In this issue

Microbes and metals

Rose fanciers cannot grow their beautiful roses unless they are aware and make use of the toxic action of copper ions on fungi. We have all become conscious of the fact that if there is radioactive fallout vegetation and grass concentrate the radioactive strontium and cows feeding on this grass produce heavily contaminated milk. This is why after the Chernobyl disaster thousands of tons of vegetables and milk had to be 'destroyed'.

The phenomenon now called 'biosorption', a process by which living matter or microbes (dead or alive) separate heavy metals from an aqueous environment, is the cause of it all. New words like 'bioaccumulation' and 'biomagnification' will some day get into the dictionary. Certain spores of some species can take up heavy metals from concentrated solutions (applied on them) so readily and in such quantities that the metal can scarcely be detected in the initially applied solution. The binding of these heavy ions to these spores or microorganisms is also extremely strong and strong chemical methods have to be used to separate them. The mechanism of biosorption seems to be either physical adsorption or chemical complexing on the microbial surface (but the details of the actual modes are yet to be completely investigated). The uptake of heavy metals by these organisms is greatly influenced by various factors such as pH, presence of other ions and even the oxidation state of the ion: for example some microorganisms seem to prefer trivalent chromium to hexavalent chromium.

One of the earliest discoveries in this field was that common moss adsorbed heavy metals and so 'moss bags' have been in use for the monitoring of heavy-metal pollutants in the air near mines. Another discovery of some significance is that active sludge preferentially removes plutonium-239 and many other toxic elements.

T. R. Muraleedharan *et al.* discuss (**page 379**) various methods of microbially removing heavy metals from domestic, industrial and mine effluents. They also discuss the mechanisms of biosorption, methods of using microbes for monitoring and controlling heavy metal pollutants, and give a series of applications. Even precious metals can be recovered from waste runoffs using this method. (One is reminded of the tribe of Central Africa which ingeniously smelted copper from termite mounds long ago!)

Elements of chemical behaviour

Intuitively developed concepts like electronegativity and hardness are very successful in rationalizing diverse chemical properties. Quantum chemists have long considered the fundamental basis of these ideas and have also attempted to quantify them from first principles. How do such numbers, derived from density-functional theory, compare with earlier, empirical values? Can the theoretically defined quantities be used to predict molecular properties reliably? P. K. Chattaraj (**page 391**) critically examines such questions. He also reports a rather interesting constancy in the hardness-to-electronegativity ratio for elements in the same group of the periodic table.

Relationships in bond-breaking

It is well known that substances undergo damage on exposure to high-energy radiation. Much research in the past has concentrated on detailing the nature, extent and dose dependence of radiation-induced damage in a wide variety of materials. S. V. Bhat and M. M. H. Abdel-Gawad (**page 397**) examine the effects of X-ray irradiation on ammonium perchlorate. The production of NH_3^+ radicals leads to the question: Which of the four protons of the NH_4^+ group was removed? Using an accurate neutron diffraction study available in the literature and electron spin resonance (ESR) studies of NH_3^+ radicals trapped in an NH_4ClO_4 lattice, the authors tantalizingly conclude that 'other factors being equal/nearly equal, symmetry-related bonds are preserved in preference to those unrelated to one another by any symmetry'.

Cinderella syndrome

Glamour in science is generally associated with the pursuit of basic research. Applied research is viewed as a poor cousin, despite its undoubted importance. Scientists in industrial research laboratories often have difficulty in clearly perceiving a role for themselves in the context of the national scientific scene. A well-defined status for industrial researchers, within the scientific community, is particularly important in raising the general morale of scientists and in enhancing performance. '"Whom are we fooling in research?"—an experience in brainstorming' (**page 376**) is the outcome of a novel experiment in collective analysis of viewpoints by a group of industrial researchers. This unorthodox presentation of an unusual exercise went through several changes during editorial consideration. The analysis focuses on a sharp conflict in the minds of industrial researchers and highlights the existence of an identity crisis. Applied scientists, it seems, must now await the arrival of the fairy godmother.

A crisis of confidence

Centralized planning has always been a hallmark of government in India. It is unsurprising, therefore, that the Science Advisory Council to the Prime Minister (SAC-PM), constituted in 1986, should have embarked on the task of producing a series of reports on the status of various areas of S&T in India, which have now been published in two volumes under the title *Perspectives in Science and Planning*. Reviewing this publication, J. K. Bajaj and M. D. Srinivas (**page 415**) analyse critically not only the reports themselves but also the apparent lack of confidence that seems to be displayed by India's scientists and technologists in coping with the challenges of taking the country to the ranks of the technologically advanced nations. The authors of the review are harsh in part – they dismiss the report on photonics as 'excellent science fiction' and suggest that the subcommittee on food has not taken their task 'with any

degree of seriousness'—but also give credit where it is due; for instance, they point out that the report on advanced materials is indeed a good model for the kind of analysis that may be helpful in charting future courses. They also note that the 'lack of seriousness' in many reports 'probably arose because, by the time the detailed reports were worked out, the political climate of pragmatism had already evaporated and the possibility of any radical initiatives in any field had become remote'. The fact that these reports were produced by a galaxy of scientists suggests to the reviewers that 'our S&T community does not yet have the confidence and commitment of plan for and undertake the task of nation-building'. The review concludes with the now obligatory look eastwards to Japan and the truism that spirit and willingness are the key to all planning.

Reviewing another book, *Scientists in the Third World*, Subbiah Arunachalam (**page 420**) points out that the environment in which scientists in developing countries work and their ability to forge a community are crucial for realizing the potential of S&T.