Centrioles

Definition: a centriole or diplosome is a characteristic, semi-autonomous cellular organelle, which, situated between the nucleus and Golgifield, regulates the division of cells by mitosis. If the area round the centriole is included in the function, the unit is called centrosome.

Morphology

The centriole or diplosome (= pair of centrioles of the cell) is situated near the nucleus, in disrounded cells mostly at the concave side – within the Golgifield, here also at the concave side of the bent multilayered Golgi lamellae (see fig. 1, 17, 18). The area round the centriole is called *centrosphere;* if the parts of the Golgi apparatus are included in the consideration, *centrosomes* are in question (fig. 3).

The positions of centrioles form the letter L (KRSTIĆ). Every centriole shows a characteristic formation of the cipher 9. Nine groups of microtubuli (triplets) about 0.5 mi m long form a cylinder of about 0.25 mi m in diameter (fig. 19). The triplets include angles of about 50°. The diameter of a microtubulus comes to about 200 Å; only the inner microtubulus turned to the lumen of the cylinder is circular, the two outer ones have a more

crescent-shaped cross-section when viewed from above. Two appendages of an electron-tight material protrude from the inner microtubulus; one of these appendages goes centripetally to the middle of the centriole cylinder and thus forms a ray of a star of 9 rays; the second appendage goes in an obtuse angle to the outer microtubulus of the neighbouring triplet (fig. 21). These branches thus outline more or less the outer wall of the centriole cylinder.

The centriole cylinder is surrounded by a zone of more compact material. Under favourable conditions of representation this zone dissolves to form spherical structures, which a stalk connects with the cylinder. These optically more compact spherical formations are referred to as satellites and are origin and guiding scope for the formation of microtubuli (fig. 21).

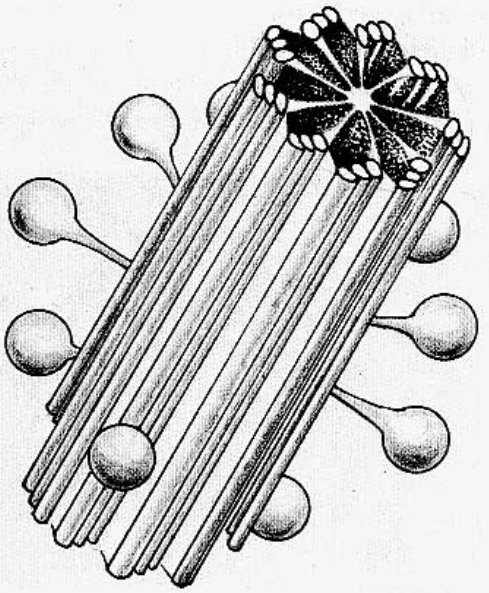

Fig. 19:
Three-dimensional representation of the *centriol.* Cylinder of 27 tubuli in 9 triplets. Radiate satellites.

In round cells, especially in leukocytes, the centrosome (= centriole + Golgifield) shows a distinct rhythmical oscillation (BESSIS M., 1972). In cell agony these movements of the central cell organelles subside, the cell undergoes some sort of liquefaction, which finally also destroys the centrosome. The centrosome is more resistant than the nucleus. The area of the centrosome is paler in the living cell and free from granules. In the oscillation, the nucleus takes shape round these seemingly more rigid structures. The centriole can just seldom be seen in the optical microscope as the size is close to the limit of dissolubility; under favourable circumstances, it can be recognized as a concentration within radial structures.

The relations between centriole and nuclear membrane are interpreted in different ways. LETTRÉ and LETTRÉ (1958), relying on a voluminous literature, were of the opinion that chromosomes, spindle fibres and centriole constituted a permanent structural unit, which remained invisible in the interphase of the cell. According to BESSIS and LONQUIN (1950), POLICARD and BESSIS (1953), the nucleus follows the movements of the centriole at a certain interval when the centriole moves away from the nucleus. The classical descriptions of the centriole by DE HARVEN and BERNHARD (1956) as well as STUBBLEFIELD and BRINKLEY (1967) give the following characterization: The centriole consists of 27 tubuli arranged in 9 groups. Three tubuli make a lamella. Every lamella forms an angle of 30° to the surface of the cylinder. Inside the cylinder there is a filamentous structure, with a helix having 8–10 threads to the length of the cylinder. The microtubuli are perpendicular to the axis of the cylinder. In the cells of the haematopoetic apparatus, the satellites are often arranged like spokes

round the centriole. The satellites have a diameter of 600–900 Å; they form two pericentriole coronae, from which the microtubuli issue. At the end of cell division the centrioles double by self-reduplication. Polyploid cells – e. g. megacaryocytes – contain up to 30 and even more centrioles.

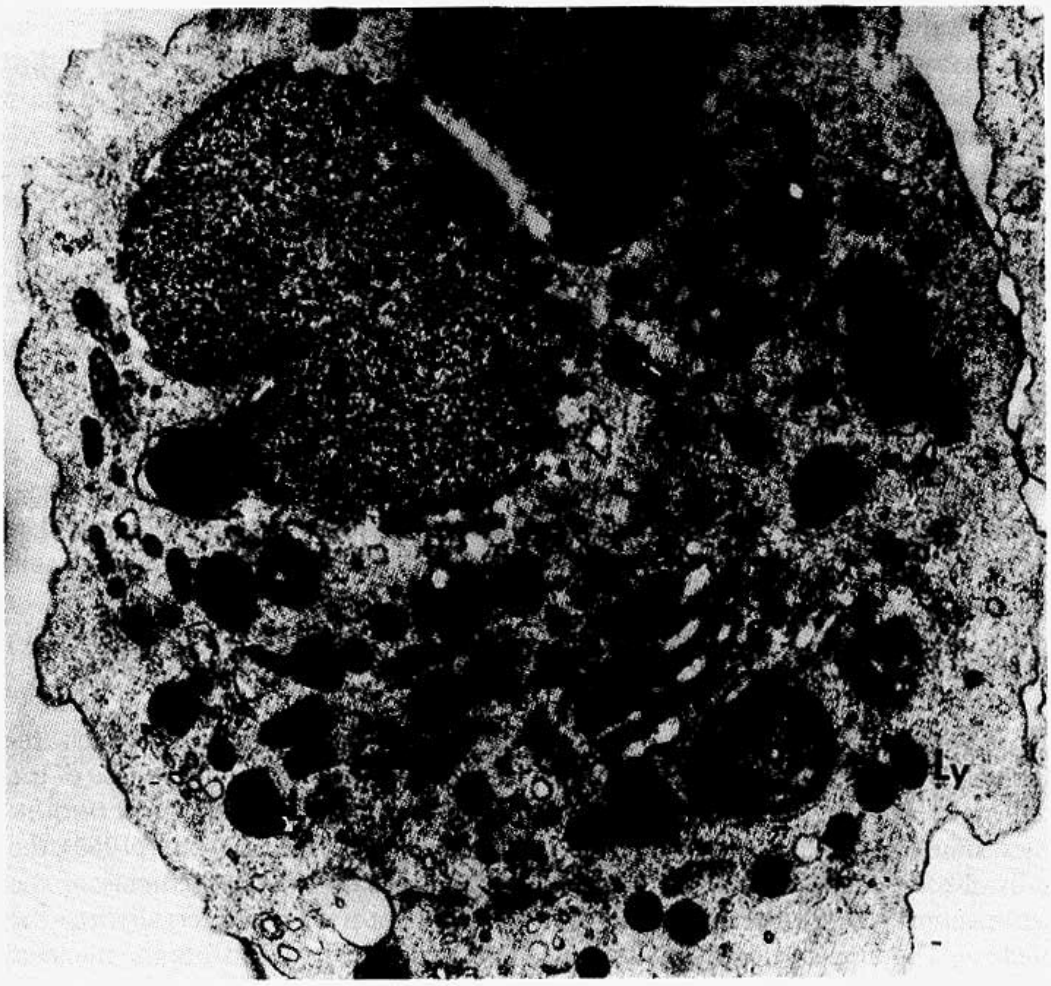

Fig. 20:
Polynuclear peritoneal exudate cell abundant in *lysosomes* (Ly) in the neighbourhood of the Golgi-field (G); N = cut nuclei. The lysosomes are homogenous, compact. Centriol (arrow).

Function

Centrioles have functions in mitosis, in the development of microtubuli as formations of the cell skeleton and for the movement of cells.

In the most important form of cell multiplication – as an expression of the perpetuation of the species of cells – mitosis is controlled by the centriole.

Prophase. In the prophase, chromatin condensations form near the nuclear membrane. The nucleolus is still in good condition, the nuclear membrane intact.

Prometaphase. The next step already shows the function of the pair of centrioles: microtubuli radiate from here and

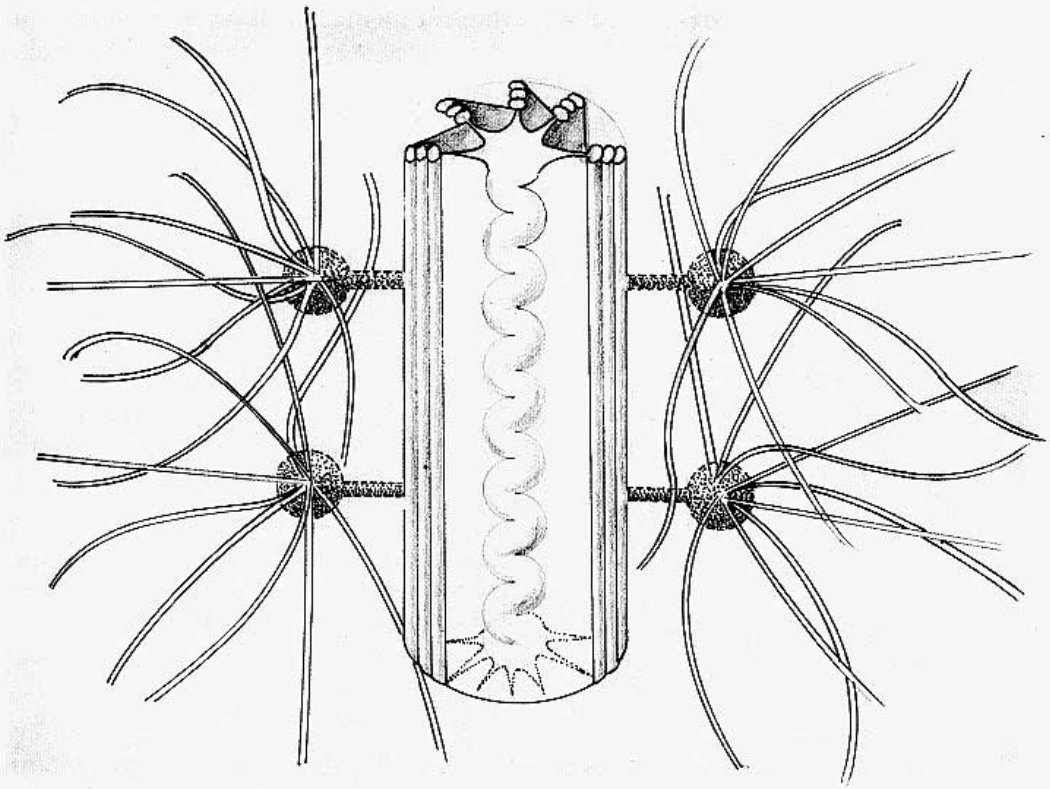

Fig. 21:
Cross-section of a *centriol* with cylinder wall, central helix, satellites and radiating microtubuli.

form the astrosphere when the chromatin masses of the nucleus have moved apart into 2 condensation fields, when the nucleolus has disappeared and the nuclear membrane shows larger or smaller interruptions or duplications. The astrosphere develops in the neighbourhood of the largest dehiscence of the nuclear membrane.

Metaphase. Microtubuli develop from the satellites in the formation of the «metaphasic spindle» (fig. 22) while the centrioles migrate towards the poles. As the chromosomes gather in the equatorial plane of the cell in the form of the so-called «equatorial plate», mitochondria, Golgi-apparatus and endoplasmatic reticulum disperse in equal parts on the halves of the cells. The microtubular apparatus issuing from the centrioles shows two orienting planes; long bipolar «continuous» microtubuli connect the centrioles of the two cell poles; short «interzonal» microtubuli are between the chromosomes. Thus the metaphasic spindle gets a three-dimensional skeleton, by the long microtubuli in the polar dimension and by the shorter in the Aequatorial plane.

Anaphase. By shortening the chromosomal microtubuli, either half of the chromosomes –the chromatides– is drawn to the corresponding cell pole. By condensation of the chromosomes isolated before, a nuclear fragment develops at either pole and is covered by a nuclear membrane first on the peripheral side.

At the same time, the microtubuli of the equatorial plane shorten and thus

cause the constriction in the middle of the cell (fig. 23–26).

Telophase. Through a wider, hourglass-like constriction go compact, nearly parallel, polewise microtubuli surrounded by consolidated substance at the narrowest point. Here, the two halves of the cells are separated later. Nucleus, nuclear membrane have formed anew in the two halves, and the nucleolus reappears at the end of the telophase.

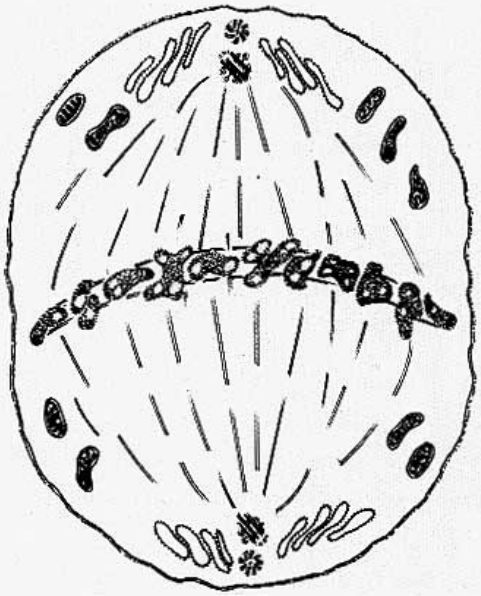

Fig. 22:
Arrangement of the *chromosomes* in the equatorial plane, of the centriols at the opposite cellular poles, of the polar interzonal and equatorial short microtubuli during mitosis.

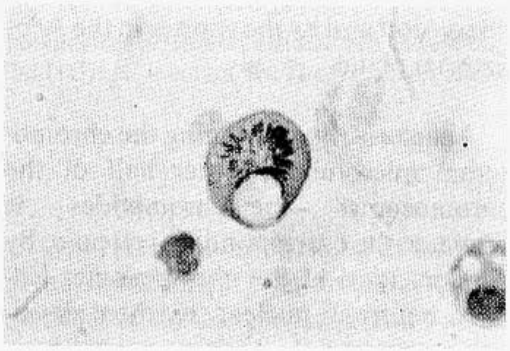

Fig. 23:
Mitosis: dispersion of the chromosomes. Monocyte. Alkal. phosphatase colouring. Peritoneal exudate, guinea-pig.

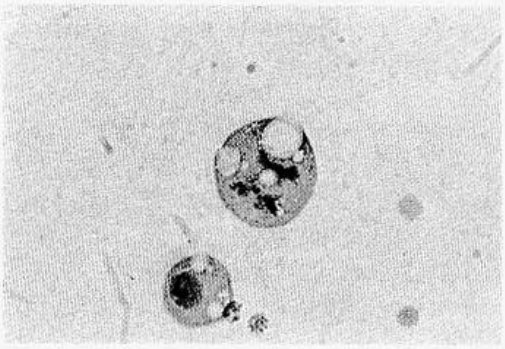

Fig. 24:
Mitosis: the chromosome couples have separated and move towards the cell poles. Monocyte. Alkal. phosphatase colouring.

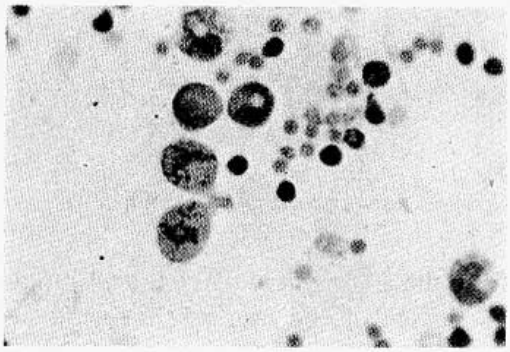

Fig. 25:
Accomplished mitosis with bridge of cytoplasm. Maturing immunocyte, peritoneal exudate, panchromatic.

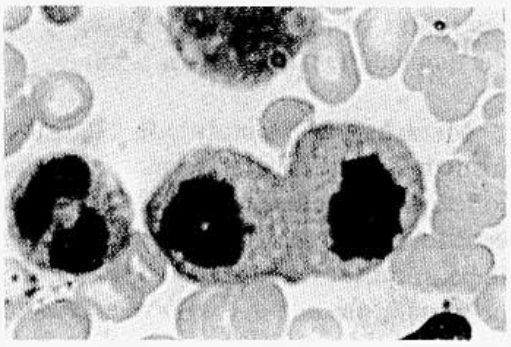

Fig. 26:
The chromosomes have reunited into a nuclear formation at the poles, the cytoplasm is about to contract in the middle. Bone-marrow, panchromatic colouring.

The RNA synthesis stops – as is visible with the nucleolus – from the middle of the prophase toward the end of the telophase. An increase of the lysosomal activity is one of the first signs of the forthcoming mitosis (BECKER and LANE/1965). This indicates a disintegration of structures of the interphase.