

essor Marsh form the best collection in existence of these remarkable animals. The Invertebrate fossil collection is very large and includes many type-specimens, and a large number of beautiful preparations made by Professor Beecher. In Mineralogy, besides the elaborate, systematic show collection in charge of Professor Dana, there are the Brush collection and several student's collections. The Petrographical collection in charge of Professor Pirsson includes typical rocks and sections from all lands.

Besides the Museum, the laboratory of Professor Williams, with its selected collections of fossils, and his rich working library on Paleontology, are open to students.

#### PHYSICS.

Professor A. W. Wright, in charge of the Sloane Laboratory, is an investigator of first rank in the fields of electricity and light, in which he has made a number of discoveries of great practical value and theoretical importance. His studies of the phenomena of electric discharge, their shadow effects, and the chemical effects accompanying it, before Roentgen's brilliant discoveries were announced, prepared him to at once appreciate the full significance of the Roentgen rays; and he was the first in this country, and among the first anywhere, to confirm the phenomena and push on beyond the confines of Roentgen's first announcement.

His studies in the volatilization of metals in exhausted tubes, and the application of the method to the formation of metal-covered glass specula, has become of the highest importance in the construction of electrodes in the vacuum tubes employed for X-ray work. The contributions to knowledge regarding zodiacal light, the spectra of the sun, the polarization of the light from the sun's corona, are evidence of his place among physical investigators, and his brilliant expositions of the X-rays phenomena, called forth by public demand upon the announcement of Roentgen's discovery, are evidence of his powers as a lecturer and expounder of intricate physical phenomena. The Sloane Laboratory is equipped with one of the finest spectroscopes in America, and is throughout provided with the apparatus required for the most exhaustive methods of experimentation and original investigation in modern physics.

Professor C. S. Hastings's researches have been chiefly in the field of optics and in the perfecting of optical instruments, more especially the telescope. His study of the solar spectrum and sun spots, and the discovery that chemical compounds exist in the sun, are some of the more important theoretical results of his labors. His investigations of the laws of double refraction in Iceland spar, and the principles of refraction of light in general, have been of the highest practical value in the determination of causes of imperfection of sharpness of detail in images, and spherical and chromatic aberration, and the calculation of the forms of surface, and the determination of the chemical composition of the materials necessary for the production of the most perfect astronomical (and also microscopical) objectives.

Professor Hasting's laboratory covers one floor of the spacious Winchester Hall, and is admirably equipped for general physical work and study, more especially in its technical applications.

Professor E. S. Dana, as a contributor to the science of physics, is chiefly known by his works on the optical properties of minerals, and in crystallography. He has also written papers on specific heat and thermo-electricity. These, and his "Text-Book in Elementary Mechanics," give him a place among the pure physicists as well as in mineralogy, where his published results have been greater.

Professor J. W. Gibbs holds a very prominent place in the modern history of mathematical physics, and his theoretical deductions form a goodly part of the foundation of Physical Chemistry. No one is more ready to acknowledge this than Ostwald himself, the father of physical chemistry, in whose room hangs a large picture of Gibbs. Hardly a single text-book on this subject but recognizes him as both an important contributor and one of the founders of the same. Perhaps his most important published works are those on the

"Equilibrium of Heterogenous Substances," "Thermodynamics," and "Graphic Methods."

#### CHEMISTRY.

The Department of Chemistry in the University is represented by four laboratories, in which a corps of twenty-five professors, instructors and assistants, furnish instruction to nearly one thousand students in about thirty courses.

The Kent Laboratory, a large, three-story brown stone building, the gift of Albert E. Kent of San Rafael, Cal., represents the chemistry of the Academic Department of the University.

Professor F. A. Gooch is at the head, aided by Assistant Professor Philip E. Browning and four assistants. Professor Gooch is an analyst, and many contributions to the practical side of quantitative chemistry, both in the way of apparatus and method, have caused him to be held in high repute both at home and abroad. The introduction of the Gooch crucible has materially modified quantitative chemistry, and his method for the determination of boric acid remains to-day the only means of estimating boric acid accurately. Since the laboratory was opened in 1888, about seventy-five papers have been published, relating chiefly to analytical and inorganic chemistry, offering new methods, or modifying and improving others already known. Many of the recent iodine methods are included in this series, as are also the amyl alcohol separations of Professor Browning. The laboratory is exceptionally well-equipped for all kinds of research, and the recent addition of a new plant for electrical work offers an added inducement for graduate study.

The fine four-story brick Sheffield Chemical Laboratory is the newest and most modern building devoted to this branch of science in the University. An excellent corps of professors and instructors is connected with the laboratory, and an ample equipment furnishes means for a fine grade of work.

Samuel W. Johnson, Emeritus Professor of Agricultural Chemistry, has been an exceptionally active investigator for half a century, and from a large bibliography, mention can be made only of his two standard works, "How Crops Grow," (1868) and "How Crops Feed" (1870), which have been translated into German, French, Russian, Swedish, Italian and Japanese. Professor Johnson was influential in organizing the first, the Connecticut, Agricultural Experiment Station, and to his work can be largely attributed establishment of experiment stations in general, throughout the country, and the origin of the methods used in them.

Professor William G. Mixer has worked with success along several different lines, and in addition to a "Text-Book on Elementary Chemistry," has published many papers, chiefly in organic chemistry, of which his work on the amido bodies, and for the detection and estimation of sulphur, deserve special mention.

Professor Horace L. Wells is well known for his work on the formation of double salts, and numerous papers on analyses of rare minerals and metals. The laboratory has a strong representation of organic chemists, and its contributions have been very numerous.

Russell H. Chittenden, Professor of Physiological Chemistry, stands at the head of his science in America. While yet a student, he made the discovery that glycocholl was a constituent of animal tissues, and since that time has been very actively engaged in the investigation of physiological chemical problems, such as the primary cleavage products of proteids, the influence of various substances—drugs, poisons, alcohol, and the like—on digestion and metabolism, and the distribution of poisons in the body and their elimination from the system. His most important work was the investigation of the chemistry of the digestive processes, summed up in his book entitled, "Digestive Proteolysis," published in 1894. From these investigations much of our knowledge upon this subject has been derived. "Studies," published from 1885 to 1889, presents in printed form much of the work of the laboratory during those years. Professor Chittenden is President of the American Physiological Society, and has just been made Director of the Department of Physiological Chemistry of the College of Physicians and Surgeons of Columbia University. With Professor Gooch, he represents the chemists of the Uni-

versity in the National Academy of Sciences.

Professor Chittenden has been well seconded in his experiments by Assistant Professor Lafayette B. Mendel, whose work on the physiology of lymph formations is of great scientific value. The laboratory possesses unusual facilities for research work, as is shown by its many publications; and the excellence of the undergraduate courses is attested by the high rank which its graduates attain in the medical profession. The laboratory is overcrowded, and greatly in need of increased accommodations, presenting a very worthy object to generous alumni desirous of materially aiding the University.

Professor Herbert E. Smith, Dean of the Medical School and Professor of Chemistry, has labored chiefly in connection with the State Board of Health. Valuable investigations in the line of sanitary chemistry, mainly the analysis of potable waters, have given him a reputation as an expert analyst, and his determination of chlorine in the waters of Connecticut furnishes the standard for the State. A new laboratory, excellently well filled and equipped, is one of the advantages offered by the Medical Department.

A Chemical Club, composed of instructors, graduate students and others interested in chemistry, holds fortnightly meetings for the presentation and discussion of papers and reviews of recent work.

#### BIOLOGY.

The instruction in General Biology, Comparative Anatomy and Embryology, both for undergraduate and advanced students, is under the personal direction of Prof. Sidney I. Smith and Dr. W. R. Coe. Prof. Smith has held the position of Professor of Comparative Anatomy since 1875. He is best known from his numerous works describing the Crustacea of America, including the embryology of certain species.

The work in Physiology, as well as in Physiology Chemistry, is directed by Prof. Chittenden, of whom mention is made above. Recently a great deal of strictly physiological work has been done in his laboratory by Prof. Mendel, assisted by some of the advanced students. Some of this work has been published in the new *American Journal of Physiology*, of which Prof. Chittenden is an editor.

The opportunities for the study of Zoology are excellent in many ways. The large collections of the Peabody Museum, although but a very small part is on public exhibition on account of the lack of space, are available for the use of advanced students, and the location of New Haven on Long Island Sound makes it possible to obtain living or fresh specimens of marine as well as other forms of animals throughout the year.

Prof. A. E. Verrill, who has been Professor of Zoology since 1864, was for many years connected with the U. S. Fish Commission, and has described a great number of the new species of

marine invertebrates, collected under its direction. His published articles, notices and works, exceed two hundred in number, and deal with nearly every class of invertebrate animals. Among the most important of them are those on the echinoderms and corals of the West coast of America, and the invertebrates of the West Indies and the Atlantic coast of North America. At the present time the majority of zoologists have specialized to such an extent that they have greatly neglected Systematic Zoology and Morphology. Prof. Verrill is an exception to this rule, and there is no American zoologist whose investigations have covered so broad a field and, at the same time, have been so thorough in character, or who is a better authority on these subjects. Prof. Verrill's private collection, containing the type specimens of many North American invertebrates, is also deposited in the Peabody Museum.

#### BOTANY.

The Department of Botany is in charge of Dr. A. W. Evans. At the beginning of the present year, the herbarium of the late Prof. Daniel C. Eaton, who was the first Professor of Botany at Yale, and held the position from 1864 till his death in 1895, was added to the facilities for study. It comprises over sixty thousand sheets, mostly different species, and is particularly rich in the flora of North America, and in the mosses and ferns. On the latter Prof. Eaton was a leading authority, and his collection is exceptionally complete.

Although hundreds of similar institutions have sprung up since the Scientific School was started, and almost every State has now its State University for the teaching of the Agricultural and Mechanical Arts, the Sheffield Scientific School has steadily grown, and to-day has more students than ever before.

Under such instructors, the opportunities for advanced work in the various departments of science are especially favorable at Yale. The quality and spirit of true research is kept constantly up to the highest standard by the monthly publication of the *American Journal of Science*; a journal started here in 1819, and for a long time the only one of its kind in America, and always a leading journal of the newest and most substantial science-progress of the country.

Special clubs in Physics, in Chemistry and in other branches, furnish means of discussing current topics and keeping alive the enthusiasm of scientific research, and for the preliminary discussion of new discoveries. The instructors, though busy men, and eager to employ all the time, not required for teaching, in their own investigations, are ever ready to welcome earnest pupils in their advanced laboratories. With the inspiration, guidance and instruction of such men, those who come to Yale to get the best are not disappointed.

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