

of those journals is concerned. If the active science communicators in general and the budding science writers hailing from such areas in particular are provided with a few S & T journals of their choice, that could be an impetus for them. That will not only help in enhancing our S & T coverage but the quality is also bound to improve.

The question now arises as to who is going to provide the funds for it. The first possibility that strikes the mind is the National Council for Science & Technology Communication (NCSTC) under

Department of Science & Technology, New Delhi, which was established a decade ago as a nodal agency for S & T communication, its sole endeavour having been towards popularization of science particularly among laymen at the grass-root level.

Apart from all its regular activities, the NCSTC should come forward to allocate the funds ensuring the purchase of S & T journals and distribution of the same to the active science writers. In order to avoid the misuse of public money, the names in the mailing list can be added

or deleted judging from the writer's performance, as suggested by Jain. On an experimental basis, the members of Indian Science Writers Association, a Delhi based professional body of science communicators, may be included in the mailing list. The commendable suggestions made by Jain must not go unheeded.

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RESEARCH NEWS

Scanning tunnelling microscopy studies of the fullerene C₆₀

In the area of fullerene research, the dust has settled and the time for rhetoric is over. The emphasis in recent months has been on mature experiments that tie up loose ends. Two 1994 papers from A. V. Narlikar, S. B. Samanta and P. K. Dutta of the National Physical Laboratory, Delhi on the scanning tunnelling microscopy (STM) of C₆₀ seem to bear this out. The papers [*Philos. Trans. R. Soc. (London)*, 1994, 346, 307–320 and *Proc. R. Soc. (London)*, 1994, 444, 325–332] report detailed STM studies of C₆₀ samples deposited on polycrystalline silver substrates. The authors emphasize the two possible classes of defect structures in these systems, the one within the fullerene cage; what might be referred to as molecular defects, and the other, extended lattice defects including dislocations and stacking faults.

In the name of self-sufficiency, we briefly review the STM technique. In STM, a pointed conducting tip is maintained at some finite bias, over the surface to be studied. The surface itself is grounded, and this restricts STM to conducting and semiconducting samples. When the tip-sample separation is of the order of nanometres, a tunnel current which depends exponentially on the separation, is set up between the tip and the sample surface. The topology of the surface is mapped by moving the tip over

the surface while following the tunnel current in the manner of a gramophone stylus 'reading' the music on a record.

The first paper emphasizes the extended lattice structure of solid C₆₀. STM images clearly show up the fcc packing of C₆₀ molecules, in agreement with existing X-ray, neutron and electron microscopy data. Figure 1a is an STM image of the fcc (001) planes of the C₆₀ lattice and Figure 1b is an STM image of the close-packed (111) plane. Typical dimensions and fcc directions are shown in these figures. In both images, each C₆₀ molecule resembles a ball, the reason being that the truncated-icosahedral structure is averaged out over a sphere due to rapid molecular rotation. STM is a technique that probes the electron density around a surface rather than directly probing the atomic position. Considering this, Narlikar *et al.* find, quite surprisingly, that the molecular diameters as measured by STM match the diameter of the carbon cage (0.7 nm), rather than the van der Waals contact (1.0 nm).

The reason why fcc type of sphere packing often prevails over hexagonal close-packing is the ability of the fcc lattice to accommodate a large variety of defects. An example is shown in Figure 1c, where one clearly sees the presence of two extra half planes, corresponding to two edge dislocations (marked), form-

ing a dislocation dipole. The Burgers circuit yields a Burgers vector of 1.0 nm in accord with slip along the (110) directions. The image in Figure 1c is almost a textbook illustration of a dislocation dipole.

The second paper concentrates on the molecular structure of the fullerene C₆₀ as determined by STM. Rapid molecular reorientation in the solid phase of C₆₀ at ambient temperatures and pressures do not usually allow for atomic details to show up in STM studies. The authors suggest that either the proximity of the silver substrate or the high fields generated by the STM tip freeze molecular motion over STM timescales allowing atomic features to be resolved. The observation that the orientations of adjacent C₆₀ molecules are uncorrelated is presented by the authors as one more detail in the mosaic of evidence showing that solid C₆₀ under ambient conditions is orientationally disordered. This mosaic includes synchrotron X-ray¹ and neutron² diffraction studies on C₆₀ powders. Of course, it is a rather sweeping assumption that STM is a totally non-invasive technique. This is something we return to elsewhere.

Figure 2a shows an atomic resolution image of a frozen C₆₀ molecule. The outline of a five-membered ring, surrounded by six-membered rings is dis-

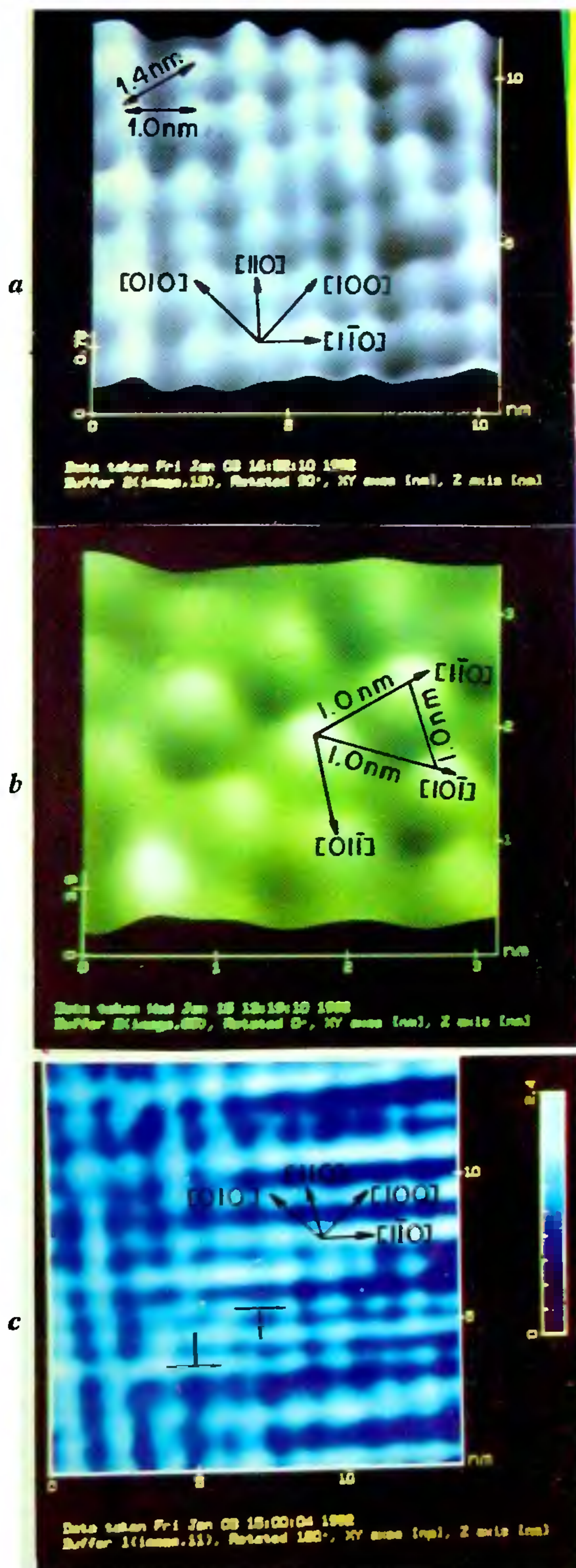


Figure 1. *a*, STM image of the (001) plane of solid C_{60} . *b*, Image of the (111) plane. *c*, Two edge dislocations on the (001) surface forming a dislocation dipole.

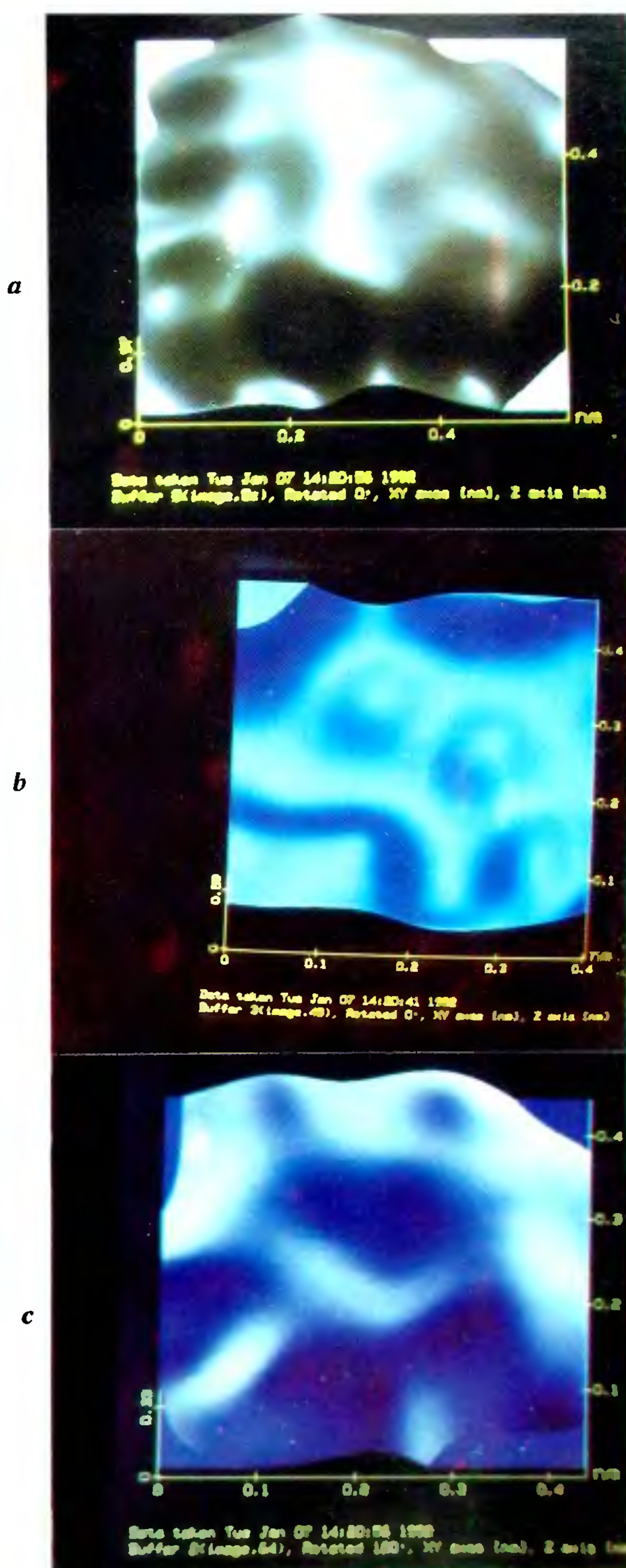


Figure 2. *a*, Near-ideal C_{60} molecule at atomic resolution showing pentagons and hexagons. *b*, Defect structure showing a pair of pentagons sharing a base to form a fulvalene unit. *c*, Defect structure possessing a seven-membered ring.

cernable just slightly to the right of the centre of the image. More interesting are the molecular defect structures unearthed by Narlikar *et al*. Figure 2b shows a pair of pentagons sharing a bond on a distorted C_{60} surface, forming a fulvalene unit. Figure 2c shows a rare occurrence in fullerenes and related structures, viz. a seven-membered ring. It must be recalled that five-membered rings provide the positive curvature required to close a structure comprising mostly six-membered rings. Seven-membered rings would tend to undo this positive curvature. In isolation, seven-membered rings are associated with saddle points, and can give rise to a veritable zoo of interesting cage structures with both convex and concave surfaces. The point mentioned earlier about the invasive nature of STM would be in order here. When imaging poorly

conducting samples, one is operating at biases as high as 1–2 V. This potential drops across distances of the order of Ångströms, resulting in fields of the order of bond energies. The question of the technique itself affecting the structure is thus one that needs looking into.

Defect fullerene structures are of considerable interest in part because of the sheer wonder that a structure as perfect as C_{60} forms under such refractory conditions. Such defect structures have been studied, for example, using semi-empirical quantum chemical calculations³ as well as various *ab initio* molecular dynamics (MD) methods^{4,6}. In the MD studies it was found that a cluster of carbon atoms rarely annealed into defect-free cages, largely because sufficiently long annealing times are computationally inaccessible. By turning this argument around, one might

ask whether defect fullerene structures can be obtained by quenching the carbon vapour in the arcs used for their preparation. Until this is possible, one can only follow the example of Narlikar, Samanta and Dutta and, in the manner of Lepidopterists, hunt for unusual species in the carbon family, only with the butterfly net being replaced by an STM.

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COMMENTARY

Acute toxicity of vitamin A in infancy

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A recent paper¹ from Bangladesh entitled 'Acute toxicity of vitamin A given with vaccines in infancy', reports that 11.5 per cent of infants who received a massive dose of synthetic vitamin A at the level of 50,000 IU developed fontanelle bulging indicative of increased intracranial tension. Commenting on the proposal to include vitamin A administration with EPI the authors point out that 'neither the efficacy nor the safety of mass vitamin A administration to infants have been established'. The infants studied were less than six months old but there is evidence that older infants are also vulnerable.

Hathcock *et al.*² had also earlier reported that children and infants are more susceptible than adults to vitamin A toxicity. Symptoms of vitamin A toxicity in children include, apart from bulging of fontanelle due to increased intracranial pressure, anorexia, drowsiness, irritability vomiting and liver

damage^{3,4}.

Indeed even children of pre-school age are vulnerable to vitamin A toxicity as Florentino *et al.*⁵ in Philippines had shown in a double blind study involving 2,471 children in their country. Earlier studies in NIN had also provided evidence of such toxicity.

Though only 11.5 per cent of infants were reported to have exhibited fontanelle bulging, it is reasonable to expect that a much larger percentage had in fact developed increased intracranial pressure which had not reached levels high enough to manifest as bulging fontanelle. Though fontanelle bulging and other side-effects were found to subside after a few days, increased intracranial tension is likely to have persisted for quite a few days after the subsidence of the clinical sign of fontanelle bulging.

Under the circumstances, we have reason to be deeply perturbed by the reported attempts to promote the use of massive doses of synthetic vitamin A in infants as an adjunct to the EPI

programme.

There is no evidence that vitamin A deficiency is at all a public health problem in infancy. It is universally agreed that the logical way to combat this problem in children is to build up maternal stores of vitamin A during pregnancy, through dietary improvement consisting of the inclusion of inexpensive carotene-rich foods in the diets of pregnant women. There is an abundance of carotene-rich foods in the countries where synthetic vitamin A is sought to be promoted.

The attempt to 'ride' the massive vitamin A dose approach on EPI is unwise for other reasons as well. There is no documented evidence that simultaneous administration of massive dose of vitamin A along with vaccination does not impair the immune response following on vaccination, with respect to all vaccines involved in EPI. Also, since vaccination is, in a sense, pseudo infection, it is reasonable to expect that the retention of vitamin A given simultaneously with vaccination will be poorer than with vitamin

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