Upper urinary tract stone incidence has increased markedly in the 20th century, coincident with a decline in bladder stones. The pattern appears to be related to rising living standards (Blacklock, 1976).

All kidney stones form from relatively insoluble substances which crystallize from urine. In section, they usually show ordered growth rings consisting of compact crystalline masses that reflect phases of crystal deposition. Histochemical techniques reveal the presence of an organic matrix, interspersed with the crystals. The crystals may be of one type only (apparently "pure" stones), or they may be mixed. The predominant crystalline component is calcium oxalate, and over two-thirds of kidney stones in developed regions consist of calcium oxalate, with or without a calcium phosphate admixture (Williams and Prien, 1977). Such stones are often loosely termed "calcium stones" (Prien, 1974).

The genesis of most other stones, e.g. magnesium ammonium phosphate ("struvite" or "infection" stones) and uric acid stones, is well understood. This is not true for most calcium stones. Only some 10 to 20% of them are attributable to well-recognised causes, such as hyperparathyroidism, sarcoidosis, etc. These conditions give rise to excessive urinary calcium excretion, an important factor in calcium stone formation. Calcium stones without recognisable associated pathology have been termed "idiopathic", which includes a high proportion of unexplained hypercalciurias.

In addition to hypercalciuria, which, in the absence of other abnormal findings, may be classed as a "metabolic disorder", attention has focussed on the association of idiopathic calcium
stones with hyperuricaemia and hyperuricosuria. Occasional unexplained hyperoxaluria has also been recognised (Williams, 1978). Both hypercalciuria and hyperoxaluria have an obvious link with calcium oxalate stones. However, the connection with urate disorder is less immediately apparent. Very few calcium stones contain readily detectable amounts of urate (Prien, 1974), though a small percentage of patients form mixed stones containing calcium and uric acid (Coe, 1978a) and monosodium urate crystals have recently been identified in 1.66% of kidney stones examined in thin sections (Cifuentes-Delatte et al, 1978).

In stone-forming populations whose biochemistry has been studied in detail, hyperuricaemia and/or hyperuricosuria are present in about 30% of idiopathic calcium stone formers. No satisfactory explanation has been advanced for an influence of hyperuricaemia, but there is good evidence for a physicochemical explanation of the link between hyperuricosuria and calcium stone formation (Coe, 1978b).

High concentrations of urinary urate encourage the formation, growth and aggregation of calcium oxalate crystals. These are important steps in calcium stone formation.

Calcium oxalate crystals can only form in urine which is already supersaturated with calcium oxalate. The same applies to any substance capable of forming crystals (i.e. a crystalloid), a number of which are present in urine. "Supersaturated" describes a solution whose crystalloid concentration is above the maximum concentration reached by dissolving the solid crystalloid in water (the "saturated" state). Supersaturation with various crystalloids occurs readily in urine. It is a relatively unstable state, in that crystal formation becomes more likely as supersaturation increases. The scale of undersaturation, saturation and supersaturation in complex solutions cannot be related directly to crystalloid concentration, but is expressed in terms of its "activity product". The activity product of calcium oxalate, for example, is "active" calcium ion concentration X "active" oxalate ion concentration. In urine, "active" ion concentrations are influenced by (i) the presence of other ions, (ii) the ionic strength, (iii) pH, and must be calculated taking these factors into account. The activity product at which crystals form (the "formation product") is variable in urine (Pak, 1978a), though it is constant for a single crystalloid in water under defined physicochemical conditions. It is raised by crystal inhibitors and depressed by crystal promoters, both of which may be present in urine (see Fig. 1).