complex' to enable the sisters to separate[16,17]. So, two different kinds of proteolysis are needed to initiate sister separation. The first is activation of the anaphase-promoting complex, the enzyme which leads to the wholesome destruction of Pds1. This, in turn, frees Esp1 to introduce two surgical snips in Scc1, thereby destroying the cohesin complex[17]. A similar functional situation has also been observed for vertebrate sister chromatid separation as well, where a protein called 'securin' which is analogous to Pds1 in budding yeast and Cut 2 in fission yeast has been identified[4]. An analysis of related data[17] indicates that changes in the cohesin subunits are responsible for the differences between chromosome segregation in mitosis and meiosis, and a single change in chromosomal protein may be enough to cause the altered pattern of chromosome segregation that is responsible for sexual reproduction.

Further, besides identification of proteins involved in sister chromatid cohesion, efforts have also been made to identify DNA elements involved in the process. Using a budding yeast minichromosome centromere assay, Megee and Koshland[18] were able to identify a centromeric element *CDEIII* that was necessary (but not sufficient) for cohesion, suggesting that the centromere cassette contains DNA elements that mediate sister chromatid cohesion, although, there may be another DNA element outside the cassette that mediates cohesion. Their data, however, do emphasize that at least in budding yeast, cohesion and kinetochore activities are coordinated through a common sequence element. Their observations further suggested that cohesion factors may bind to chromosomes nonspecifically like histones or specifically to multiple sites. In either case, the DNA elements are functionally redundant.

1. Kimura, K., Hirano, R., Kobayashi, T. and Hirano, T., *Science*, 1998, **282**, 487–490.
2. Kimura, K., Rybenkov, V. V., Crisona, N. J., Hirano, T. and Cozzarelli, N. R., *Cell*, 1999, **98**, 239–248.
3. Uhlmann, F., Lottspeich, F. and Nasmyth, K., *Nature*, 1999, **400**, 37–42.
4. Zou, H., McGarry, T. J., Bernal, T. and Kirschner, M. W., *Science*, 1999, **285**, 418–422.
5. Lavania, U. C., *Curr. Sci.*, 1999, **77**, 216–218.
6. Murray, A. W., *Science*, 1998, **282**, 425–427.
7. Losada, A., Hirano, M. and Hirano, T., *Genes Dev.*, 1998, **12**, 1003–1012.
8. Hendzel, M. J., Wei, Y., Mancini, M. A., Hooser, A. V., Ranalli, T., Brinkley, B. R., Bazett-Jones, D. P. and Allis, C. D., *Chromosoma*, 1997, **106**, 348–360.
9. Morgan, D. O., *Nature*, 1995, **374**, 131–134.
10. Nicklas, R. B., *Annu. Rev. Biophys. Chem.*, 1998, **17**, 431–449.
11. Rieder, C. L. and Salmon, E. D., *Trends Cell Biol.*, 1998, **8**, 310–318.
12. Nasmyth, K., *Trends Biochem. Sci.*, 1999, **24**, 98–104.
13. Toth, A., Ciosk, R., Uhlman, P., Galova, M., Schleifer, A. and Nasmyth, K., *Genes Dev.*, 1999, **13**, 320–333.
14. Klein, F., Mahr, P., Galova, M., Buonomo, S. B. C., Michaelis, C., Nairz, K. and Nasmyth, K., *Cell*, 1999, **98**, 91–103.
15. Hirano, T., *Genes Dev.*, 1999, **13**, 11–19.
16. Yamamoto, A., Guacci, V. and Koshland, V., *J. Cell Biol.*, 1996, **133**, 99–110.
17. Murray, A., *Nature*, 1999, **400**, 19–20.
18. Megee, P. C. and Koshland, D., *Science*, 1999, **285**, 254–257.

U. C. Lavania is in the Central Institute of Medicinal and Aromatic Plants, Lucknow 226 015, India; Seshu Lavania is in the Botany Department, Lucknow University, Lucknow 226 007, India; and Y. Vimala is in the Botany Department, Ch. Charan Singh University, Meerut 250 005, India.

OPINION

From Auschwitz to Indian science

Amulya K. N. Reddy

A World Energy Assessment meeting in Cracow (Poland) a few days ago gave me an opportunity to visit the concentration camps at Auschwitz and Birkenau 50 km away. Brought from all over Nazi-occupied Europe during World War II, about 1.5 million innocent victims, overwhelmingly Jews, either went directly to the gas chambers and the crematoria at Auschwitz and Birkenau, or indirectly via the camps where they were held prisoners until they were too weak to labour.

The tour of the camps, now preserved as a museum, created a completely unexpected feeling. The scale was so enormous that it is difficult, particularly because the camps have been unpopulated since 1944, to imagine that there used to be human beings here. Human belongings – toothbrushes, shoes and suitcases – were piled separately from floor to ceiling in huge rooms, but the aggregate was more reminiscent of factory inputs. Even the enormous mound of human hair was raw material for the manufacture of tailor's lining cloth. If Auschwitz was unbelievable, its neighbour Birkenau located 3 km away, beggared the imagination. Birkenau was spread over 175 hectares with 300 buildings each capable of housing 1000 inmates. It was a scale-up from the pilot plant demo at Auschwitz with a peak of 20,000 prisoners to full scale commercialization at Birkenau with 100,000 prisoners in August 1944. The powerful impression that persisted was of detailed engineering resulting in '... the immense technological complex created ... for the purpose of killing human beings' (*Auschwitz – How Many Perished*, Yad Vashem Studies, Jerusalem, 1991, vol. XXI,

p. 11). The meticulous organization and rigorous management were characteristic of mega-industries, 'gigantic and horrific factories of death'. The main gate of Auschwitz displayed the inscription 'Arbeit macht frei' (Work brings freedom). Perhaps a more apt announcement would have been 'Technology completely decoupled from values'. Also, one could not help reflecting on the frailty of social institutions and the failure of legal safeguards that sanctioned these horrors.

The tyranny of scale

As the scale of killing increases, the technology often tends to become more and more sophisticated – from knives to guns to machine guns to bombs to gas chambers and crematoria to atomic bombs. Also, with increasing scale, not only does the distance from victims become greater, but also the challenge becomes more and more technical. Burial is sufficient for one body, but for hundreds or thousands of bodies, terms such as 'throughput', 'air–fuel ratio' and 'burning capacity' come to mind.

In Auschwitz, it is obvious that nothing happened spontaneously. Everything was designed and planned. One of Germany's top chemical industries, IG Farben, produced the poison Cyclon B for exterminating people in the gas chambers. Careful experiments were done to determine the time it would take for a person to be poisoned. An engineering firm designed the crematoria furnaces to each process 350 bodies per day in Auschwitz. So, there must have been engineers preoccupied with the technical problems. Perhaps, like Oppenheimer talking about the atomic bomb, some even thought that the problem was 'technically sweet'. Or, like the statement made at the Bangalore Kaiga debate in 1989: 'Hiroshima provided us with a fortunate opportunity to study radiation effects!'

Decoupling from values

Once the problem was defined as eliminating hundreds and thousands of people per day, the Auschwitz solution was inevitable. But, who defined the problem and promulgated the order? By and large, it is political decision-makers that define the problem. There was a conference at Wannsee, a suburb of Berlin, on 20 January 1942, at which the Nazi leadership decided in less than two hours on the 'final solution' to exterminate the Jews. Ethnic superiority, racial/religious hatreds and fundamentalist views are well-known bases for decisions with far-reaching destructive impacts on human beings.

Why was this definition of the problem so widely accepted? There could be several reasons. There was the silencing of the informed and articulate who became the first inputs to the camps. The media and journals were not allowed to reveal the truth. As a result, many can genuinely claim ignorance as an excuse. The most serious problem is the plea of duty and the obligation to carry out orders. Recall the movie 'Judgement at Nuremberg' describing the trial of the Nazi judges charged with furthering the extermination of Jews. These judges defended themselves by submitting that they were just carrying out orders. The judgement at Nuremberg was that a human being has to take full responsibility for the consequences of his/her actions and that the excuse of obeying orders is inadmissible.

Apart from the above factors that operate in the case of officials and technical personnel, there is the additional device of taking a top–down macro view (e.g. national security, geopolitical considerations, etc.). In such a macro view, numbers and statistics displace human beings. New proxy words dominate the discussions – 'burning capacity' replaces 'the number of corpses burnt', 'kilotonnes yield' replaces 'kilodeaths', etc.

Functionaries, however, cannot avoid contact with the prisoners and victims to keep the system going. What is overwhelming in Auschwitz and Birkenau is the unbelievable cold-bloodedness of the operation. It appears that the guards treated inmates inhumanly because they believed that the victims were sub-human. Once this belief is propagated and accepted, anything goes – as in the growing number of examples of ethnic cleansing and genocide (native Americans, Partition, Rwanda, Bosnia, Kosovo, East Timor, etc.).

Auschwitz and Alamogordo–Hiroshima

The tour of Auschwitz ends at the gas chamber and the crematorium. But just before that, near the main gate, is the gallows where Rudolf Hoess, the bestial camp commander, was hanged after a trial.

Is this just retribution? Or, are only the vanquished tried as war criminals while the victors go scot-free?

An equally important question is: how does the development of the atomic bombs at Los Alamos, the test at Alamogordo and the bombing of Hiroshima and Nagasaki differ from the Nazi concentration camps? Of course, the Allies in World War II were not driven by the racism of the Nazis, and they were not pursuing a final solution of extermination of a religious group. But with regard to the scale of killing, the harnessing of science and technology, the extent of organization, the resort to effective management, and the choice of target to maximize annihilation of Japanese civilians, the Manhattan project was like the concentration camps, in fact, even more horrendous in its impact.

Beyond Pokhran to . . .

What does Auschwitz–Birkenau mean for India? Over the past year and a half, the country had witnessed the scientist–politician nexus underlying the nuclear tests at Pokhran, the use of security arguments to advance party agendas, the jingoism of the scientists, the virtual absence of dissent, the silence of its journals with a few notable exceptions and the obfuscation of reality. For instance, after an initial silence on the subject (as if it never happened), *Current Science* publicized the official/government version of the 'kilotonnes yield' of the test bombs but rejected/suppressed estimates of the hundreds of thousands of innocent non-combatants who would be killed if even a primitive atomic bomb were exploded on Mumbai/Karachi.

There are other questions. Are the institutions on the sub-continent necessarily more robust and moral than those in the Germany of the 1930s and 1940s? Are Indian politicians and parties less prone to exploit religious animosities? Are Indian scientists and engineers less eager to get political support for their next ego trip or power play (e.g. neutron bombs because they kill but don't destroy). Once the nuclear-tipped missiles are deployed, are there guarantees against some crazy guy doing some crazy thing?

Is it certain that Pokhran will not lead as inevitably to Lahore, and/or Chagai to Mumbai, as Alamogordo led to Hiroshima?

Life affirming values

The claim of the amorality of science is a clever way of escaping responsibility for the horrors that have sprung or can spring from science. For example, the missile developer's statement that 'he is only an engineer' and that 'his missile can also be used for delivering flowers'. The relationship between the scientist (the subject) and the object of scientific study must be such that initial separation (and distance) ends in subsequent unification (and embrace). The suppression of emotion **during** analysis must give way to emotion **after** analysis. The functioning of scientists as individuals, groups and institutions must be constrained and limited by moral strictures and taboos. Otherwise, the isolation of the subject from the object and the removal or absence of emotions and feelings lead inevitably to science becoming the instrument of violence, oppression and evil and viewing people as 'things'. Science, therefore, is not neutral, but it can be – and must be – encoded with life-affirming values. The link between science and morality must be re-established.

A crucial safeguard is to insist that, quite apart from the top–down macro view of security, yields, kill-ratios, etc., there must be a bottom–up micro view based on human beings. One must see beyond the numbers and the statistics, one must see children and parents and grandparents, lovers and married couples, siblings, friends and comrades. The Gandhi talisman must never be forgotten: 'Recall the face of the poorest and most helpless person . . . and ask yourself if the step you contemplate is going to be of any use to him. Will he be able to gain anything from it? Will it restore to him control over his life and destiny?'

Amulya K. N. Reddy lives at 7/12, Palace Cross Road, Bangalore 560 020, India.

SCIENTIFIC CORRESPONDENCE

Elevated serum levels of 25-hydroxyvitamin D_3 in outdoor workers of South India

Serum 25-hydroxyvitamin D_3 (25-OH-D_3) levels in humans are enhanced after short-term ultraviolet exposure either from natural sunlight or artificial UV irradiation[1–5]. Stamp *et al.*[1] have shown that serum levels of 25-OH-D_3 continues to rise for several days after exposure to solar irradiation has ceased. Mawer[2] confirmed these findings and also provided data to suggest that there is a rise in serum 25-OH-D_3 following ultraviolet radiation. The effect of extended and continuous exposure of sunlight on vitamin D metabolism in humans is not known[4]. Individuals living in tropical regions constitute appropriate subjects for examination because they have extended and continuous solar exposure throughout the year. Reports on vitamin D status in tropical populations are limited to dark-skinned individuals subjected to short-term ultraviolet radiation, elderly individuals, pregnant women and children[6–9].

We report here high serum levels of 25-OH-D_3 and significant differences in the vitamin D status between indoor and outdoor workers among a segment of apparently healthy population in Thiruvananthapuram, a coastal city in South India, located within 12° of the equator (latitude 8°N, longitude 74°E) which has abundant sunshine throughout the year. Environmental temperature in this region varies within 28 to 34°C during the year.

Blood samples were collected from 66 clinically normal males aged 18 to 65 years (mean ± SD : 33.05 ± 11.0) during the period between March and November. Twenty-five were indoor factory workers (Group I) and 41 were either labourers (Group II; $N = 21$) or fishermen (Group III; $N = 20$) who spent daily 6–8 h outdoors with no clothing on their chest. Dietary intake was recorded by using 24-hour recall method and vitamin D intake was computed using tables of nutrient data on locally consumed foods[10]. Serum 25-OH-D_3 was estimated according to the method of Jones[11] using high pressure liquid chromatography (HPLC) by measuring UV absorbance at 265 nm using Schimadzu 1989 model HPLC system (Figure 1). The sensitivity of the assay is 0.25 nmol/l. Accuracy of assay for 25-OH-D_3 was determined by adding known amounts of the vitamin to plasma and estimating its levels. Recovery of the extraction was 90 to 95%. Reference standard 25-OH-D_3 was obtained from Hoffmann La Roche, USA. HPLC was employed because of its specificity and availability though radioligand binding assay is superior in terms of sensitivity. Serum levels of calcium and magnesium were determined by atomic absorption spectrophotometry using a Perkin Elmer 2380 atomic absorption spectrophotometer and measuring the absorption at wavelengths 422.7 nm and 285.2, nm respectively. Sensitivity of the assay for Ca is 0.0125 mmol/l and for Mg is 0.00125 mmol/l. Inorganic phosphate was measured by the method of Fiske and Subbarow. Coefficient of variation of the assay for 25-OH-D_3 determined from pooled serum ($N = 10$) was 12.3%. Samples from different groups were assayed randomly in batches and the identity was not revealed to the person doing the assay of the samples. Data on all variables were available only in 49 subjects; 22 in Group I, 11 in Group II and 16 in Group III. Group medians of all outcome variables were compared using Kruskal–Wallis one-way ANOVA followed by Mann–Whitney test for pairwise comparisons. Overall and within-group correlations (Pearson's r) were computed between 25-OH-D_3 and