Given those considerations, it seems whimsical not to evaluate the potential role of nuclear energy in the future global energy equation. In the present public climate of almost religious fervor against nuclear power plants, there seems little chance that dispassionate analysis will be undertaken except within the scientific community. We have a responsibility, as always, to review such issues without regard to current political trends.

William R. Dickinson*
4831 North Via Sonrisa,
Tucson, AZ 85718, USA

*Emeritus Professor of Geosciences, University of Arizona.

■

Intrachain Calcium Binding

In the introduction of their article about vitamin K and energy transduction, Paul Dowd *et al.* (22 Sept., p. 1684) discuss the role of γ-carboxyglutamic acid (Gla) in serine proteases involved in blood coagulation. They outline a mechanism whereby Ca^{2+} ions anchor the proteins to cell membranes by means of ion bridges involving Gla side chains on the proteins and negatively charged phosphate head groups on the phospholipid membrane surface, a hypothesis that has been favored for a long time.

Recent studies have cast new light on the mode of interaction of Gla-containing proteins with biological membranes. We have found (*1*) the side chains of the Gla residues to be exposed on the surface of the protein and a cluster of three hydrophobic amino acids in the interior of the protein (*2*). Upon Ca^{2+} binding, the Gla residues fold into the core of the domain where they ligate Ca^{2+} ions in a cooperative manner. This leads to the exposure of the hydrophobic amino acids (Phe^4, Leu^5, and Val^8 on bovine factor X) that in the Ca^{2+}-free form are "hidden" in the interior of the Gla domain (*3*). These experiments, as well as other pieces of evidence, makes it seem likely that the reversible interaction of Gla-containing coagulation factors entails a significant component of hydrophobic interactions.

The role of Ca^{2+} in epidermal growth factor (EGF) domain–containing coagulation factors is even more complex, as a single Ca^{2+} ion, bound with five ligands from the EGF domain and one or two from an adjacent Gla domain, orients the Gla and EGF domains relative to each other in a manner commensurable with biological activity.

Sture Forsén
Chemical Center, University of Lund,
221 00 Lund, Sweden
Johan Stenflo
Malmö General Hospital,
University of Lund,
214 01 Malmö, Sweden

References

1. M.w. Soriano Garcia, K. Padmanabhan, A. M. deVos, A. Tulinsky, *Biochemistry* **31**, 2554 (1992).
2. M. Sunnerhagen, S. Forsén, T. Drakenberg, O. Teleman, J. Stenflo, *Nature Struct. Biol.* **2**, 504 (1995).
3. W. T. Christiansen, A. Tulinsky, F. Castellino, *Biochemistry* **33**, 14993 (1994).

Letters to the Editor

Letters may be submitted by e-mail (at science_letters@aaas.org), fax (202-289-7562), or regular mail (*Science*, 1333 H Street, NW, Washington, DC 20005). Letters will not be routinely acknowledged. Full addresses, signatures, and daytime phone numbers should be included. Letters should be brief (300 words or less) and may be edited for reasons of clarity or space. Beginning in October 1995, our previous policy of consulting with all letter authors before publication will be discontinued.