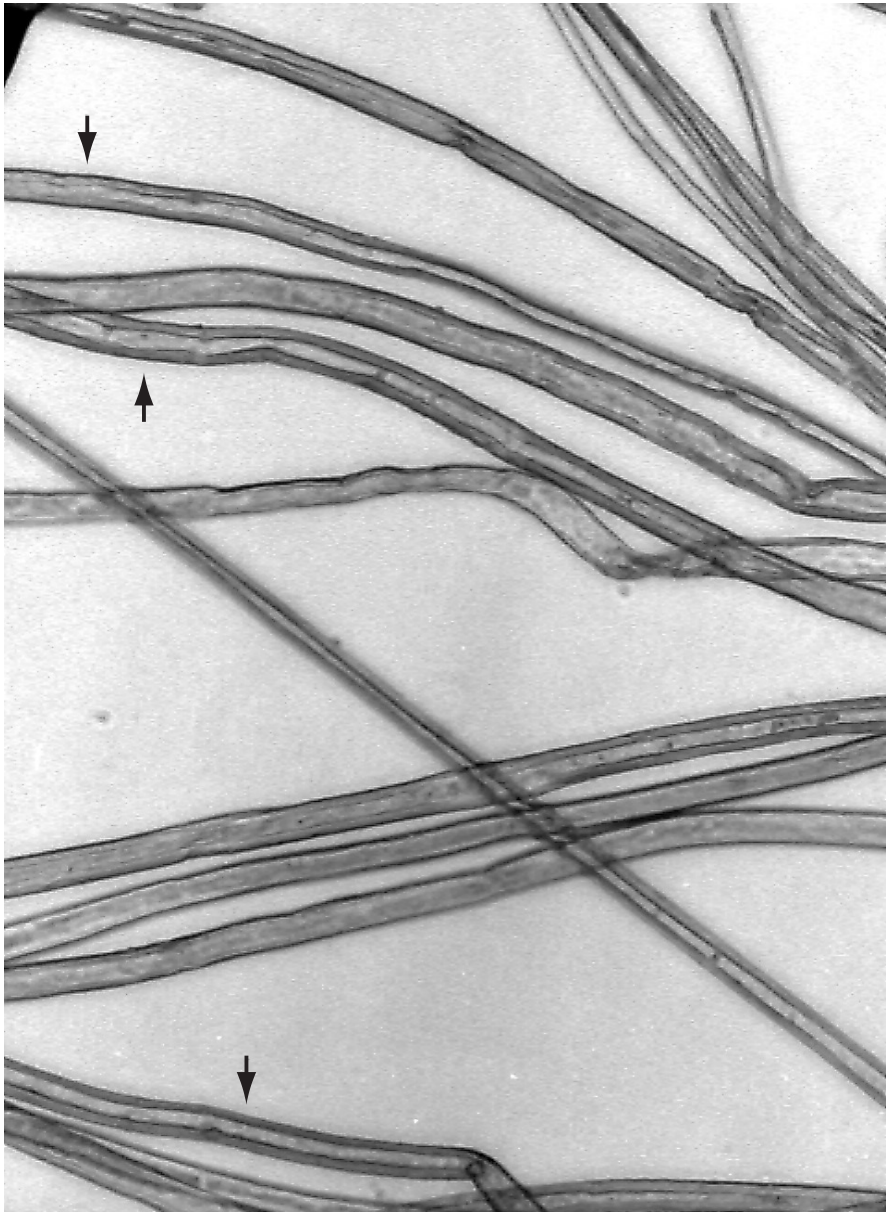


FIBER MATURATION

The mature fiber, before it dries, appears as a long cylinder (Figure 45). The normally cylindrical fibers collapse, producing a flattened, twisted ribbon structure (Figure 46).

Figure 45. LM view of mature fibers from a closed boll (i.e., never dried fibers). These fibers exhibit a cylindrical morphology and thick cell walls (arrows). (R.W. Seagull)

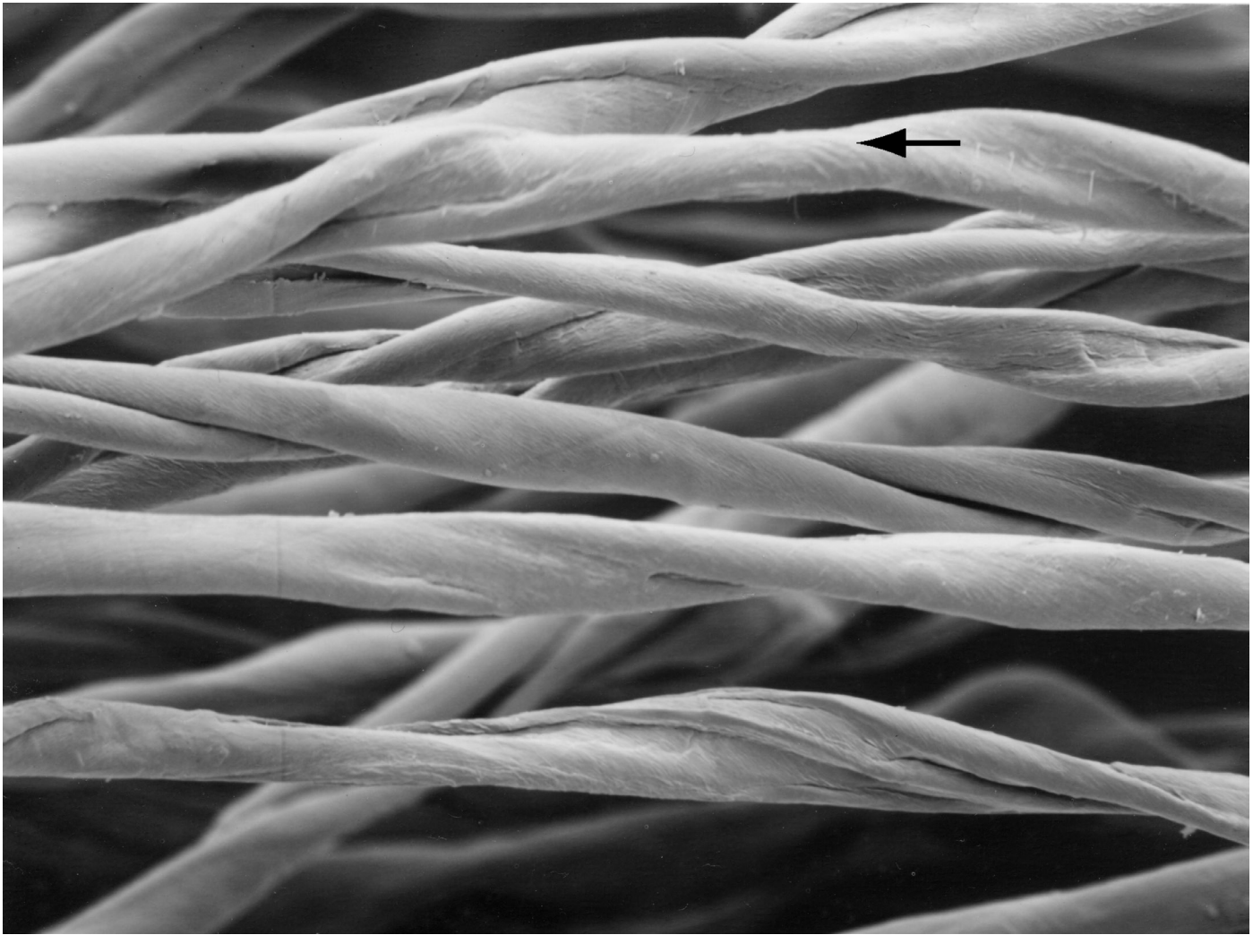


Figure 46. When mature fibers dry they twist and flatten slightly. Using SEM, the convolutions of the fiber are easily observed. Reversal patterns in the secondary wall are observed as impressions (arrow) in the thin primary wall. (Y.L. Hsieh)

If the fiber does not produce a thick secondary wall, the fiber is said to be immature. When such fibers are dried, they form thin, flattened ribbons with minimal twisting (Figure 47).

Figure 47. If fibers die before sufficient secondary wall is made, then fibers form flat ribbons. When viewed using SEM these immature fibers lack convolutions and exhibit abrupt bends and flat twists. (Y.L. Hsieh)

Because of the extreme length of the fiber it is impossible to photograph the entire fiber at a magnification that is suitable to see detailed ultrastructural elements. Low magnification views exhibit overall fiber structure whereas high magnification allows for the detailed analysis of fiber wall structure. When mature fibers dry, they bend and twist together to form an entangled, three-dimensional network (Figure 48). This natural twisting and entangling facilitates the spinning of fibers into yarn.

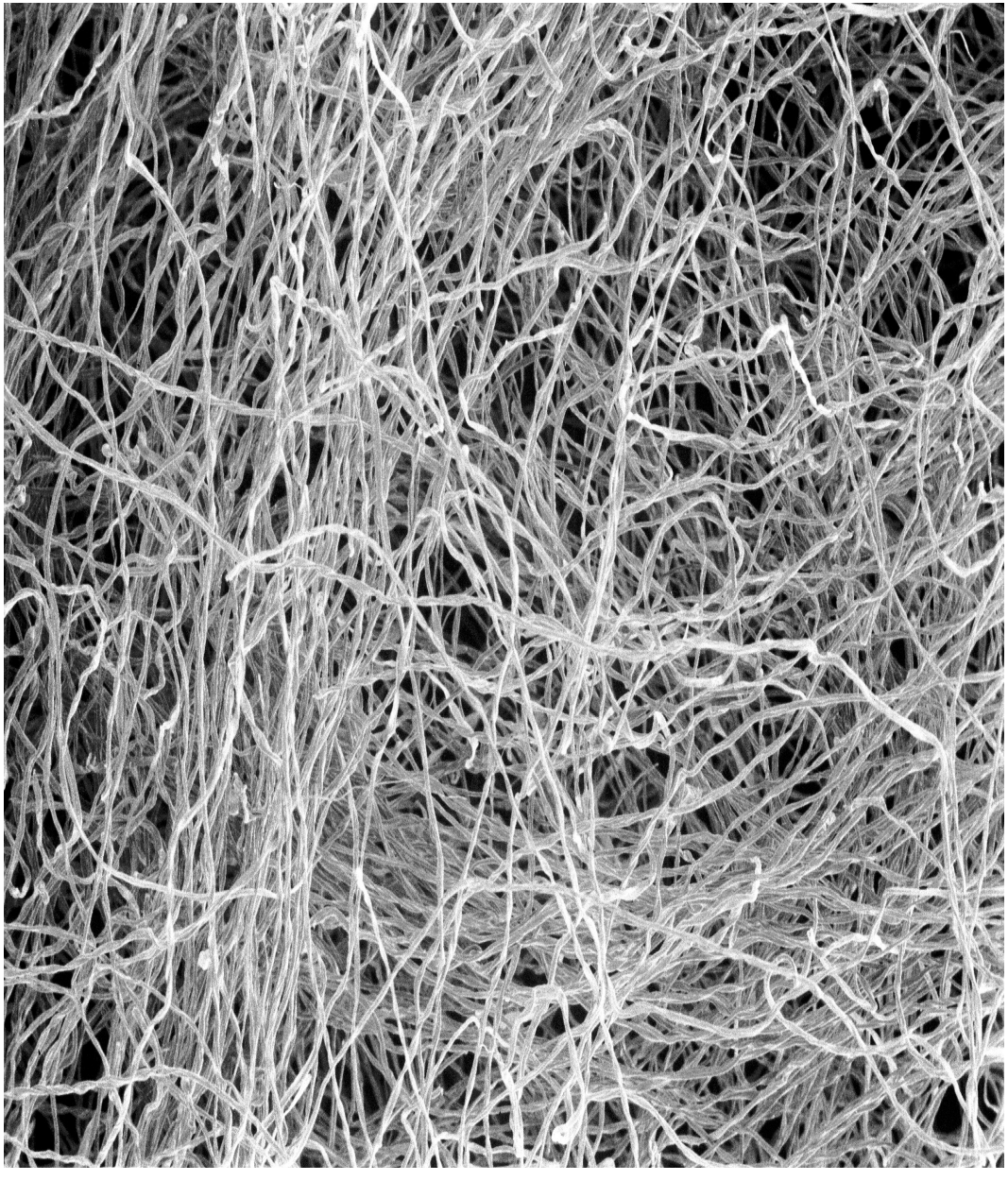
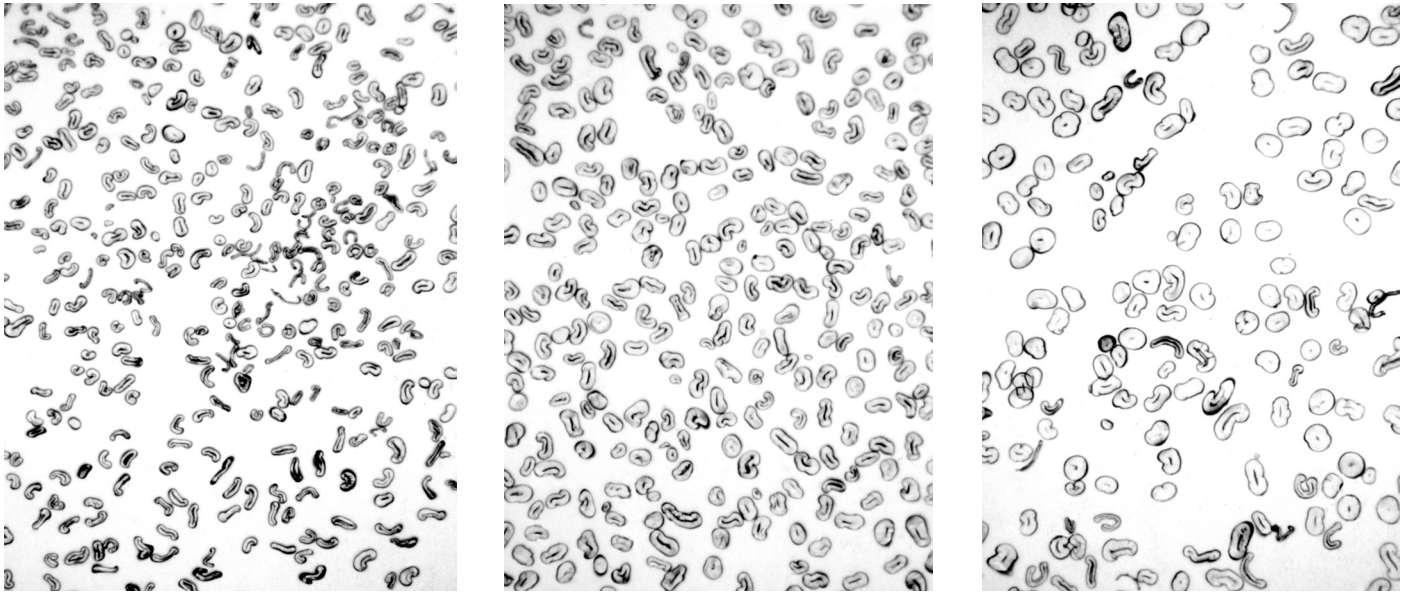


Figure 48. When viewed with LM, populations of dried fibers naturally exhibit twists and convolutions that facilitate the formation of yarns and fabrics. (M.J. Grimson)

Yarn and fabric quality is partially determined by the mechanical and physical properties of the fiber secondary cell wall. There is a direct correlation between the measurement of micronaire and wall thickness at maturity (Figure 49).



A. 3.1 micronaire **B. 4.6 micronaire** **C. 6.5 micronaire**

Figure 49. As fibers mature, the secondary walls thicken, thus increasing micronaire. Mature fibers can exhibit a range of micronaire values, depending on wall thickness. Panels A, B and C exhibit increasing micronaire values from 3.1 to 4.6 to 6.5, respectively. Note that fibers with thinner walls [panel A] have lower micronaire values. (E. Boyleston)

Because fibers begin development at different times (see section on initiation), on a mature seed there may be fibers with differing levels of maturity. If a population of fibers is examined for wall thickness, one often observes fibers with differing degrees of wall thickness (Figure 50).

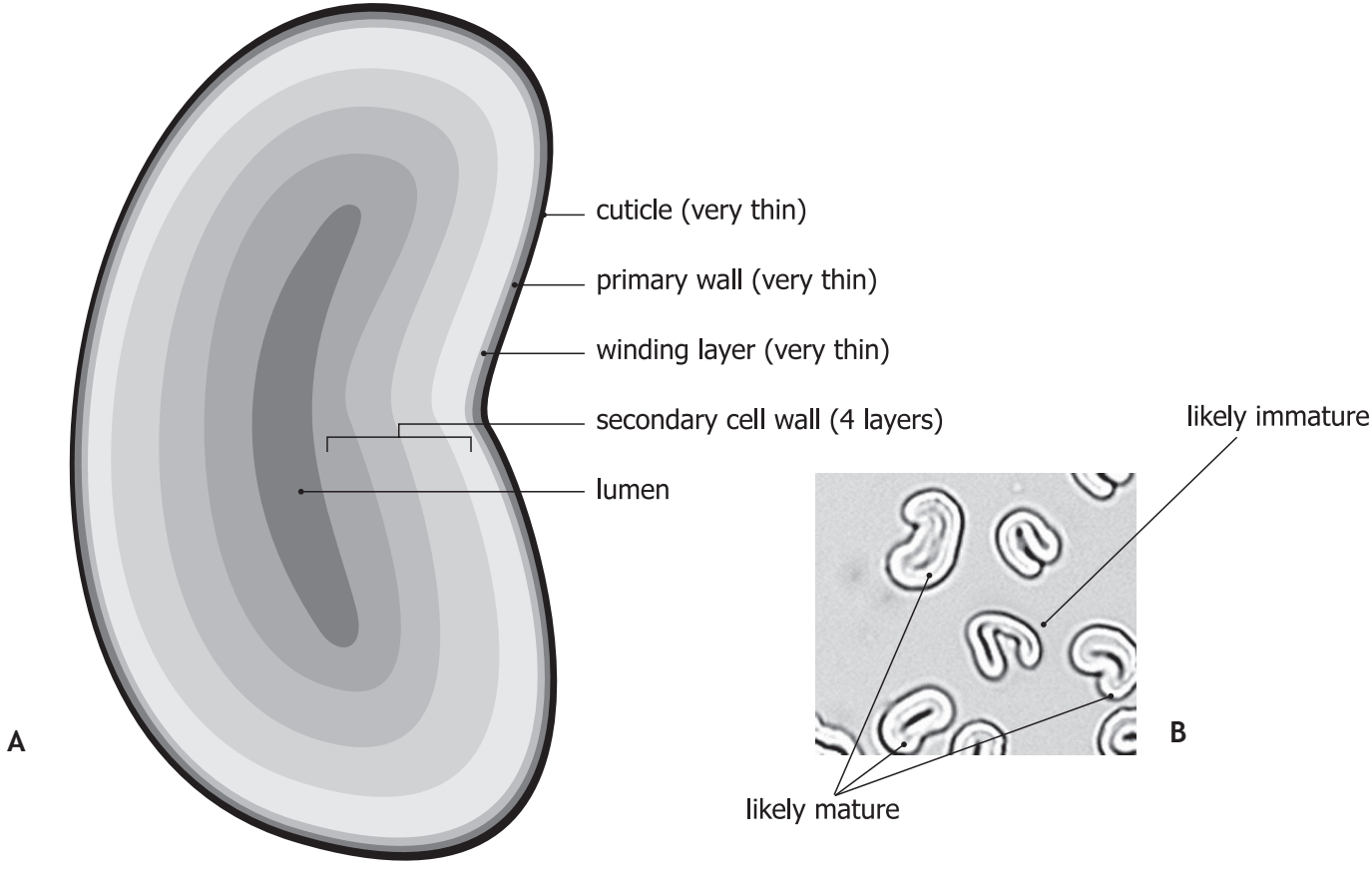


Figure 50. Within a population of fibers there is a natural variability in wall thickness (i.e., fiber maturity). This is easily observed when fiber cross sections are examined with light microscopy (B). Each fiber is composed of the multi-layered cell wall (A). (K. Charlton)

The mature dried cotton fiber represents the culmination of many biological processes. Reproductive branch development, flower production, ovule fertilization, embryo growth and epidermal cell differentiation all occur in specific sequence to produce fibers. The growth patterns of seed epidermal cells determine the quantity of fiber and the length characteristics. Wall development is the final biological process in the life of the fiber. Composition, organization and amount of wall material define fiber strength. Combined, these biological parameters determine the physical properties of cotton textile.