bacteria possess an electron transport chain containing many of the components familiar from mitochondria, such as flavoproteins, iron–sulphur proteins, ubiquinones and cytochromes. Since these bacteria are simpler to work with we now have, for example, a means of studying proton translocation to verify aspects of the Mitchell chemiosmotic theory and also to look at the role of compounds such as cyclic AMP in determining alternative pathways of electron transfer. Both these organisms can be grown in anaerobic and aerobic conditions, with precisely specified nutritional conditions, sulphate or iron limitation for example, which will affect components of the electron transport chain.

The occurrence of the enzyme superoxide dismutase to protect organisms against the harmful effect of the superoxide which is produced when oxygen interacts with free radicals is now a very active field. Only recently have anaerobic organisms been shown to contain superoxide dismutase. C. Hatchikian (CNRS, Marseilles) reported on the isolation and purification of superoxide dismutase from the sulphate-reducing organism *Desulphovibrio*, an obligate anaerobe. This enzyme has iron in its active centre and is similar to the superoxide dismutase from aerobic prokaryotes, such as *E. coli* and the blue-green alga *Spirulina*. One of the hypotheses put forward as to why anaerobes need such an enzyme is that so-called anaerobic organisms need to be tolerant to small quantities of oxygen. The superoxide dismutase may be inherent to these organisms, or may have been acquired from an aerobic organism by plasmid transfer.

I. Probst (Göttingen) reported on the interesting symbiotic relationship between the sulphate-reducing, anaerobic bacterium *Desulfuromonas* and a green, sulphur photosynthetic bacterium *Chlorobium*. *Desulfuromonas* can utilise acetate as its electron donor and sulphur as its electron acceptor; the net energy difference in this reaction is rather small, but is quite sufficient for the organism to grow in symbiotic association with green photosynthetic bacteria. The green photosynthetic organism *Chlorobium* uses CO_2, in a classic photosynthetic mechanism, with H_2S as its electron donor, and produces sulphur, which is then used by *Desulfuromonas* with acetate as its carbon source to produce CO_2 and H_2S thus completing the cycle.

The recent discovery of three different ferredoxins was reported by A. Xavier and J. Moura (Lisbon Institute of Science and Technology) from *Desulphovibrio gigas*. These ferredoxins exist as trimers or tetramers and interestingly enough are able to catalyse electron transfer at negative and positive redox potentials in states of oxidation similar to those of the so-called "C-states" of Carter. What Xavier and Moura have shown is that naturally occurring 4Fe–4S proteins are able to exist as oligomers which themselves can give variations in redox potential. If it is a natural phenomenon and not simply induced by association of monomers *in vitro*, this may be the way in which iron–sulphur proteins can alter their redox potential either within a specific monomer or within the molecule as a whole by association of oligomers; oligomers, of course, can be induced by alterations in salt concentration, pH, and so on. This may in fact be one of the ways in which complex iron–sulphur proteins like nitrogenase and hydrogenase may be able to accumulate a number of pairs of charges before they catalyse reactions such as nitrogen fixation and hydrogen evolution. □

Control of external radiation dose

from a Correspondent

An international meeting sponsored by the Society for Radiological Protection and the UKAEA was held on October 19, 1976, at AERE Harwell.

THE protection of the environment has been widely discussed over the past few months. The objective of this meeting was to consider the main sources of occupational exposure which come from external β, γ and neutron radiations. J. A. Dennis (NRPB, Harwell) discussed the concept of dose-equivalent index and related topics. He expressed the personal opinion that the present lack of guidance from the International Commission on Radiation Units on the use of surveying parameters could give rise to overexposures. It is necessary to measure the dose equivalent at different depths in the body and the NRPB has proposed depths of 5 to 10 mg cm^{-2} and 700 mg cm^{-2} for skin and body respectively. J. R. Harvey (CEGB, Berkeley) was keen to introduce the concept of dose equivalent ceiling to avoid any possibility of overexposure. Thus it would be possible that a survey would give a potential dose of 200 mrem in a particular situation whereas measurements with personal dosimeters would give 100 mrem, both being equally valid, and it is on the latter dose that ultimate control would be exercised.

F. W. Spiers (University of Leeds) described the work by himself and T. Ashton to measure the dose to different organs in a man phantom, exposed to isotropic γ-ray sources (energy range 0.05 to 2 MeV). During discussion Spiers suggested that the dose to the active bone marrow was a reasonable approximation to the whole body dose and is approximately the dose under 53 mm of tissue. He also stated that the response obtained by rotating a phantom in a beam produces different results from those obtained by the use of isotropic radiation.

The large differences in shielding required by nuclear reactors and high energy accelerators was brought out by two papers by A. F. Avery (AEA, Winfrith) and G. R. Stevenson (CERN II, Switzerland). The accelerator shielding consists of earth and masses of iron (100 m long by 2 m in diameter) to bring the dose rate down to 1 mrem h^{-1} for occupational locations and 85 μrem h^{-1} at the site fence. Nuclear reactor shielding is required to reduce the dose rate to 0.1 mrem h^{-1} in these areas, but of course far less material is needed.

In contrast to these two papers E. J. Henshaw (Radiological Protection Centre, Liverpool) said radiation levels up to 1 rem h^{-1} were common in fluoroscopy, but these levels are only present for brief periods. Henshaw suggested that it was important to measure the X-ray generator parameters, in particular the potential across the tube. During the discussion it was suggested that it would be of interest to do a comparative cost-benefit analysis between reactor shielding and dose control in radiology departments.

H. W. Julius (TNO, Netherlands) contrasted the film dosimeter and the thermoluminescent dosimeter (TLD) for personal dose control. The former provides much more detailed information but the TLD has advantages of low atomic number, and linearity of response with fewer environmental effects. J. A. Douglas (AERE, Harwell) described some of the work of Cavallini from Italy and his own studies on the limitations of the albedo technique for personal neutron dosimetry. His work had showed that the ratio of the incident to reflected flux of neutrons could not be used to give the energy of the neutrons except in certain circumstances which could apply for a limited range of radiation shields. J. R. A. Lakey (Royal Navel College, London) brought the meeting to a close by discussing what we do when we cannot reduce the dose rate below 2.5 mrem h^{-1}. He emphasised the importance of working schedules and the sharing of the dose between workers. □