pled with relatively short-term biological residence, insured recovery of characteristic fibers.

In contrast to experimental animal studies, the amount of asbestos recovered from lungs of persons occupationally exposed to the fiber has ranged from reported values of 0.6% to 0.001% of lung weight.[18,19] Nagelschmidt noted[20] that the recovery of chrysotile asbestos from lung tissue is always low and recovery of amphibole asbestos generally high for human cases.

The second reason for the difficulty in extracting unaltered chrysotile fibers from human lungs lies in the fact that the nature of chrysotile asbestos is such that it tends to break down chemically and physically after prolonged biological residence. This is especially true of chrysotile fibers that have separated into their fine unit fibrils.

Chrysotile asbestos is chemically unstable even in distilled water.[21,22] An aqueous solution with a pH below 10.8 will cause the fiber to be leached of some of its magnesium. Chemical instability in a biological environment has been demonstrated several times. Morgan and Holmes,[23] following the "daughter" decay products of radioactive chrysotile asbestos, showed that magnesium was rapidly leached from the chrysotile fibers while in biological residence. This was also indicated by the work of Langer et al.[10] Electron microprobe studies of chrysotile asbestos fibers removed from the lungs of hamsters indicated a wide range of magnesium values in contrast to the narrow range in the fibers before injection. Similar results have been obtained in analyses of fibers and bodies removed from lung tissue of a Canadian chrysotile miner.

These findings are consistent with optical studies previously reported,[20,24] in which chrysotile asbestos removed from the lungs of workmen exposed to this fiber was found not to possess the same optical characteristics as did the materials to which they were exposed. Rather, the findings reflected chemically degraded fibers.

Marked physical changes in chrysotile may also take place in vivo. The chrysotile fiber composed of bundles of fibrils—breaks open, and the individual unit fibrils are separated. This has been demonstrated by Suzuki and Churg.[25] No such observations have been made with amphibole asbestos types, eg, amosite.[10]

This chemical and physical instability of chrysotile has made the quantitative extraction of asbestos fibers from the lungs of exposed individuals a problem that has not yet been completely solved. (See Nagelschmidt[20] for discussion.) As an alternative, it has been considered useful to at least obtain those fibers which had become coated (the "asbestos bodies"). While there are no data to quantitatively relate the presence of such asbestos bodies to the remainder of the asbestos present, it has been thought that it may at least reflect, to an undetermined degree, the presence of asbestos in general. Moreover, individual asbestos bodies can be removed for analysis of their coating and, more germane to the current problems, of their central, fibrous cores.

A useful method to obtain individual asbestos bodies for study is to isolate them by micromanipulation.[6] It should be noted, however, that micromanipulation must be done under the optical microscope, generally using low magnification. This inevitably produces a biased selection of large asbestos bodies from lung tissue,[10,16,26] since by definition the only bodies that can be manipulated are those that can be seen at such low magnifications! Micromanipulation of asbestos bodies precludes small asbestos bodies from analysis. Micromanipulation of asbestos bodies from human lung tissue, therefore, leads to particle selection. On the basis of the physical and chemical differences observed experimentally and determined theoretically for chrysotile and amphibole types, it may be concluded that the large recoverable fibers and bodies, selected by using the optical microscope, are more likely to be amphibole asbestos than unaltered chrysotile.

Timbrell et al[27] observed that what is seen by light microscopic methods often differs from what may be observed by electron microscope methods and that respirable-size fractions need not have the same size distribution or properties as those observed in the gross overall sample. Similarly, Lynch and Ayer[28] in describing the inadequacies of the impinger method of particle counting, concluded that only about one in 100 fibers present in the air could be seen by light