Thermodynamic solubility considerations of apatites have suggested that fluoride may occupy a special role in altering the solubility characteristics of this mineral family at equilibrium conditions. There is a need to expand these observations to include enamel. The use of animal models should also allow the effect of fluorides to be observed as a function of development of enamel and of dose of fluoride.

Parallel studies of the effect of fluoride on enamel development should also feature the use of pyrolysis to determine the effect of fluoride on the conversion of acid calcium phosphates to apatite.

Animal models will also provide an opportunity to assess the effects of fluoride on the overall porosity and pore size distribution of enamel formed under the influence of varying fluoride doses. These latter properties can be studied by the use of adsorption isotherms and their accompanying hysteresis loops.

A fourth aspect of fluoride effects on enamel centers around the effect of this element on the amount and distribution of elements in enamel which are not usual constituents of synthetic apatites. Chief among these is carbonate which is known to occupy at least two different sites in apatitic structures as shown by thermal analysis. The use of such thermal analysis to determine the relative amounts of carbonate at each effective temperature is recommended for: (a) apatites synthesized with known carbonate content, and (b) enamel which is clinically identified or experimentally derived as normal, fluoridated and fluorosed. Additional studies of the effect of varying levels of fluoride on Mg, Na and Cl ion incorporation should also be performed.

Critical tests of the thermodynamic model of fluoride anticaries mechanism, as opposed to the kinetic interpretation of the action of fluoride, should be developed. The former identifies the dominant factor as the energy available for the ejection of surface ions. The latter identifies the major factor as the diffusion of ejected ions away from the surface. Critical tests are required to determine which of these models can be shown to be incompatible with the observed facts of fluoride-apatite interaction.

On the assumption that small carious lesions are continually forming under in vivo conditions and that some of these must be restored to their native unaltered condition, it would be desirable to determine the
magnitude, duration, and other characteristics of such lesions. To do this it is recommended that efforts be made to study by in vitro means the development and reversibility of small carious lesions. Reversibility efforts should include complete restoration of the lesion as judged by at least two different criteria. The development of a technique for complete remineralization should help to identify the conditions necessary for producing this result as well as those factors capable of retarding the complete eradication of the lesion. Such knowledge is fundamental to an effective program of prevention. Methods which lead only to partial re-mineralization may be producing a delay of the caries process only. Since the process of lesion development is an intermittent one, it may recur with greater frequency in small lesions than in intact surfaces. The frequency with which CaF2 formation has been observed as a component of topical fluoride anticaries regimens makes it impossible at this time to conclude that this salt is not protective. While solubility considerations suggest that CaF2 may not provide lasting protection, its possible role as a reservoir of Ca and F for fluorapatite formation cannot be discounted. We recommend a systematic effort to determine the importance of CaF2 as a protective layer against caries. Current knowledge allows the use of inhibitors of apatitic structure such as Mg or phosphonates to be employed to influence the relative amounts of apatitic fluoride as compared to CaF2. Analysis of the amount of CaF2 can also be made using the KOH method. With the development of regimens which can produce fluorapatite or CaF2 at will, clinical trials should be instituted to determine the importance of each of these separately in preventing caries.

A similar experimental approach is needed to decide on the relative merits of finely divided vs. coarse surface coatings. Theoretical arguments concerning the physical consistency of surface coatings are not sufficiently advanced at this time to permit abandoning an experimental approach.

The mechanism by which fluoride enters enamel or apatite is as yet undecided. The relative roles of exchange, recrystallization and crystal growth need further investigation. Likewise the mechanism by which fluoride leaves apatite and enamel needs further study. Entry and departure mechanisms of fluoride in apatite may not be the same. The role of fluoride in promoting or inhibiting the absorption of protein films needs systematic study. The adsorbent needs to be studied by systematic variation of the amount of fluoride and surface area; and the possible adsorbate molecules need to be studied by stepwise changes of single variables to determine the roles of molecular size reactive groups and net charge in adsorption.