

TUMORS
of
BONE and CARTILAGE

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ATLAS OF TUMOR PATHOLOGY
Second Series
Fascicle 5
TUMORS OF BONE AND CARTILAGE

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Published by the
ARMED FORCES INSTITUTE OF PATHOLOGY
Washington, D. C.

Under the Auspices of
UNIVERSITIES ASSOCIATED FOR RESEARCH AND EDUCATION IN PATHOLOGY, INC.
Bethesda, Maryland
1971

Accepted for Publication
1970

For sale by the American Registry of Pathology
Armed Forces Institute of Pathology
Washington, D. C. 20305

ATLAS OF TUMOR PATHOLOGY

Sponsored and Supported by
AMERICAN CANCER SOCIETY
NATIONAL CANCER INSTITUTE, NATIONAL INSTITUTES OF HEALTH
U. S. PUBLIC HEALTH SERVICE
and
ARMED FORCES INSTITUTE OF PATHOLOGY

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EDITOR'S NOTE

The Atlas of Tumor Pathology was originated by the Committee on Pathology of the National Academy of Sciences-National Research Council in 1947. The form of the Atlas became the brainchild of the Subcommittee on Oncology and was shepherded by a succession of editors. It was supported by a long list of agencies; many of the illustrations were made by the Medical Illustration Service of the Armed Forces Institute of Pathology; the type was set by the Government Printing Office; and the final printing was made by the press at the Armed Forces Institute of Pathology. The American Registry of Pathology purchased the fascicles from the Government Printing Office and sold them at cost, plus a small handling and shipping charge. Over a period of 20 years, 15,000 copies each of 40 fascicles were produced. They provided a system of nomenclature and set standards for histologic diagnosis which received worldwide acclaim. Private contributions by almost 600 pathologists helped to finance the compilation of an index by The Williams & Wilkins Company to complete the original Atlas.

Following the preparation of the final fascicle of the first Atlas, the National Academy of Sciences-National Research Council handed over the task of further pursuit of the project to Universities Associated for Research and Education in Pathology, Inc. Grant support for a second series was generously made available by both the National Cancer Institute and the American Cancer Society. The Armed Forces Institute of Pathology has expanded and improved its press facilities to provide for a more rapid and efficient production of the new series. A new Editor and Editorial Advisory Committee were appointed, and the solicitation and preparation of manuscripts continues.

This second series of the Atlas of Tumor Pathology is not intended as a second edition of the first Atlas and, in general, there will be variation in authorship. The basic purpose remains unchanged in providing an Atlas setting standards of diagnosis and terminology. Throughout this new series, the term chosen by the Committee on Tumor Nomenclature of the International Union Against Cancer is shown by an asterisk if it corresponds to the author's heading, or as the first synonym in bold if it differs from the author's first choice. Hematoxylin and eosin stained sections still represent the keystone of histologic diagnosis; therefore, most of the photomicrographs will be of sections stained by this technic, and only sections prepared by other technics will be specifically designated in the legends. It is hoped that in many of the new series a broader perspective of tumors may be offered by the inclusion of special stains, histochemical illustrations, electron micrographs, data on the biologic behavior, and other pertinent information for better understanding of the disease.

The format of the new series is changed in order to allow better correlation of the illustrations with the text, and a more substantial cover is provided. An index will be included in each fascicle.

It is the hope of the Editor, the Editorial Advisory Committee, and the Sponsors that these changes will be welcomed by the readers. Constructive criticisms and suggestions will be appreciated.

Harlan I. Firminger, M.D.

ACKNOWLEDGMENTS

We are indebted to many persons who have contributed their time and effort to rewrite this fascicle for the second series of the Atlas of Tumor Pathology. We extend our special gratitude to Dr. Henry L. Jaffe, Dr. Alfred A. Angrist, and Dr. Raphael R. Goldenberg of New York, New York, and to Dr. J. Barnett Finkelstein of Houston, Texas, for the generous use of their case material.

The excellence of the photographs is due to the efforts of the staffs of the Medical Illustration Services of Washington University School of Medicine, Baylor College of Medicine, the Hospital for Joint Diseases, and the Armed Forces Institute of Pathology. Acknowledgment is made to Mrs. Marilyn N. Smith for her valuable aid in the preparation of the electron micrographs.

We gratefully acknowledge the secretarial assistance of Mrs. Adel Miles and Miss Pam Marker of Baylor College of Medicine and Miss Katherine Sandiford of the Hospital for Joint Diseases.

We wish to thank Dr. Harlan I. Firminger, Editor of the Atlas of Tumor Pathology and his staff, the members of the Editorial Advisory Committee, and the special critics for their invaluable assistance in making publication of this fascicle possible.

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- A. Sundermann & G. Bast.:
Folia Haemat. 86:47-69, 1966. For our figures 228a & b
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Cancer, Vol. II, 1958. For our figures 320, 321
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- The Franklin H. Martin Memorial Foundation:
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- The Journal of Bone and Joint Surgery:
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- The Journal of Bone and Joint Surgery (British):
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All illustrations are the authors' unless otherwise acknowledged. The atlas numbers are for identification of negatives at the Armed Forces Institute of Pathology.

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