THIEME FLEXIBOOK

Pocket Atlas of Cytology and Microscopic Anatomy

Wolfgang Kühnel

2nd Revised Edition

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Pocket Atlas of Cytology and Microscopic Anatomy

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Preface to the Fifth German Edition

Just over three years have elapsed since the fourth edition of this paperback was published, and two impressions have been necessary in the meantime. The success of this book may be interpreted as a confirmation of the author's opinion, formulated in the preface to the fourth edition, that in order to acquire the necessary knowledge of histology and microscopic anatomy the morphological structure is of major importance and that this pocket atlas provides appropriate guidance for the student faced with the task of recognising correctly the manifold forms and structures of a slide specimen in his histology course.

The fifth edition pursues the same didactic aims. The presentation and organisation of the contents have remained unaltered, but the number of illustrations has been increased from 300 to 337. Some photograms have been replaced by new ones, and in many places the brief textual descriptions have been revised and reformulated. I am grateful to Dr.h.c. G. Hauff, who made these substantial additions and revisions possible. Critical reviews and remarks received from colleagues and students have been gratefully accepted and have been incorporated in this edition whenever possible. I hope to profit from their comments and suggestions for improvements in the future as well. I am sincerely thankful to those colleagues at Aachen who have furnished me with illustrations; they have again been acknowledged in the respective legends. Mrs. I. Ackermann typed the final version of the manuscript, and Mrs. U. Grässler helped with the proof-reading and the subject index. I should like to thank them, as well as the staff of the Georg Thieme Verlag.

Aachen, December 1980 Wolfgang Kühnel

Preface to the Fourth German Edition

Ernst von Herrath, Professor of Anatomy in Berlin, worked – after the war – under great material difficulties on a book which was finally published in October 1949 under the title of "An Atlas of Normal Human Histology and Microscopic Anatomy". His illustrations were then praised as a pioneer achievement in the field of microscopic color photography. The book has gone through three editions since, the third edition appearing in 1971 under the title of "An Atlas of Human Cytology, Histology and Microscopic Anatomy". Ernst von Herrath did not live to witness the wide acceptance of this last, thoroughly revised and improved edition; he died on 12 June, 1972, shortly after his 65th birthday.

When the Georg Thieme Verlag suggested the production of a revised and restructured fourth edition, this presented an honorable, but at the same time rather difficult task. The cost of paper, printing and human labour have increased enormously in recent years so that the traditional layout and form of the book would have resulted in a price beyond the possibilities of students. Hence the original plan had to be changed: publisher and editor agreed upon a paperback edition. One consequence of this decision was some limitation in the amount of material to be included in the book. In its present form, the "Pocket-Atlas of Human Cytology, Histology and Microscopic Anatomy" contains only 300 illustrations. 198 illustrations have been taken directly from the third edition; 102 microphotograms, including 35 photographs using the electron microscope, have been newly added.

The pocket-atlas is mainly addressed to students of medicine and dentistry, who, in a course on microscopic anatomy (with reduced hours), are initially confronted with a confusing plethora of shapes to be found with histological structures. The intensity of our training suffers not only from reductions of teaching hours resulting from the most recent course regulations, but also from excessive numbers of students. One must add that, because of large numbers of students, staff shortages, and restrictive economic measures in the institutes, it is no longer possible, as in earlier times, to present a complete set of slide specimens to the students of medicine free of charge, which could then help them to widen their knowledge of histology individually. In such a situation a histological atlas plays a particularly important role as a body of illustrative material. However, this pocket-atlas cannot replace an unabridged course-book on cytology and microscopic anatomy. It is not intended to supply theoretical knowledge as presented in a histological text-book, but rather to help students orientate themselves in their courses on histology. It should also assist the student in recognizing correctly the form and structure of a histological specimen, and thus in formulating his diagnosis. In order to explain the illustrations, a legend containing the appropriate technical data, labels, etc. has been provided on the page facing each photograph. In most cases the order of pictures follows the traditional sequence of histology courses. Since an increasing number of photograms produced by electron microscopes tends to be employed and

discussed in histology courses everywhere – modern cytology is hardly conceivable without the knowledge of ultrastructures – a few illustrations of important cell structures by means of the transmission and the scanning electron microscope have been added.

The author is fully aware of the fact that opinions concerning the selection and order of the illustrations may differ considerably. Criticism will certainly be raised. But in order to further our goal it should incorporate concrete suggestions for improvement. We hope that we have succeeded in re-structuring the book and that this pocket-atlas will accomplish its task.

In the course of preparing the fourth edition I received a great deal of support. First of all I should like to thank Prof. Dr. med. Drs. h.c. W. Bargmann, Kiel, for checking the illustrations, for his suggestions and criticisms. I am particularly grateful to my colleagues at the Aachen Institute of Anatomy, as well as to the experts from institutes elsewhere who supplied the originals of photographs to me. They have been acknowledged in the legends accompanying the illustrations. I am also grateful to Mrs. I. Ackermann and Mrs. R. Becht, from Aachen, who took great care over the manuscript and the subject index, and also helped with the proof-reading. I owe special thanks to the Georg Thieme Verlag and the publisher, Dr. med. h.c. G. Hauff, whose encouragement resulted in the continuation of the atlas in its new form, as well as to Mr. A. Menge and Mr. G. Krüger, who never failed to show understanding for my aims and intentions.

Aachen, October 1977 Wolfgang Kühnel

Preface to the Second English Edition

To understand the microscopic structure of the human body, students need proper illustrations in addition to text descriptions. Particularly valuable as a learning source are actual light photomicrographs of the histological sections generally used, as well as illustrations of these tissues as seen through transmission or scanning electron microscopes. This pocket atlas of microscopic anatomy has been a useful tool in teaching histology to our classes at the medical school in Aachen. The core content of microscopic anatomy is included into this small pocket book. Obviously, it is difficult – if not impossible – to define the core content of microscopic human anatomy in such a way as to please all anatomists, physiologists, biochemists, embryologists, and pathologists. We have, however, done our best to include what the medical student should learn in this fascinating and continually growing branch of biomedical science. We are indebted to many associates of our Department of Anatomy who have assisted in preparing this totally new second English edition. Our co-workers, Julie O'Toole and Jennie Barbour, merit particular appreciation for their help in the translations. Mrs. Ria Becht and Mrs. Ursula Grässler have been extraordinarily helpful in the preparation of the translation manuscripts. Finally, we want to express our gratitude for the encouragement and assistance of Dr. H. C. G. Hauff, Mr. A. Menge, and the staff of Thieme Publishers.

Aachen, April, 1981

Wolfgang Kühnel
Henning Beier

Contents

Pocket Atlas of Cytology and Microscopic Anatomy

Cell Types

Fig. 1 Cells of the Spinal Ganglion

Size, shape and structure of mammalian cells vary considerably according to their various special functions. The cells of the spinal ganglion, depicted here, are spheroid or ellipsoidal elements, the diameter of which is between 20 and 120 μm. The nuclei are large and spheroid, and they contain only dispersed chromatin, but always a clearly visible nucleolus. The periphery of the ganglion cells is covered by neuroglial cells, here in the peripheral ganglion called satellite or capsular cells. The small, round or spindle-like nuclei of these satellite cells are nicely visible because of their heavy staining. There are bundles of nerve fibers among the ganglion cells, and in addition there is a portion of connective tissue with bundles of collagen (blue staining).

Cf. this figure, with Figs. 32, 133 and 134.

1 = nucleus of spinal ganglion cell with clearly visible nucleolus

2 = nucleus of satellite cell

Stain: Azocarmine G – aniline blue; × 400

Fig. 2 Multipolar Nerve Cell (Neuron) of the Columna Anterior of the Spinal Cord

This motor neuron has been obtained by careful maceration and squash preparation of spinal cord tissue. By means of this technique it is possible to preserve a considerable number of nerve cell processes, and these are stained in total.

A histological section would demonstrate only a few of the cut processes (cf. Fig. 14). However, it is not possible to distinguish between the axon (the axis cylinder) which finally ends with synapses at the skeletal muscles, and the branched dendrites.

Acid fuchsin method; × 200

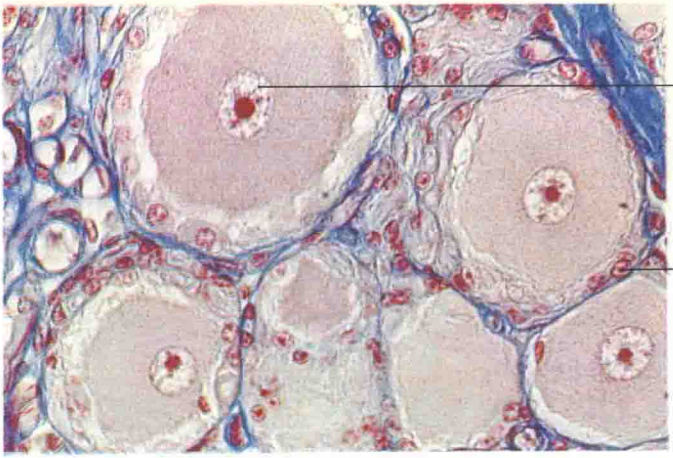
Fig. 3 Smooth Muscle Fibers

Smooth muscle fibers are long, spindle-shaped cells, which frequently are closely associated in bundles or sheets. Smooth muscle cells form the contractile portion of the wall of the digestive tract or other hollow organs (cf. Fig. 113).

By maceration techniques using nitric acid, these smooth muscle cells can be teased from the wall of those organs. The cells vary greatly in length in different organs. The average length varies between 15 and 200 μm, however, in the pregnant human uterus, they may reach even a half millimeter and more in length (500–1000 μm).

The elongated, rod-like single nucleus is found to occupy the thickest part of the fiber about in the middle of the cell. The nuclei of contracted muscle cells usually have a folded outline or may take on a helical form which is frequently seen in longitudinal sections.

Stain: Carmine; × 80



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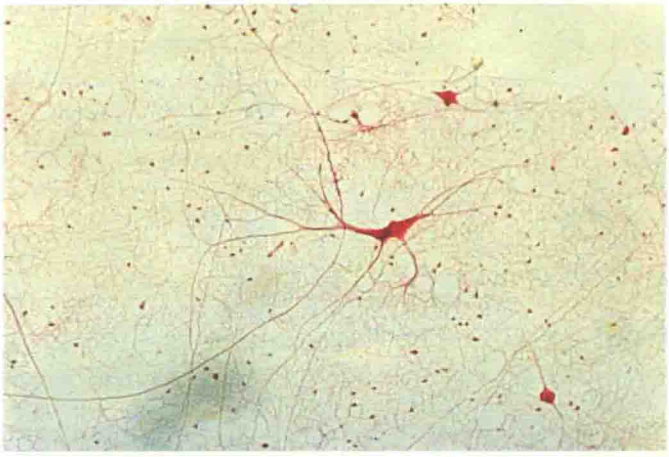

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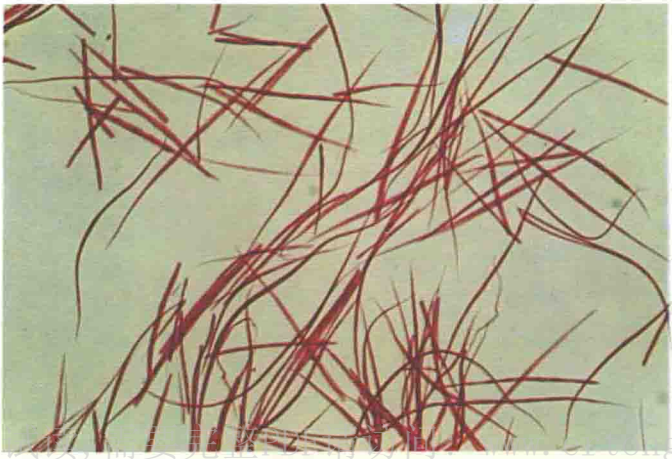

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Fig. 4 Fibroblasts

Fibroblasts (= fibrocytes) can be demonstrated in tissue sections only as slender spindle-shaped elements, however, spread preparations (e.g., mesentery of similar structures) yield the total configuration of these cells. The fibroblasts' shape depends on their physical substrate. They appear sometimes as flattened, stellate cells, sometimes as elongated elements with long tapering processes. With these processes, the cells often adhere to each other to form a cellular network.

The large, ellipsoidal nuclei in this figure show a rather homogeneous matrix. Usually, the chromatin is sparse and distributed in very small karyosomes.

1 = fibroblast

2 = nucleus of a free connective tissue cell

Gomori technique, silver staining in modified variation by the author; × 650

Fig. 5 Purkinje Cells from the Cerebellar Cortex

Golgi preparation of a Purkinje cell, showing its highly branched dendritic tree. The cell body (perikaryon) measures about 50–70 μm and it has 2 or 3 main dendrites, the branches of which reach the surface of the cerebellar cortex. The axon emerges from the basal part of the cell body and reaches up to the cerebellar white matter. A complete picture of the branching can be demonstrated only by using metal stains.

1 = axon

Golgi technique, silver staining; × 50

Fig. 6 Oocyte

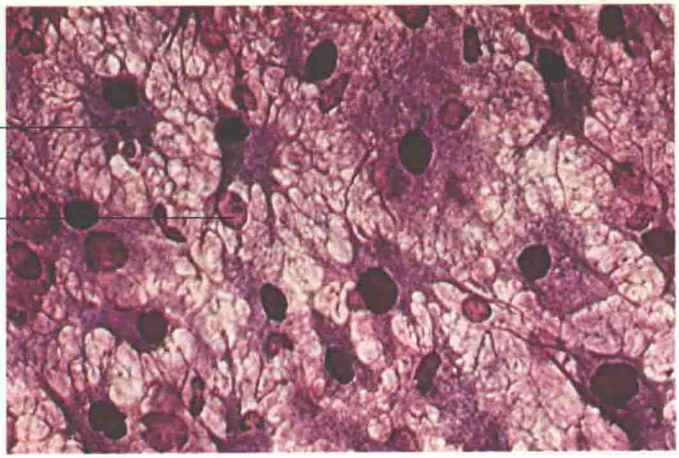
Oocyte (egg) from the ovary of a sea urchin. The large, intensely stained nucleolus is visible within the more faintly stained areas of nucleoplasm. The granular material of the surrounding cytoplasm represents predominantly yolk material, the cytoplasmic organelles are not visible by light microscopy of this preparation.

1 = nucleus 2 = nucleolus Stain: Azan; × 150

Fig. 7 Ganglion Cell of the Autonomic Nervous System

A large ganglion cell of the plexus myentericus (Auerbach) from the cat duodenum. Note the size of the nucleus.

Silver preparation according to Cauna; × 650. (Preparation by Prof. Dr. Sc. Med. Werner Stach, Rostock.)



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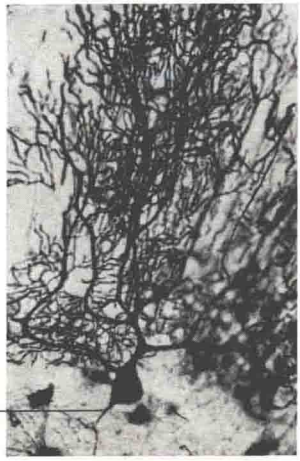

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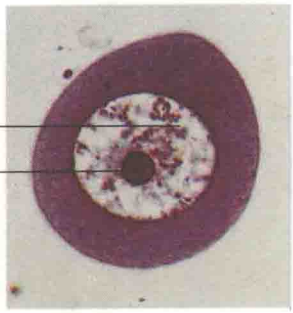

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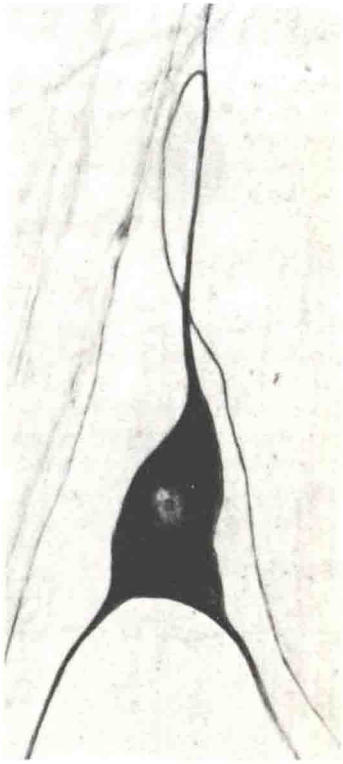

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The Nucleus of the Cell

Fig. 8 Nucleus

The nucleus and the cytoplasm can be regarded as a functional unit. The nucleus is the repository of the genome, and the regulatory center for the control of any cell function. The morphological shape of the nucleus is frequently related to the shape of the whole cell and can often be regarded as a diagnostic feature in pathologically altered cells. In most cells the nucleus is a spheroidal body, in the columnar epithelial cells it is usually an ellipsoid, in smooth muscle cells it is spindle-shaped, and in squamous epithelial cells the nucleus is also remarkably flattened. In the largest population of white blood cells, the granular leukocytes, the nucleus is segmented (e.g., polymorphonuclear neutrophilic cells).
In this micrograph we see a fibroblast of the subcutaneous connective tissue. The nucleus shows deeply electron opaque material distributed in fine granules (chromatin) and condensed along the nuclear envelope (heterochromatin). There is no nucleolus visible. Around the whole nucleus, we can see the nuclear envelope consisting of two parallel membranes enclosing the narrow perinuclear space. The cytoplasm of this fibroblast contains mitochondria, secretory granules, vesicles, free ribosomes, and parts of the rough endoplasmic reticulum.

Electron micrograph; × 13,000

Fig. 9 Nucleus

There are two elongated nuclei of two secretory epithelial cells from the Fallopian tube (rabbit), showing various indentations. The cytoplasm reaches all deep recesses and seems to divide the nucleus into segments. The granular chromatin generally appears fine and dispersed. Condensations are found only in few places at the inner nuclear envelope. The surrounding cytoplasm shows granular endoplasmic reticulum, secretory granules, and a few mitochondria.

Electron micrograph; × 8,500

Fig. 10 Nucleus

This nuclear profile shows a particular rectangular shape. It belongs to a cell of the lacrimal gland of a lizard. The nucleoplasm contains two large nucleoli, fine granular chromatin and abundant electron lucent "karyolymph", the interchromatin substance. The nuclear envelope is free of condensed material at the sites of nuclear pores.
i = wide intercellular spaces
↗ = desmosomes

Electron micrograph; × 12,000

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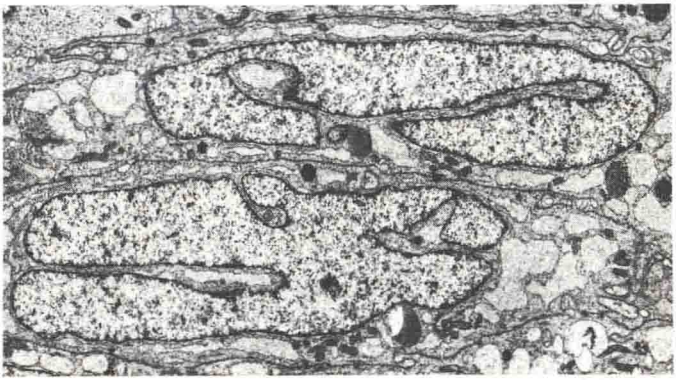

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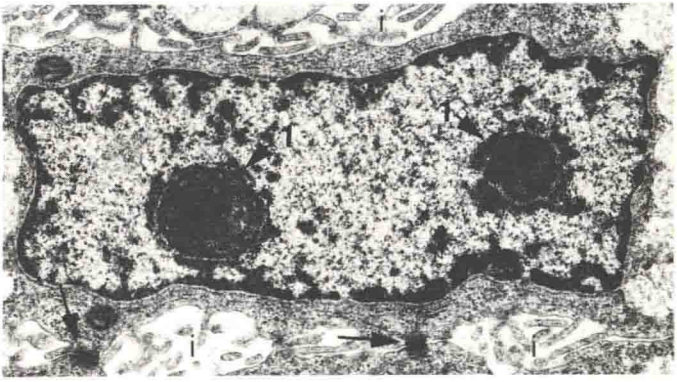

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Fig. 11 Nucleus

Part of spheric nucleus to demonstrate the structure of the nuclear envelope. This envelope is formed of two parallel membranes enclosing a 20–50 nm wide perinuclear space. The outermost membrane is continuous with the membranes of the endoplasmic reticulum. After mitotic division, the envelope reconstitutes by coalescence of membrane elements of the endoplasmic reticulum, demonstrating that the perinuclear space (perinuclear cisterna) may be considered as an integral part of the endoplasmic reticulum.

The inner membrane of the envelope is usually somewhat thicker than the outer membrane. Condensed chromatin is frequently located on the inner membrane of the nuclear envelope.

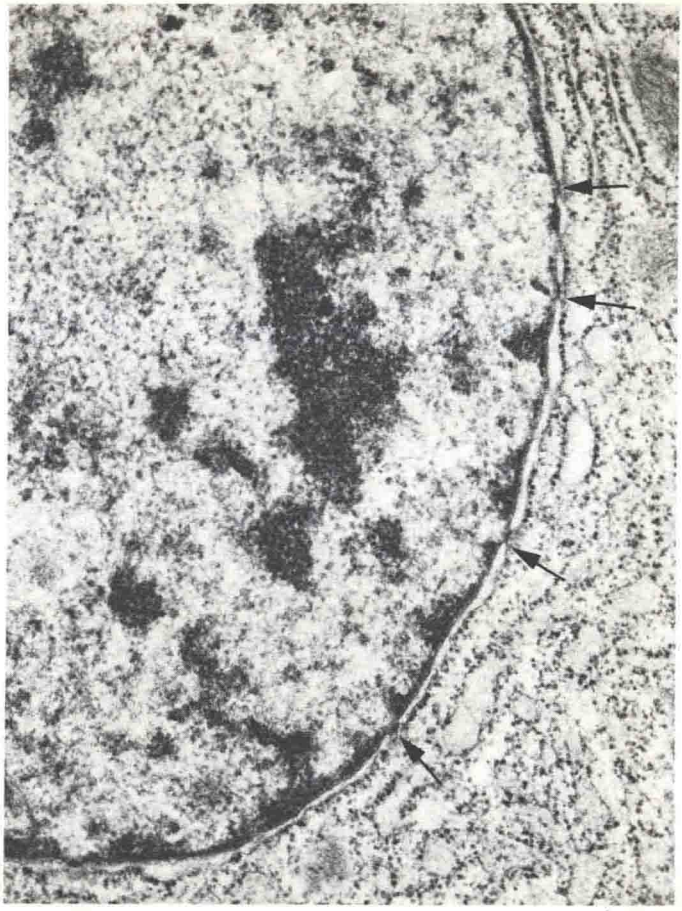
The nuclear envelope shows nuclear pores. These openings are about 50–70 nm in diameter, and are actually closed by a delicate septum, called the diaphragm, at which the inner and outer membranes are continuous.

Electron micrograph; by courtesy of Dr. Uda Schramm, Aachen; × 50,000

Fig. 12 Nuclear Pores

Tangential section of the surface of a nucleus showing the nuclear pores (P). The round, osmophilic coarsely granular area represents the heterochromatin, which is attached to the inner membrane of the nuclear envelope. The surrounding cytoplasm contains mitochondria and parts of endoplasmic reticulum.

Electron micrograph; by courtesy of Dr. Uda Schramm, Aachen; × 38,000



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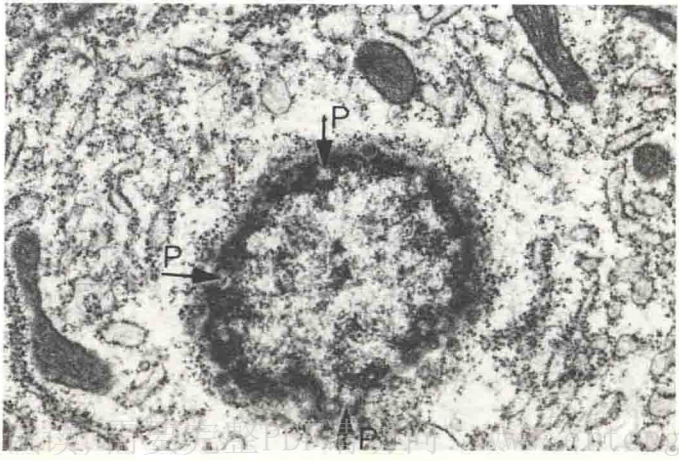

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