the direction of pharmacognosists, who were subsequently employed in the discovery of new drug candidates and received academic funding for new discoveries.

In this "grind and find" approach, biological materials are ground up and extracted with the purpose of finding new, pure chemical entities as drug candidates. This led pharmacognosists into the organic chemistry laboratory and away from the original plant-based medicines, the microscope, botany, zoology, and pharmacy. The result was an almost complete eradication of the botanical and microscopic aspects of pharmacognosy that had dominated in earlier decades. As recently as 2004, Norman Farnsworth, professor of pharmacy at the University of Illinois, Chicago, stated that "pharmacognosy, at least the aspects of crude drug identification and analysis, has disappeared from the professional curriculum of virtually all Colleges of Pharmacy in the United States—probably never to return!" This prediction, undoubtedly destined to become true, raises the important question: In which academic venue shall the invaluable skills of the classical botanical pharmacognosist be preserved? Perhaps, as originally, herbalists and botanists will preserve these skills, but it is a question yet unanswered.

Botanical Microscopy—Pharmacy's Unique Contribution to Science

The microscopic examination of plant tissues represented a uniquely new technique that offered a more in-depth and comprehensive view of the plant than was ever previously possible. With a microscope, even the contents of the cells could, for the first time, be visualized in a manner previously not attainable with the naked eye. Microscopy allowed detailed descriptions of plant anatomy and complemented the botanical illustrations and macroscopic characterizations of early herbals, adding a new dimension to the physical characterization of plants. As microscopic examination became overshadowed by chemical assessment as a means of evaluating identity and quality of botanicals, a misperception developed that chemical assessment was superior to physical examination—an assertion of many today. However, the analytical endpoint, rather than the tool, determines which of the many methods of pharmacognosy is most appropriate.

With every method of analysis, the intended use of the technique is the determinant of its utility. Macroscopic and microscopic evaluations remain the techniques of choice for establishing identity and for some quality determinations (e.g., foreign matter). Botanical microscopy, in particular, is uniquely valuable for the evaluation of dried plant materials whose characteristics are often dramatically altered from the fresh state, such as with cut and sifted or powdered forms. Drying and fragmentation of plants do not result in the loss of most characteristic microscopic features, which are therefore among the most stable of plant characteristics when it comes to identification. However, drying and fragmentation can result in dramatic changes in the chemical profile of the plant, thus limiting the usefulness of chemistry for identification purposes.

Molecular assessment is an emerging interest but remains insufficiently developed for purposes of routine plant identification and quality control. Analysts must make an informed choice about which of the available pharmacognostic tools will provide the information needed for solving the analytical challenge. From this perspective, all analytical techniques are complementary to each other. Additionally, in many cases associated with medicines derived from plant materials, microscopic examination can provide information that cannot be obtained by other methods. Thus, any assertion of the superiority of one method over another is simply a matter of its application, rather than a comment on the tool itself.

Microscopic Sleuthing

In 1775, British botanist and physician William Withering (1741–1799; Figure 1.12) was asked his opinion of a family herbal recipe for dropsy (edema), consisting of approximately 20 botanicals, used by a Shropshire herbalist, Mrs. Hutton. Presumably, Mrs. Hutton's secret formula was succeeding, whereas treatment by conventional physicians was failing (Withering 1785). Withering laboriously separated the leaf fragments of the prescription and identified fragments of *Digitalis* leaves through microscopic examination (Leake 1975). More than 200 years earlier, the famed German botanist-physician Leonhart Fuchs (1542) reported on the use of *Digitalis* for "the scattering of dropsy." Withering was familiar with the work of Fuchs and quickly surmised *Digitalis* to be the putative active ingredient, which subsequently led to the isolation and introduction of digitalis glycosides into modern medicine (Lee 2005) (Figure 1.13).