

expertise, since the international chains came up only during the past five years by massive transfers of foreign technology. Ancient equipment now lies side-by-side with the most recent acquisitions in laboratories, thanks to foreign generosity. Given the lack of adequate infrastructure for public utilities, ordnance factories had to manufacture simple appliances such as washing machines and fans to give at least a taste of comfort to less than 6 per cent of the population.

The manufacture of high-technology items such as computers and nuclear power plants still awaits adequate agreements with foreign collaborators, whereas they are taken for granted in India.

In order to replace the Soviet Union as the bastion of world communism, Mao spent enough of the gross national product to create one of the largest but most backward armies in the world. Whereas the Chinese military is struggling to modernize 30-year-old Soviet models, some of the latest versions are manufactured in India, even though defence spending under Nehru was low enough to account for India's reversals in border conflicts.

China has long replaced India as a model for developing countries in western thinking, given all its anti-Soviet rhetoric, and its close defence and economic ties with the United States.

Unfortunately, democratic institutions in India provide enough dissent to verge on myth and propaganda. You will nowhere experience this sense of freedom and individual dignity, supposed to be the essence of western values, in a China bent upon change along occidental lines.

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SIR—N.H. Antia's letter criticizing India's scientific progress (*Nature* 331, 384; 1988) is unduly harsh and emotional. If the "capitalist West" has a "morbid fear of communism", then Antia's letter reveals a distorted view of India and adoration for so-called communism. Many of the problems of the poor in India are due to the increasing population, which has nearly doubled since independence, and rises more rapidly in economically lower strata of society. China has been able to arrest the sharp rise in population at gunpoint. In China, it is not the individuals who decide how many children they should have but the state.

India's recent history shows that the suppression of freedom by Mrs Gandhi pushed her out of office. The result of an election does not depend just on the votes of the 'privileged' but on those of the masses, which shows how important freedom is for an average Indian. It would

have been shameful for India to take the path of China in order to make more rapid scientific, technological and material progress and to pay the price not only with the suppression of freedom of expression and movement, but also by sacrificing the most vibrant and oldest surviving traditions in the world.

Indian scientists and doctors going abroad speak for India's great scientific and medical awareness and competence in global participation in those two fields. The rural population moving to urban areas and living there in bad conditions is a transitional phenomenon of any industrial revolution, as history shows. "Freedom for a few only" are the words used by communists or latent communists even in the affluent West.

Antia should take a balanced view of the problem and take note of the price China has paid in terms of its culture and tradition as well as human lives and suppression.

It is better for us, as scientists, to take a more positive view in order to cure the evils of Indian society rather than condemning its achievements in science and technology. Those who condemn are also the first to be outraged at the suppression of any freedom. It is easier to criticize and condemn a system when one is allowed to do so. If such people were forbidden to travel from Bombay to Poona without the permission of the authorities, they would realize the value of freedom.

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Unjust Congress

SIR—We were distressed by your report (*Nature* 332, 670; 1988) on the recent congressional hearings regarding fraud in science. Your article merely repeated the various allegations made at the hearings by Drs Margot O'Toole, Charles Maplethorpe, Ned Feder and Mr Walter Stewart regarding the paper by Weaver *et al.* that appeared in *Cell*.

As the three scientists who, on O'Toole's request, reviewed the data on which the *Cell* article was based, we feel that other views should have been aired, not just the charges. Your failure to do this perpetuates the injustice generated by hearings in which none of the scientists who performed the relevant experiments or participated in the reviews was asked to testify. The result is that a one-sided version of events has been put before the public.

O'Toole initially turned to us as friends to seek our help and judgement on what to her seemed evidence of fraud involving the article in *Cell*. Her accusations were not based on her own work at Massachusetts Institute of Technology (MIT), but on some notebook data that she had

come across by chance. After reviewing the data and consulting the involved parties, we unanimously concluded that there was (1) no sign of fraud; (2) no evidence of misrepresentation; (3) no error that undermined the article's basic conclusion. Contrary to O'Toole's statement at the hearings, we did not concede that her criticism was sound.

It was suggested at the hearings that the whistle-blowers in this case have sacrificed their careers by questioning the science of senior investigators. To our knowledge, nothing was done to impede O'Toole in making an official complaint to MIT or *Cell*. On the contrary, she testified that she was encouraged to ask for an official inquiry but chose not to do so. We are not aware of steps that she has taken to continue her career, nor have we, or anyone to our knowledge, made any attempt to block her in this endeavour. Furthermore, the other person who raised charges of fraud, Dr Charles Maplethorpe, is still in science.

Up to the present, the scientific issues have not been put before the public. We thus welcome the independent scientific investigation being organized by the National Institutes of Health. But a picture depicting the authors of the *Cell* article as guilty has been created, and we fear that no matter what results from the official inquiry, an after-image will remain.

It has always been our belief that the most important test of a scientific claim is independent experimental verification, not judicial review. We hope that the editors and readers of *Nature* share this view.

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Life begins at . . .

SIR—In their paper on human gene expression¹, Braude *et al.* use the term "pre-embryo", though obviously with a certain reserve as they were careful to reference the source². The term itself is not an objective, well-defined scientific descriptive, but in its origins and application it is a mere administrative device to obviate the legal and ethical considerations limiting experiment on human entities at more advanced stages of development, however far that ulterior motive may be from the intentions of the authors.

Indeed, the experimental results reported by Braude *et al.* reveal the lack of a scientific basis for the prefix, given that they have established a specific biochemical effect characteristic of human individuality already at the 4- or 8-cell stage, in the expression of its distinctive genes.

I would therefore expect that this example of subjective and arbitrary terminology be carefully excluded from the scientific literature, the considerations of Chargaff in a recent Commentary in *Nature* being surely of some relevance to this issue³.

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1. *Nature* 332, 459 (1988).

2. 1st and 2nd Reports of the Voluntary Licensing Authority for Human Fertilisation and Embryology (Medical Research Council, London, 1985 and 1986.)

3. *Nature* 327, 199 (1987).

PhD theses

SIR—Lars H. Breimer (*Nature* 332, 481; 1988) paints too rosy and chauvinistic a picture of the Swedish PhD system, which has some disadvantages. It is true that a Swedish thesis is often based on four or five articles published in journals but this is not a statutory requirement. In fact, the Swedish statutes allow as equally valid alternatives a collection of articles (single or multiauthored) not published in this way as well as a monograph-type, previously unpublished thesis.

Because a thesis in Sweden has been given an ISBN number, printed and distributed before its public defence, it remains registered as a PhD thesis in the university library, whether or not it is passed by the examiners' committee. There is no provision in the Swedish system (as there is in the British) for revision and resubmission of a thesis, a major drawback that sometimes amounts to pressure on the examiners to give a borderline candidate the benefit of the doubt rather than fail him/her. And according to the Swedish Universities Statutes, neither the reasons for the acceptance of a thesis nor any dissent in the examiners' committee meeting may be reported in the minutes of the meeting or in any other document (Chapter 8, Article 37, paragraph 5). The majority decision of the committee is final.

The printing and mailing costs for the statutory number of copies are paid by the faculty only up to a certain maximum amount. Local faculty rules may require that 100–150 copies be made available before the defence. Although the costs are paid in part, the work of addressing, mailing and delivering copies is done largely by the secretarial staff of the department concerned and its cost is not

reimbursed. Even if the thesis consists of published journal articles, these must also be supplied in the required number. The system tends to be wasteful of work and material.

The public oral defence is potentially a valuable procedure that should be retained but a candidate is rarely failed once the thesis has reached this stage. Such an event creates newspaper headlines. I can recall only two cases of rejection in Sweden in the past 15 years.

The upshot is that although the Swedish system has many good points, it is in need of some overhaul.

As to the part of Breimer's letter concerning the situation up to about 25 years ago, it is true that there used to be three opponents. One of them was, however, nominated by the candidate himself and confined himself largely to pointing out undotted i's, uncrossed t's, punctuation errors and the like. The third opponent, also nominated by the candidate, was invariably a ceremonial figure, who made witty remarks at the end about the thesis (no real criticism). Even in those days, a thesis could almost never be failed at this stage although one redeeming feature of the old system used to be that the thesis could be given a grade (1 to 5 or rather on a letter scale C to A) instead of only passed or failed as in the present system.

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SIR—In "The thesis that won't go away" (*Nature* 331, 497; 1988), Beverley Halstead puts forward a number of important but contradictory views. As research students, we would support the suggestion that a PhD should be a period of apprenticeship but we do not agree with the idea that the only way to assess the worth of a scientist is by measuring the volume of work published. In order to demonstrate one's competence as a research scientist, is it absolutely necessary to reach a point at which the work is suitable for publication? Indeed, such a requirement could feasibly lead to a situation in which the integrity of the work is sacrificed for prompt and plentiful publication.

In addition, the successful completion of a project is not solely dependent on a student's ability as there is great variation between PhD projects with regard to difficulty, supervision and availability of resources. A student in a well-funded laboratory who is part of a large group may receive greater stimulation and help than a student of equal ability struggling on his or her own in an ill-equipped laboratory. Furthermore, a student who focuses on a single problem with the aim of publishing the data may become a less competent research scientist than one who

has been encouraged to take a more holistic view of his or her work. It is already apparent that the pressure to produce a thesis encourages students to consider only those areas within their own field which are of immediate relevance to their project and the pressure to publish inevitably increases the risk of their pursuing their subject narrow-mindedly.

The thesis system is certainly not perfect, but it is still the fairest method of establishing whether or not a student is worthy of a doctorate. We believe there is urgent need for change within this system rather than its replacement with another. Most importantly, an attempt must be made to unify across universities the standards of assessment used by individual examiners.

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SIR—A. J. Greenfield's letter (*Nature* 332, 481; 1988) about the apparent disparity in the remuneration of PhD students and PhD research assistants is misleading.

The salient differences, which he omits to mention, may be summarized as follows. The PhD student is generally a new graduate with few financial responsibilities, and can therefore afford to take a higher degree which will enable him or her to pursue research in any field which takes his or her fancy.

A PhD research assistantship, however, is preferentially given to someone with a number of years' relevant experience in industry or elsewhere on top of a good first degree, and is therefore likely to be considerably older with many more financial commitments. His salary is being paid by an institution which requires a specific piece of research to be undertaken, and about whose direction the researcher has very little say. He is therefore being paid to do a job of work, after which he will no doubt be required to produce a report of his findings to his sponsor.

The fact that a revised copy of the report may be submitted as a thesis and offered to the research institution for evaluation is irrelevant. The PhD is a bonus which is rightfully gained for having satisfied the academic criteria governing such research.

The saving grace of this alarming debate is that, given the historic traditions of the better universities, it will be a very long time indeed before any change is seen in the present, and eminently satisfactory, system.

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