study of Human Growth. By J.M. Tanner. Pp.499. ISBN 0-521-22488-8. (Cambridge University Press: 1981.) £30, \$69.

PROFESSOR Tanner has made important contributions to the practice and methodology of anthropometry; one thinks especially of his studies of secular changes in human growth rates and in landmarks such as age of onset of sexual maturity in the two sexes. He is well known also for his advocacy of the cohort method in the analysis of human growth (the "longitudinal" method as opposed to the more familiar "cross-sectional" method

which has the disadvantage that curves of growth tend always to be confused by curves of distribution).

It is not usual for practitioners of a science to write of its history, but if it comes off, as it does here, the result is a triumph. Tanner could hardly do otherwise than begin with the voluminous and in the main tiresome works by or attributed to Aristotle: instead of calling attention to his more egregious and least easily explicable blunders, such as the belief that human semen is infertile until the age of 21, Tanner makes the best of Aristotle by finding grounds for the neat and convincing inference that "in 350 BC children were maturing at approximately the same rate as now".

Among Tanner's most interesting passages are those that deal with the hebdomadal tradition: the number-magic that found expression in the belief that the body is divided into seven parts and the life of man into seven stages each seven years long.

The mystique attached to the seven-fold system makes reliance on the truth of any actual age impossible however; both at the time and for centuries later there is a tendency for all ages to be rounded to the nearest hebdomadal number.

Tanner is a learned and widely read man, and his book is full of fascinating historical and sociological insights:

... the growth of children of the manual labouring classes in England in the 1830s, and even the 1870s, was still more depressed than that of the poorer groups in some of the underdeveloped countries nowadays ... we should not be too surprised. Indeed children of slaves in the plantations of the southern states of America at this time ... were taller (by some 2 to 5 cm) than contemporary children of manual labourers in England (although nowadays the heights of children of European and of African descent living under similar economic circumstances are almost identical).

Tanner devotes some amusing paragraphs to passages from J.J. Virey ("that would have done credit to Baden Powell") professing to demonstrate the debilitating effects of masturbation. J.J. Virey (1775–1846) was a pharmacist who contributed to the *Dictionnaire des Sciences Médicales*.

Although the book is mainly about human growth, Tanner casts a wider net and manages to make mention of D'Arcy Thompson, who had little to say about human growth. As an admirer of D'Arcy's, I can vouch that Tanner's placing and appraisal of him are exactly right — "a late flower of the Renaissance" who wrote superlative prose.

This is an excellent book which may be read with advantage by all biologists interested in the history of ideas — and should certainly be read by sociologists and social historians as well. □

Sir Peter Medawar is Head of the Transplantation Biology Section at the Medical Research Council's Clinical Research Centre, Harrow, Middlesex.

Education in science, science in education

Nevill Mott

Science in Schools: Which Way Now? By Richard Ingle and Arthur Jennings. Pp.185. ISBN pbk 0-85473-100-8. (University of London Institute of Education/NFER-Nelson: 1981.) £5.30.

THE authors of this book give an account of what has been happening in science education in the UK and of what, in their opinion, ought to happen now. One of them graduated in physical sciences, the other in biology; both had considerable experience of school teaching before moving into the field of teacher training and educational research. The emphasis of their book is on "science for all" and it gives as clear a discussion as any I have seen of the objectives to be achieved by giving all children, up to the age of 16, considerable time for science. What the authors discuss rather little, in that they do not present it as a separate problem, are the needs of that minority who after further education are going to make use of their science, as engineers, technicians, research scientists and doctors.

The rise of general science in the interests of science for all, and its subsequent decline up to the time of the change to comprehensive education, is described here, as it is perhaps more fully in the chapter "The General Science Movement" in E.W. Jenkins's book *From Armstrong to Nuffield* (John Murray, 1979). In the years between the two wars, Ingle and Jennings say that the move towards general science was based on the notion that science should be for everyone, not just for the embryonic professional scientists (which presumably includes engineers, doctors and others), and that it should form an essential part of the general education of all young people. But in practice, they add, general science was found to be "a scrappy mixture of physics, chemistry and biology". Certainly, in the immediate pre- and post-war periods it enjoyed little prestige as a university subject, in comparison with the specialist honours degrees. Moreover in the post-war period, policy-makers, conscious of the role of science in the war and of the perceived need for qualified scientists and engineers (QSEs) in industry, had little use for general science. Two authorities, quoted by Jenkins (p.99) wrote that

An improvement in ... school science teaching is a requirement for the continued existence of this country as a leading scientific and industrial nation. As a first step in this direction general science should be abandoned.

Ingle and Jennings report that in the 1950s, in independent and grammar schools, general science was declining fast and two or three specialist O-levels were the norm. However, in the secondary modern schools, they say, teacher training colleges serving them were sufficiently independent

from universities to help teachers make the science more child-centred and less academic than in grammar schools. Unfortunately these teachers were rarely encouraged to publish their methods, "so that their experience and wisdom died with them".

A second chapter deals with "the curriculum development era", starting in 1960, and particularly the Nuffield Science Teaching Project, beginning in 1961–1962. This aimed to produce material in the three separate sciences, initially in the age group 11–16, for children in the selective grammar schools, and equally suitable for both future science specialists and others. In all three projects it was the aim that children would learn science largely through experimental enquiry, with the guidance and support of the teacher. The reception of Nuffield in the schools is described, as is its influence even in schools where the whole package was not accepted. Two criticisms of the original Nuffield scheme have been that the work was very demanding, even for the more able pupils, and that neither the O-level nor A-level schemes went far in illustrating the social relevance of science. Later projects for the less able child are described, including Nuffield Science 13–16 (now being published), the Association for Science Education's (ASE) project for "Less Academically Motivated Pupils" (LAMP), and also the much more demanding Schools Council's Integrated Science Project (SCISP), which with a time-table allocation equivalent to that for two O-levels brings together the three sciences with time for ample attention to be paid to their social aspects. Also described is the Schools Council's Project Technology, which had the aim of helping pupils to understand the importance of engineering in our way of life. In spite of the expenditure of £300,000, this project, they say, has had little impact; perhaps this is because science teachers teach best what they know best, and very few science teachers have been trained as engineers. In this context, the authors include an apposite quotation from B. Prescott:

Perhaps one of the greatest weaknesses of science teaching is that it is science teachers who do it — science teachers who have been initiated into the profession by science teachers and they teach courses written by scientists and science teachers.

But if this is a weakness, how is it to be corrected?

In chapters on aims and ideals in science education, and on hopes for the future, Ingle and Jennings identify themselves with the swing back towards general science and science for all, and away from the objective of producing QSEs, a movement which has undoubtedly taken place in the last decade. Reasons for this