for the nucleus to be reprogrammed. But even Solter[4] now admits that this is not insurmountable, in the light of successful experiments by Wakayama *et al.*[5] using adult cumulus cells for the cloning of mice.

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1. Tsunoda, Y. & Kato, Y. *J. Reprod. Fertil.* **113,** 181–184 (1998).
2. Illmensee, K. & Hoppe, P. *Cell* **23,** 9–18 (1981).
3. McGrath, J. & Solter, D. *Science* **226,** 1317–1319 (1984).
4. Solter, D. *Nature* **394,** 315–316 (1998).
5. Wakayama, T., Perry, A. C. F., Zuccotti, M., Johnson, K. R. & Yanagimachi, R. *Nature* **394,** 369–374 (1998).

Forging links in an electronic paper chain

Sir — The Briefing on electronic journals was interesting and timely (*Nature* **397,** 195–200; 1999). But one issue that was not addressed was how Internet publishing will change the style of scientific writing. One imagines that the length of on-line articles will be less restricted than paper ones — even in the most selective journals. This will encourage a more thorough, but perhaps windier, writing style.

Counterbalancing this are the possibilities of hypertext. This will allow authors to connect their articles to supplementary material on their own sites or in external databases. This will enable them to reduce the main body of their text and to make it less technical, moving the details to linked sections. It may also lead to a more segmented, 'fact-box' style of presentation. Copious links will require careful layout, ensuring that they remain stable and reflect an underlying logic.

Finally, the use of hypertext in papers raises the issue of whether authors will be free to modify linked material on their own websites, or whether the content related to a paper should be frozen on submission. This is especially relevant to the refereeing process.

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The editor as an endangered species

Sir — I used to feel a great sense of security in my job as editor of *Physical Review Letters*. Receipts continue to increase, the journals of the American Physical Society are leading in most aspects of electronic publishing, and, of course, an editor could never be replaced by a computer program.

Alas, your Briefing on electronic journals tells me I am an endangered species (*Nature* **397,** 195–200; 1999). Apparently the *Journal of High Energy Physics* already has a robot that reads manuscripts and assigns them to referees. I imagine your reporter meant to say "assigns them to editors". And, according to a picture in your article, my boss Martin Blume has become a web page! He was spotted in the editor-in-chief 's office recently, so that must have been a printer's error.

No doubt the electronic future will have robots that will avoid such errors, but will readers be able to trust them?

Please tell me that editors are really needed.

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Space-grown crystals may prove their worth

Sir — The first building block of the International Space Station was launched on 20 November 1998, but the potential uses of the space station are still under debate. A recommendation to scrap NASA's research on protein crystals was reported recently[1]. The reason given was that no serious contributions to our knowledge of protein structure have yet been made in space. We wish to point out, on the basis of recent experimental and theoretical evidence, that in many cases the potential benefits of the microgravity environment have not been fully exploited. This explains the low rate of success of protein crystallization in microgravity and opens up the scope for enhancing the efficiency of experimentation in space.

Microgravity eliminates sedimentation and convective mixing, so offering a more homogeneous growth medium compared with growth on Earth. Since this is likely to improve the degree of perfection of the crystals, why has microgravity crystallization not been more successful?

There are four common methods for crystallizing proteins: batch, vapour diffusion, dialysis and free interface diffusion (FID). Vapour diffusion is the most successful technique for crystallization on Earth. Naturally it became the method of choice for crystallization in microgravity. Thanks to the European Space Agency providing new means of conducting experiments in a far more systematic way, a comparison of microgravity crystallization using different methods was facilitated. The results demonstrated that vapour diffusion is not the best technique for crystallization in microgravity[2].

Images from CCD cameras recorded during flights showed that some crystals grown by vapour diffusion displayed a cyclic motion within the aqueous drop in which they grow[3]. This motion is attributed to Marangoni convection, an effect which serves to reduce concentration gradients along the interface between the solution and the vapour[4]. In the case of FID and dialysis there is no interface between solution and vapour and this cyclic motion does not occur[5].

Cyclic movement of the crystals in microgravity destroys the very benefit that is sought from the unique environment of outer space and thus may be a limiting factor in the ultimate perfection (indicated by X-ray diffraction) of the crystals that can be obtained[6–8].

Several researchers have mentioned that crystals grown in microgravity by dialysis and FID methods appeared to be superior to those grown by vapour diffusion[9,10], but those results were not taken seriously enough and most experiments were still done by vapour diffusion. Recent video recordings[2,3,5] show beyond any doubt that crystal movement (akin to sedimentation referred to above) takes place in the case of vapour diffusion but not with the other methods.

It is apparent that we may have only now grasped how best to use the microgravity environment. Hence it would be a great shame if the experiments were scrapped now, just at the stage when a better understanding of crystallization in space and its fluid physics and biophysical chemistry is being gained. We are now in a position to explore more efficient ways of increasing the success rate of these experiments. The translation of the results to improve protein structure determination will come later. The stage of basic research is not yet completed to allow targeted exploitation to take place.

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1. Reichhardt, T. *Nature* **394,** 213 (1998).
2. Boggon, T. J. *et al. Phil. Trans. R. Soc. Lond. A* **356,** 1–17 (1998).
3. Chayen, N. E. *et al. J. Cryst. Growth* **171,** 219–225 (1997).
4. Molenkamp,T., Janssen, P. B. M. & Drenth, J. "Protein crystallisation and Marangoni convection. Final reports of sounding rocket experiments in fluid science and materials science" *ESA Report SP–1132*, 22–43 (ESA, Paris, 1994).
5. Snell, E. H. *et al. Acta Crystallogr. D* **53,** 747–755 (1997).
6. Snell, E. H. *et al. Acta Crystallogr. D* **51,** 1099–1102 (1995).
7. Normile, D. *Science* **270,** 1921–1922 (1995).
8. Savino, R. & Monti, R. *J. Cryst. Growth* **165,** 308–318 (1996).
9. Koszelak, S. *et al. Biophys. J.* **69,** 13–19 (1995).
10. Eposito, L. *et al. Acta Crystallogr. D* **54,** 386–390 (1998).