teachers receive training in preparing and planning materials for laboratory work and demonstration purposes.

3) *The fifth year.* A fifth year of work is strongly recommended. At least half of the course work during this year should be in science courses.

4) *Related science.* The elements suggested for inclusion of the earth science course are enumerated in the previous section. No statement is made about preparation of teachers to teach related science alone. Recommendations for preparation of teachers in such basic sciences as chemistry, physics, biology, mathematics, and physical or general science have been considered of major concern at this time.

5) *Credit to maintain certification.* Teachers who are required to take a certain number of credit hours to maintain their certificates after several years of teaching should take basic science courses in their teaching field unless they can show sufficient background of *recent* course work in that field.

6) *A synoptic view.* A survey of the requirements for the five science majors in this report (biology, chemistry, physics, physical science, and general science) shows that there exists a pattern of background common to all. Thus, each science major can be thought of as consisting of this common foundation plus certain additional preparation.

Specifically, the pattern of background common to all of the science preparations (but not including preparation for mathematics teaching) is, in semester hours, as follows: (i), biology, 6; (ii), chemistry, 8; (iii), physics, 8; (iv), related science, 3; (v), mathematics, 6—or a total of 31 semester hours.

Because there is so much in common among the five curricula in science, it is quite practical for the prospective teacher to qualify in at least two of the five science areas involved in this report. Specifically, it is quite practical for the prospective teacher of biology, chemistry, physics, or physical science to add a few more courses and qualify also as a teacher of general science. This combination, known in some places as a "comprehensive science major," is an ideal preparation for the modern teacher of science to high school students, although it must be recognized that it does *not* prepare him for more advanced study.

For the four-year programs, the requirements are summarized in Table 8. This synthesis of recommendations also suggests multiple qualification in secondary school science—for example, a teacher prepared in biology could also qualify in general science by taking four additional units in physics and three additional units in related science. By the addition of 10 units in physics and 9 units in related science, the major in chemistry could qualify for teaching physical science.

References and Notes

1. *School Science and Mathematics* (Feb. 1946).
2. The recommendations were as follow. (i) A policy of certification in closely related subjects within the broad area of science and mathematics should be established and put into practice. (ii) Approximately one-half of the prospective teacher's 4-year program should be devoted to courses in science. (iii) Certification to teach general science at the 7th, 8th, and 9th grade levels should be granted on the basis of a broad preparation including college courses in all the subjects concerned in general science. (iv) Colleges and certification authorities should work toward a 5-year program for the preparation of high school teachers. (v) Curriculum improvements in the small high schools should go hand in hand with improvement in teacher preparation.
3. "Bulletin on Advanced Placement Program" (College Entrance Examination Board, New York); B. Norton, "College admission with advanced standing," *J. Chem. Educ.* **33**, 232 (1956).

Milton Charles Winternitz, Pupil of William Henry Welch

In setting down the above title I felt no temptation to write "Milton Charles Winternitz, Pathologist." For if Winternitz were so described, where today would we find pathologists?

Four inscriptions adorn the walls of the School of Medicine at Yale. The first, over the main portal, announces: "The Institute of Human Relations–The Sterling Hall of Medicine." Here, high enough and plain for all to see, is set forth the great objective Winternitz set for medical science and the central ideal for which he strove—medicine, a study of the total man. To Winternitz, catching up the sparks of this lofty concept from his great teachers, endowed with youth, with brains, and with the courage and energy of a crusader, it mattered little that material assets at Yale were few when he arrived. You know the exciting story: bricks and mortar, the men, and always the ideas—ideas born of the happiness of constant work, of constant thought, and of steadily accumulating experience. "Yale will study man—total man," he said. With bewildering rapidity there came into existence, besides the magnificent medical school, a conception of the enormous importance of preventive medicine and public health, broad applications for psychiatry, the neurological study unit, the atypical-growth research unit, the dental study unit, the School of Nursing, and above all, the concept for the Institute of Human Relations. In each major field young men of extraordinary promise were assembled. But Winternitz, the dean, was not complacent. Often he said, "It's easy enough to grow apples, but can we grow better apples?" For him, any idea of a template for replication was unthinkable; all was new—spontaneous generation, or as some have said, "spontaneous combustion"! There is no doubt that things caught fire in New Haven. With what pride must he have viewed in 1932—side by side—the magnificent Institute of Human Relations and the Sterling Hall of Medicine, symbolizing then as they do today the ideals and ideas of many generations of teachers and students yet to come.

Over the inner doorway of the Sterling Hall of Medicine in the Greek of Plato is written: "Carrying torches,

they will pass them on, one to another." No need to say who put that there! Teaching for Winternitz dealt with inspiration and with inspiration alone. Vivid in his own memory was the joy he had in learning from William Henry Welch and the others at Johns Hopkins. If the student could only be inspired to think, learning would follow. "Universities," he said, "should be interested primarily in providing opportunity for learning and not in giving instruction: teaching need enter only so far as there is failure to learn. . . . A university should protect learning against the inroads of teaching or methodology of all sorts." These thoughts, translated of course into action, led to the freedoms of the Yale plan for medical education. The students have done well under this system, and I have yet to hear a graduate of the school decry it.

To the individual student, Winternitz always seemed, and often was, like an animal about to spring, so that alertness in class was essential for survival. His constant probing beyond the obvious was at times confusing, but it stimulated thought, and we never doubted that we were close to great events when he was with us. Even when speaking to the class he seemed to speak to each of us alone.

"Here is the place where death rejoices to be of aid to life." These humble words, in Latin, are inscribed over the Brady Laboratory of Pathology. Winternitz in his early days as dean worried about pathology as a science, but later on his worry ceased. He believed that pathologists in the old sense—morbid anatomists—would find their niche chiefly in service in hospital laboratories, and that they would play, in more academic surroundings, a decreasingly important role. He conceived the new pathology to be based on chemistry, on physics, and on physical chemistry, with morbid anatomy remaining as a yardstick. He became impatient with the microscope and with men with microscopes. For him, the new pathologist might have his basic training in any phase of medical science, and he must, among all men in medicine, be eclectic in his viewpoint, and be able to make correlations of importance and to synthesize ideas. With the enthusiasm of a man half his age, Winternitz welcomed in the era

Milton Charles Winternitz (1885–1959) [From a sketch for a portrait by Deane Keller]

of histochemistry, of electron microscopes, and of radioactive isotopes. That is, he welcomed these things for the younger men; he himself never mastered any of the more modern techniques.

Winternitz' own investigative work was carried out with the "old tools." He was too much of an administrator to get along easily with natural phenomena. Thus, he was often impatient when nature refused to follow a course he had laid out! Yet no matter how negative the report of a student's experiment, he always saw in it some budding principle of importance that would send the younger man off with renewed patience and determination. His love of administration runs through all his scientific work. One has but to look at the beautifully organized and illustrated monographs on influenza, on war gas poisoning, and on arteriosclerosis to sense his extraordinary ability for organizing research. Later, when he was no longer in the laboratory, he continued to organize. The three-volume *Fasciculus on Chemical Warfare Medicine,* edited under his direction during World War II, testifies to this. There followed, during his association with the National Research Council, the magnificent volumes of the *Atlas of Tumor Pathology* and, among many other creative projects, two active centers for the exchange of scientific information: the Chemical–Biological Coordination Center and the Bio-Sciences Information Exchange. During all of this time, too, he was leading, as director of the Board of Scientific Advisers, the Jane Coffin Childs Memorial Fund for Medical Research into the support of important projects on the fundamental aspects of growth. Whether in the laboratory, in the hospital, in a scientific meeting, or in the board room of a foundation, at the local or the national level, he always spoke out loud and clear—and usually those present listened.

The last inscription at Yale that comes to mind in writing of Winternitz is the most personal. It is a barely legible "MCW," rudely scratched in the pine panel over the door of the elegantly appointed Beaumont room in the Sterling Hall of Medicine. Hoisted on the shoulders of his friends and students, Winternitz carved it there at the climax of a party at the time of his retirement in 1950. This seemingly trivial act represents to me the very essence of the man, the very human side of this "human dynamo which ran at full speed through light and darkness." Much has been written and many have known of "Winter's" catalytic qualities. Many I know would have it, rather, that he was an inflammatory agent, causing rubor, calor, turgor, and dolor on contact! Winter the showman is also known to all. But not many of his colleagues over the world in science know of his extreme kindness and personal sacrifices for individuals sick or in trouble. How many know of his modesty or have witnessed the humble soul-searching that his high ideals, his bad mistakes, and his volatile temperament so often made necessary for him? His students loved him well. But I suspect that not even they really know how deep and lasting was his love for the medical institution he raised and cherished for so many years in New Haven. The sprawling initials over the door—was this the thoughtless act of a carefree moment? I doubt it. Those who were there went home silently.

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