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PREFACE

Since 1897, when Leo Loeb took the first steps to maintain blood cells, connective, and other tissues outside the body in plasma or serum, there has been a remarkable increase in the volume of published research in the field of cell culture. There are several journals as well as numerous, excellent books devoted primarily or exclusively to this subject. Today cell culture is a scientific discipline which operates far beyond the narrow confines of its original goals.

Surprisingly, no periodical review of this field has appeared as yet, and the aim of this new serial publication, *Advances in Cell Culture,* is to fill this gap. The volumes will have international appeal, and will deal with all aspects of cell culture. "Cell culture," as used in this publication, includes the growth of individual cells or cell populations, the growth of small fragments of explanted tissue, the growth of organs, and the growth of obligate parasites in cell culture systems.

Volumes of *Advances in Cell Culture* will provide critical reviews of important aspects of *in vitro* cultivation and will reflect the increasing understanding of the wide ramifications of *in vitro* techniques. For this task we shall be relying on the continuous cooperation of our colleagues in many countries to review, synthesize, and interpret the advances made in their individual areas of investigation. It is our hope that *Advances in Cell Culture* will reveal from year to year the dedicated quest for the mastery of cell culture and the combined efforts of eminent authorities to evaluate new information so as to benefit all who use *in vitro* techniques in basic and applied research.

I am grateful to the Board of Advisors—Paul J. Chapple, Andreas Dübendorfer, Harry Eagle, Edwin H. Lennette, Toshio Murashige, Keith R. Porter, and James S. Porterfield—who will continue to suggest authors and review topics, thus providing invaluable assistance in the preparation of the volumes in this series. I am also indebted to the staff of Academic Press for their aid in producing this book.

KARL MARAMOROSCH

R. Goldschmidt.

RICHARD BENEDICT GOLDSCHMIDT
1878–1958

In the first volume of *Advances in Cell Culture* a biographical note was devoted to Ross G. Harrison, whose work formed the basis of vertebrate cell culture. In this second volume we felt it appropriate to include the biography of Richard B. Goldschmidt, the first pioneer of invertebrate tissue culture.

Goldschmidt was born in Frankfurt-am-Main, Germany to a wealthy, old German-Jewish family. He attended primary and high school in Frankfurt. His interest in biology started at 13, and by the time he was 18 he decided to become a biologist. At the request of his parents he first enrolled at Heidelberg University as a medical student, but two years later went to Munich where he became a zoology student. He returned to Heidelberg to receive his Ph.D. degree. His compulsory service in the German army ended with the withholding of an officer's commission because of his Jewish background. Similar experiences throughout his life in Germany had an impact on his personality (7). He returned to Munich University and remained there until the outbreak of World War I in 1914. During these early years he published several papers on histology, cytology, protozoology, and embryology. His most important work was on the nervous system of *Ascaris,* done from 1903 to 1910.

Goldschmidt then became interested in cell research, particularly meiosis. At the age of 29 he founded the *Archiv für Zellforschung,* and in 1911 he published one of the first textbooks on genetics. His work with the gypsy moth, *Lymantria dispar,* resulted, in his own words, in "an unbelievable piece of luck." He crossed the European moth with isolates from Japan and obtained normal males, but abnormal females that were sex intergrades. He repeated the crosses on a larger scale using other geographic isolates of gypsy moth. The results were outside the accepted laws of Mendelian genetics and formed the basis for the balance theory of sex determination.

In 1914 Goldschmidt was appointed a member of the newly created Kaiser Wilhelm Institut, and at the same time he obtained a fellowship to Japan to collect races of *Lymantria.* His return from Japan was prevented by the outbreak of the war in Europe, so Goldschmidt came to the United States and began working at the Osborn Zoological Laboratory at Yale University as a guest investigator. There he became associated with Ross G. Harrison. At that time, undoubtedly under Harrison's influence, he decided to attempt the cultivation of insect cells and thus became the pioneer of invertebrate cell culture. He suc-

ceeded in obtaining the spermatogenesis of the cecropia moth *in vitro*. He published his first paper on this subject, entitled "Some experiments on spermatogenesis *in vitro*" in 1915 in the *Proceedings of the National Academy of Sciences* (1). This contribution was followed in 1916 by a paper in German, "Notiz über einige bemerkenswerte Erscheinigungen in Gewebekulturen von Insekten" (A note about some remarkable events in the tissue culture of insects), in *Biologisches Zentralblatt* (2). The third and last paper on invertebrate tissue culture by Goldschmidt (3) was published in 1917 in *Archiv für Zellforschung*. It describes all his attempts to obtain spermatogenesis *in vitro* ("Versuche zur Spermatogenese *in vitro*"). Unfortunately, he did not follow up this work, and the next important step in invertebrate cell culture was made two decades later when William Trager succeeded in maintaining silkworm tissues *in vitro* (8) and, shortly thereafter, mosquito tissues (9), providing evidence for the multiplication of equine encephalitis virus in mosquito tissues.

J. S. Nicholas (6) recalls an incident that occurred during World War I. One night three graduate students who lived in the Osborn Tower were awakened by a Military Intelligence officer who wanted to know why lights were burning in certain rooms. The rooms were those of Goldschmidt's laboratory and the incident gave rise to rumors that he was sending signals to German submarines off the coast of New Haven. Many accepted this version even though the windows were at the rear of the Osborn Laboratory and the lights could not be seen from the harbor. When the United States entered the war, Goldschmidt was interned at Fort Oglethorpe in Georgia. After the war, he returned to Germany and continued his work in genetics.

In 1936 Goldschmidt was forced by Nazi Germany to leave the Kaiser Wilhelm Institut. He was offered a professorship at the University of California in Berkeley. He described this event as one of the happiest in his life. In 1942 he became a United States citizen and in 1947 he was elected to the National Academy of Sciences. His theory of evolution and his outdated concepts of genes and alleles were all but appreciated by modern geneticists, but in 1951 he was invited to deliver the opening address at the Cold Spring Harbor Symposium on Chromosomes and Genes (4). It was my good fortune to attend this symposium at the suggestion of Keith R. Porter and George E. Palade. At that time I knew nothing about Goldschmidt's pioneering tissue work, but his name was well known to me from my genetics course. During the symposium he was interested mainly in the work of molecular geneticists, particularly in the results presented by Barbara McClintock.

In September 1953 I saw Goldschmidt for the last time at the 9th International Congress of Genetics in Bellagio, Italy, where he was honored as the President of the Congress. Shortly thereafter he suffered a severe heart attack. Despite his illness, he was able to write an extensive treatise, "Theoretical Genetics" (5), many parts of which remain relevant to current genetic work.

KARL MARAMOROSCH

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