The Nucleus

The core of the cell (nucleus) is an obligatory cell organelle (except for the erythrocytes), usually the most voluminous and most conspicuous formation inside the cell, typically spheric, oval or reniform but very capable of adapting itself to functional requirements. The chromatin built of desoxyribonucleic acid is divided into heterochromatin and euchromatin (interchromatin) with a more active metabolism. The nucleolus (corpuscle of the core) containing ribonucleic acid is embedded in the chromatin substance. The covering of the nucleus separates its «genetic area» from the «economic area» of the cytoplasm. Interruptions of the nuclear covering, the nucleopores, assure an exchange of material between the nucleus and the space of cytoplasm.

Definition

The nucleus is an obligatory cell organelle surrounded by a membrane, which includes the genetic potential in the form of the DNA-containing chromatin and the nucleolus.

Historical data

After the discovery of the cell structure of charcoal and cork by R. HOOKE (1663), it took nearly two centuries till R. BROWN (1837) recognized the nucleus and E. R. v. PURKINJE (1839) postulated that all living creatures consisted of cells (cell theory). At the same time, M. SCHLEIDEN (1838) was the first to describe the nucleolus and recognized the cellular structure of the plants, which recognition was extended to the animal kingdom by TH. SCHWANN in 1839. In

his classical work «Microscopic Studies on the Conformity of the Structure and Growth of the Animals and Plants» he defines the cell as a structure of cell mucus, cell wall and nucleus with one or several nuclear corpuscles (cit. H. A. HIENZ, 1971).

The chromosomes were described first by K. W. NÄGELI in 1842. Not until more than 30 years later, E. STRASSBURGER (1875) became aware of their part in mitosis. The name «chromosomes» (chromo = colour–some = body) goes back to H. W. G. v. WALDEYER (1888).

Morphology

The findings resulting from the light microscope became more differentiated by electron-optical information.

The nucleus is spheric, ovoid, reniform, but can adapt itself very well to functional requirements (fig. 7). The contents of the nucleus are formed, in the language of the light-microscopy, by the «nuclear dyestuff» namely the chromatin and the nuclear corpuscle or corpuscles (nucleolus). Electron-optically, two kinds of chromatin can be differentiated: the heterochromatin near the nuclear membrane of the nucleolus consists of osmiophile granules 100–150 Å in diameter and of filaments about 50 Å thick (R. V. KRSTIĆ, 1976). The euchromatin or interchromatin, being less tight to electrons, is between the areas of heterochromatin; in question is probably the chromatin with a more active metabolism (fig. 6, 7).

The chromatin contains the genetic information in its desoxyribonucleic acid structures; the nucleolus includes ribonucleic acid.

Metabolic activity of the nucleus is suggested by deformation and deficiency in chromatin. At the same time, the nucleolus or nucleoli grow, the perinu-

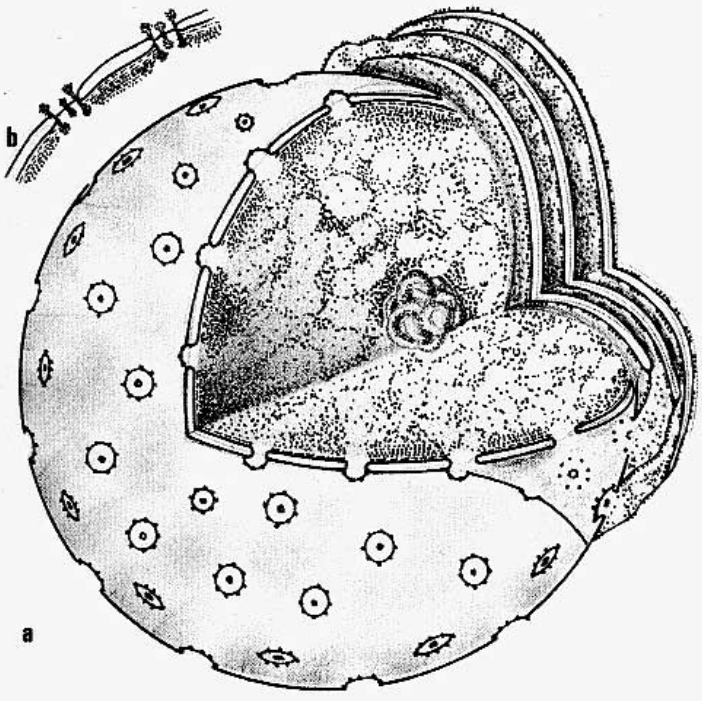

Fig. 4:
Model of nucleus seen from above with segmental section. Nuclear membrane of two layers, with nucleopores, in b) in longitudinal section; heterochromatin and euchromatin and nucleolus. The connections with the endoplasmatic reticulum are lined out on the right.

cleolar chromatin increases, a pars amorpha and a nucleolonema can be marked off clearer inside the nucleolus.

The form and structure of the nucleus meet the functional requirements. The nucleus in the head of the sperms e. g. is adapted to the hydrodynamic conditions of sliding and penetrating membranes, as a mediator of the genetic substance comparatively large in proportion to the threadlike cytoplasm. The egg-cell, on the other hand, has a relatively small nucleus and a large space for the cytoplasm. Nuclei of cylindric epithelia are adapted to the axis of the cylinder, the multi-dimensional osteoblasts have many nuclei.

The nucleus is covered by a membrane, or rather, by a system of membranes. This covering of the nucleus consists of (fig. 4, 5):

a) The Lamina fibrosa nuclei (Zonula nuclei limitans), an optically lighter zone 200–600 Å deep, which separates the chromatin substance from the (inner) nuclear membrane; it consists of microfilaments 20–50 Å thick, and probably represents the nuclear skeleton.
b) The inner layer represents the nuclear membrane proper i. e. the boundary line between the nucleus and the cytoplasm.

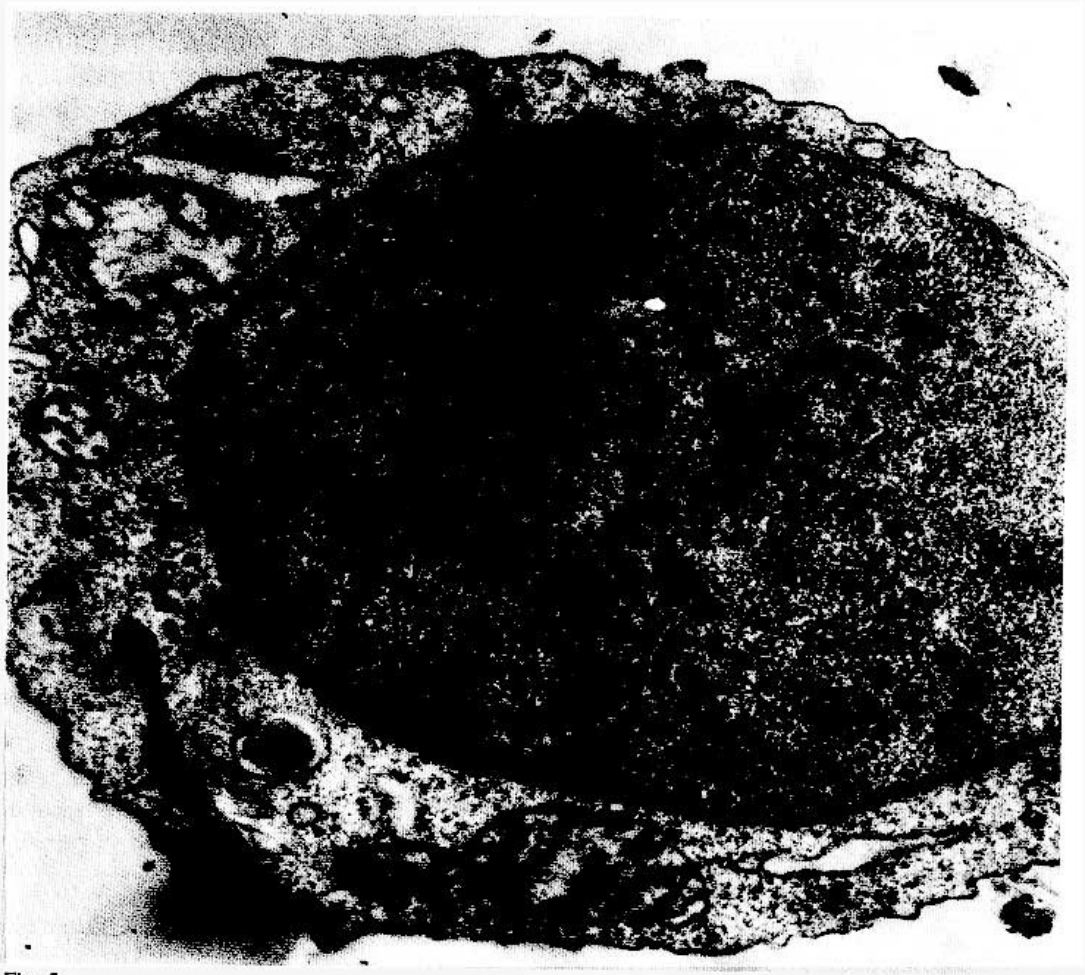

Fig. 5:
Double-layer nuclear membrane (arrows) in a large lymphocyte. Electron-optic final magnif. 1:20,000.

c) The outer leaf belongs to the endoplasmatic reticulum and is usually lined with ribosomes.
d) Both leaves are separated from each other by the perinuclear space 200–500 Å deep.

The nuclear covering is interrupted by the nucleopores.

Nucleopores

At the crease of the inner leaf of the nuclear covering adjacent to the outer leaf (fig. 4a, b) a membrane 50–100 Å thick, called diaphragm, spans the gap of the covering structure. Round openings are formed with a mean diameter of about 600 Å – the nucleopores. The centre of a nucleopore includes a consolidation area large about 100 Å, osteophile structures at the edge consolidate to constitute the so-called anulus; these structure elements make the nucleopores look like shooting practice targets when viewed from above.

A hypothetic postulate (FRANKE 1970, KRSTIĆ 1976) maintains that the anulus and the centre of the nucleopores consist of 8 or 1 (for the centre) clusters of thread molecules. These thread molecules span the diaphragm and, partly, project into the nuclear space, with their

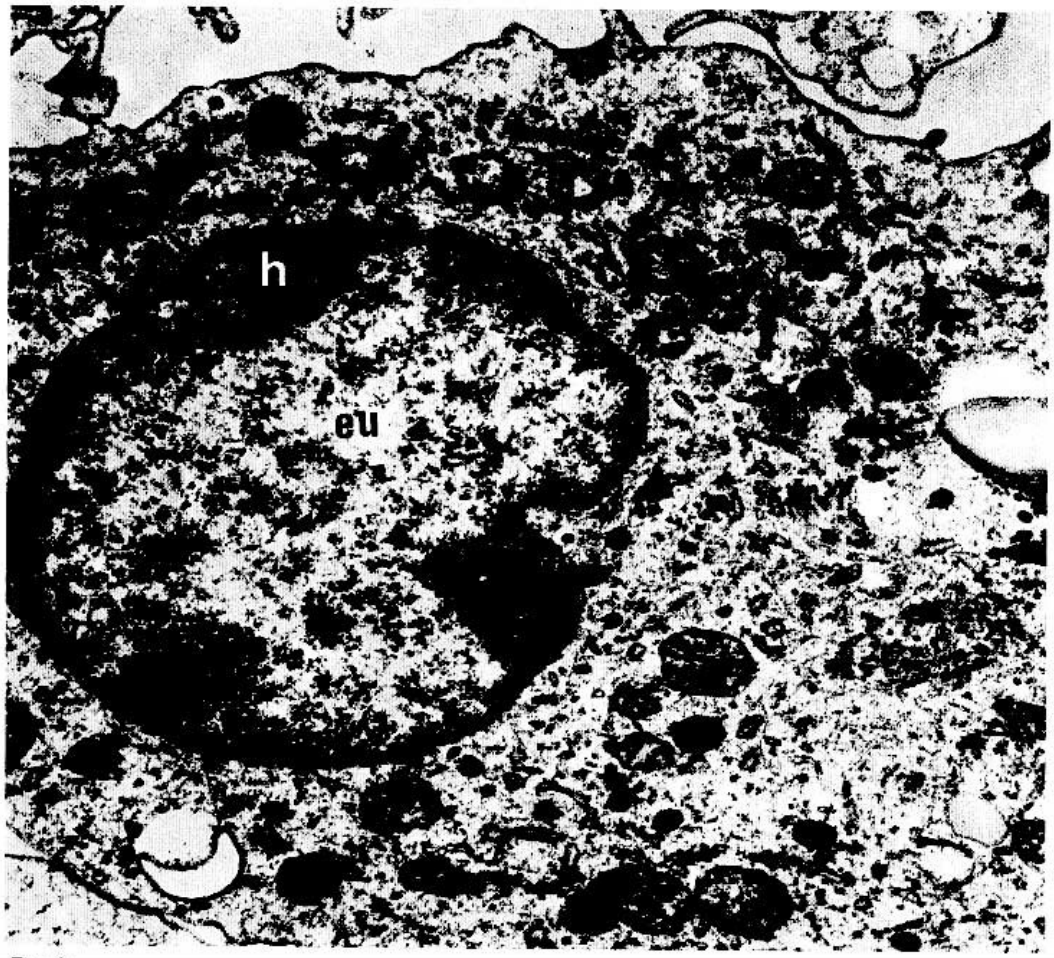

Fig. 6:
Dispersion of *heterochromatin* (h = darker areas in the nucleus) and euchromatin (eu = lighter parts) in a monocyte. Magnif. 1:15,000.

centripetal ends into the cytoplasm (fig. 4b). The areas of nuclear heterochromatin in the zone of the nucleopores are interrupted, which, electron-optically, causes brighter halos within the covering of the nucleus.

Even though it is difficult to make exact assertions about the function of the nucleopores, it can hardly be called in question that they serve for the metabolism between the nucleus and the space of cytoplasm. A quarter of the nuclear surface is occupied by the nucleopores. Through them, elements of the nucleic acids – chiefly aminoacids, purines – get from the cytoplasm into the nucleus. The nucleus for its part infiltrates, via the nucleolus, RNA (ribonucleic acid) through the nucleopores into the space of the cytoplasm.

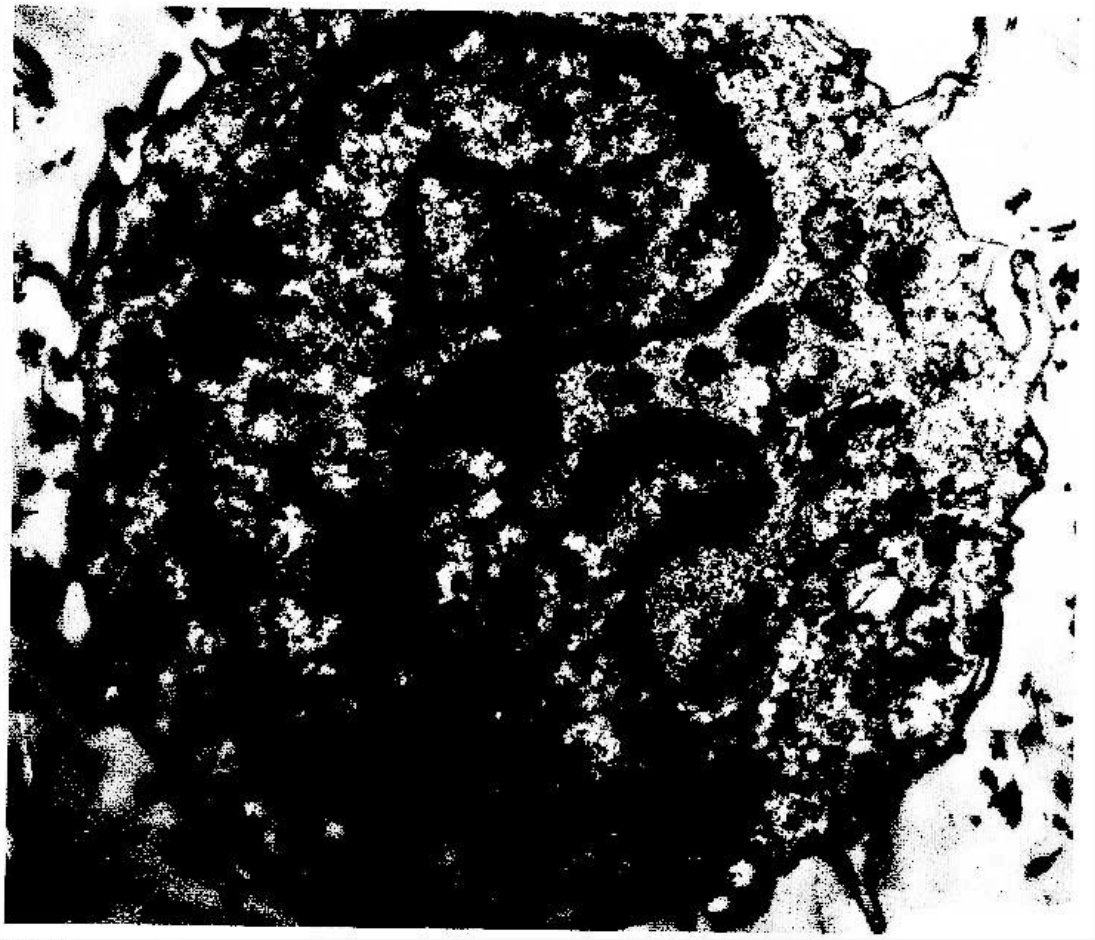

Fig. 7:
Plastic adaptability of the *nuclear form* in a monocyte. Large and optically compact nucleolus. Magnif. 1:15,000.