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Postmortem changes at a cellular level

by A.J. Chura

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Postmortem Changes at the Cellular Level

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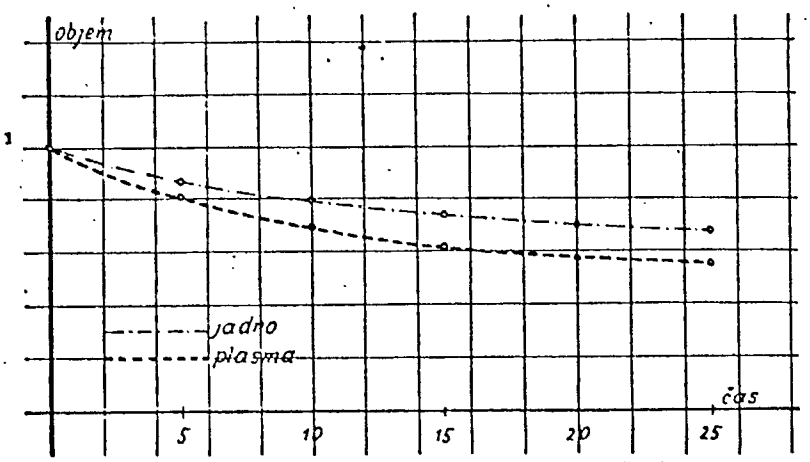
In order to determine what postmortem changes occur in different organs, a series of white male mice were sacrificed and the stomach, small intestine, colon, liver, pancreas and adrenals were fixed at hourly intervals for up to 25 hours postmortem. The organs were fixed by the Altmann and Kolster methods and stained with iron hematoxylin, according to the methods of Benda and Altmann.

Characteristically, the details of the protoplasmic structure are more clearly visible in the initial stages after death. There is a decrease, however, in the number of chondrioconts. The first changes in the stomach occur in the epithelium. The granules dissolve and the protoplasm takes on a diffuse coloration. In the other cells, the granules do not dissolve, but rather clump together or form around the nucleus in roundish clusters of varying sizes. These changes only occur slightly later in foveolae cells. The granules dissolve in adelomorphous cells, and whereas the greatest changes in these cells occur in the necks of the glands and the slightest in the pits, the converse is true for delomorphous cells. In the latter, vacuoles are also seen. The cells tend to separate but adelomorphous cells may also fuse together. The nuclei stain darker and as early as four hours postmortem, a typical structure develops in which lumps of chromatic material line the underside of the membrane (the Radspeichenstruktur

referred to by German authors). The surface epithelium separates from the base seven hours postmortem at which time the necks of the glands may already be invisible. Desquamated delomorphous cells retain their granules fairly well. The epithelium of the cardia does not show signs of disintegration until sixteen hours postmortem and the nuclei remain visible for longer periods than the cytoplasm. In the adelomorphous cells, either an increase in vacuole numbers is noted or very large granules are found throughout the cellular body. In delomorphous cells, on the other hand, the granules either decrease in number or dissolve and completely disappear or else, they lose their ability to stain and transform into vacuoles. All the cells decrease in size after death. The decrease is equal to 0.315 after ten hours for delomorphous cells and 0.445 after twenty-five hours (the area of a cross section of a cell fixed when fresh is taken as 1). Decrease in nucleus size is not as acute (0.215 and 0.23 respectively) so that without accurate measurements, the nucleus would actually seem to increase in size after death. Naturally the effect of the fixative must be taken into account.



In the small intestine, the chondriosomes of basal epithelial cells fuse together as early as one hour postmortem. The cuticle becomes distinctly striated and appears to be higher. Later, the entire basal group drifts towards the nucleus, the cuticle disintegrates into fibrils and a clearly visible band is seen at its base. After three to four hours, cilia form in the cuticle and well defined basal bodies replace the basal band. The cilia are quite long and slightly coiled in the middle. Champy noted the phenomenon in frogs during resorption and Koelliker and Heidenhain, subsequent to use of anisotonic solutions of NaCl. The epithelial elements of the intestinal villi separate and each cell takes with it half of the corresponding terminal bar.

The chondriosomes clump together and gravitate towards the cuticle. On the upper portion of the villi, the chondrioconts disintegrate or dissolve. In some of the cells at the tip of the villi, vacuoles form and quickly increase in number, occupying the entire supra-nuclear portion of the cell and leaving only a narrow base beneath the cuticle free from vacuoles. Their formation is not related to the fixative employed. In other instances, vacuoles are not seen, but the protoplasm (precipitates and aggregates of granules or their remains may still be found in the precipitated material. Vacuoles do not occur in the crypt cells other than in the cells of Paneth. Here, they displace the large granules which continue to stain for some time. But even in this case, the vacuoles are not a common-place occurrence; what actually happens is that the granules gradually lose their ability to stain until they disappear altogether and nothing is left except a large-mesh protoplasmic network. Mucous cells either swell in size or shrivel, apparently depending on the

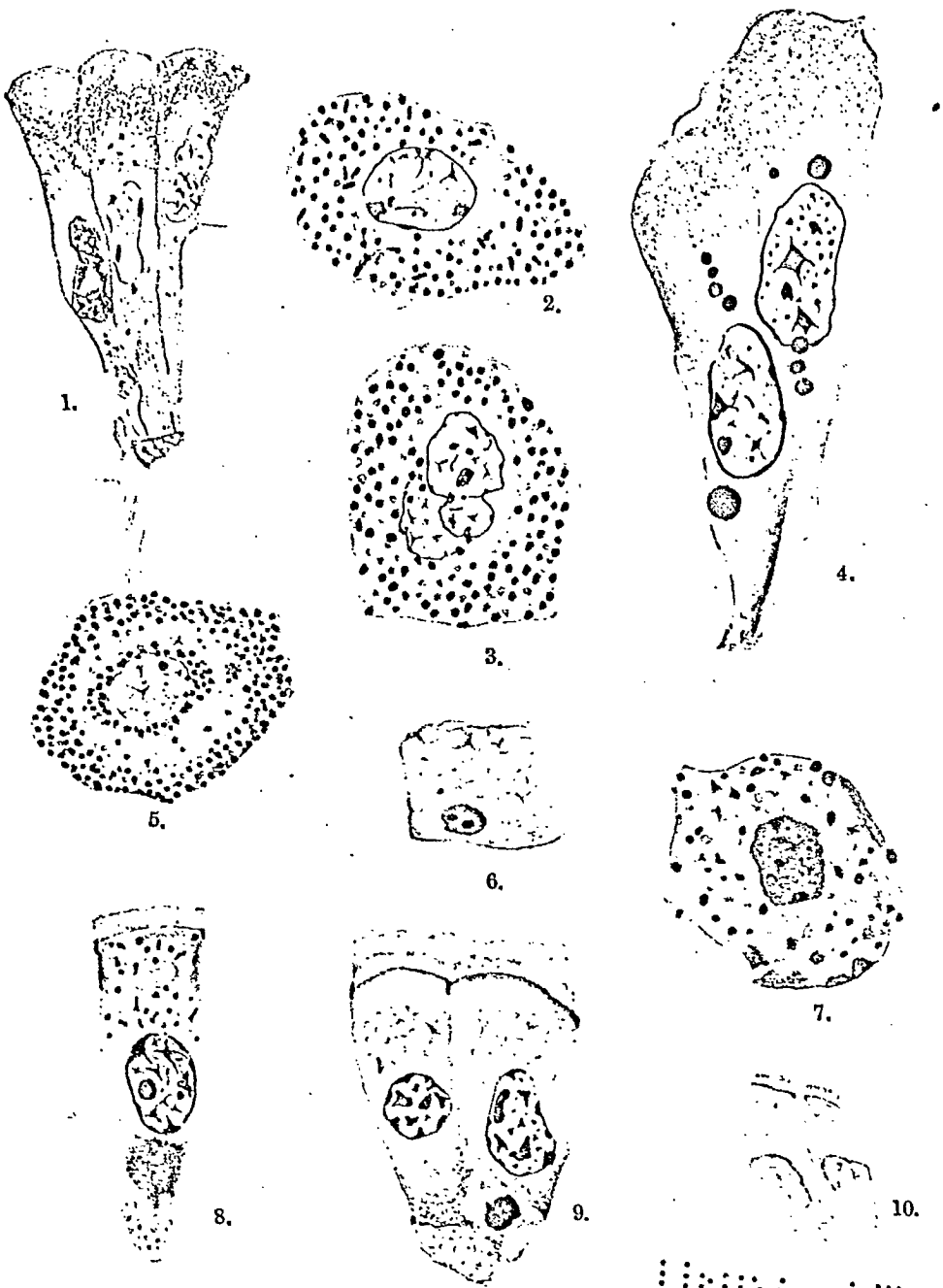
physicochemical makeup of the mucus, i.e., whether it is capable of absorbing water or not. The most pronounced changes occur in areas with the greatest resorption from where they progress to deeper regions. After eleven to thirteen hours, there are no longer any granules and the cytoplasm becomes a lumpy or amorphous mass although occasional epithelial cells may still be found in contact with the base twenty-five hours postmortem. They are, however, smaller than usual. Approximately ten hours postmortem, the nuclei become completely homogeneous and pyknotic.

While changes in the epithelium of the large intestine are very similar, they occur slightly later. Alterations in the chondriosomes may be easily followed. The centers of the granules become lighter in colour and the granules increase in volume. Colour loss continues until only a thin coloured strip is seen at the surface of the granule. This strip finally disappears and the protoplasm takes on a vacuolated appearance. The process could be compared with the one described by Champy during very advanced stages of resorption. Nuclear structure is altered, "Radspeichenstrukturen" are seen here also, and the nuclei ultimately disintegrate and disappear but at a later stage than the cytoplasm. At times, especially in epithelial cells that are in direct contact with intestinal content, discoloration does not begin in the center of the granules; rather, it occurs abruptly throughout the granule. The cytoplasm becomes homogeneous and there are no signs of vacuoles or alveolar structures. Caliciform cells lose their mucus content. In cells where mucus can still be found, it takes on a lumpy or grainy aspect.

Tab. I.

A. J. CHURA: Les changements cytologiques postmortaux.

Postmortem Changes atthe Cellular Level



Bulletin international de l'Académie des Sciences de Bohême. 1925.
(International bulletin of the Bohemia academy of sciences)

Tab. II.

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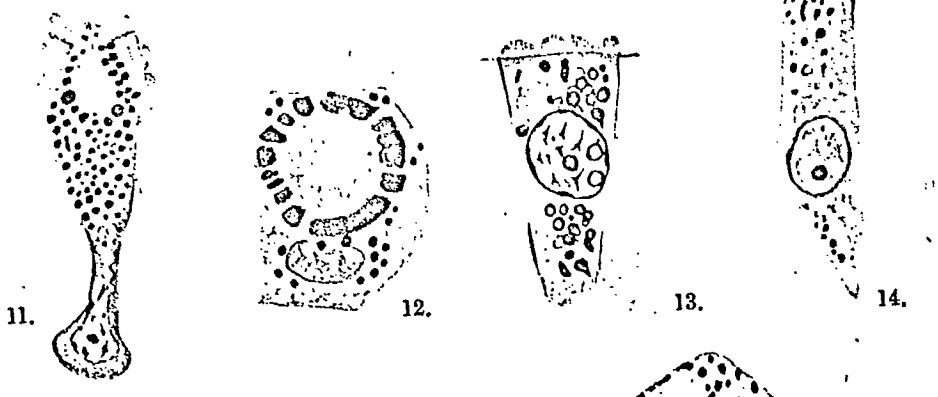

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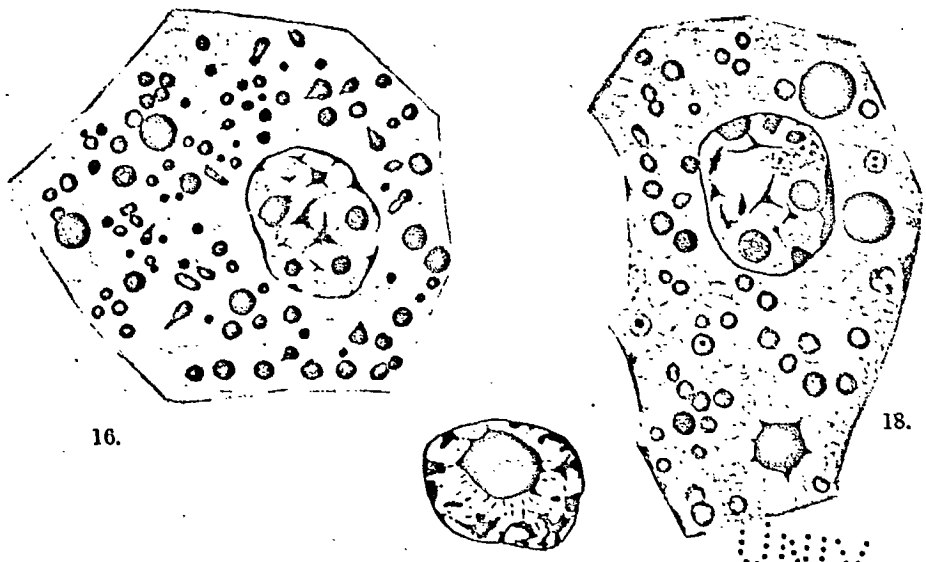

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Tab. III.

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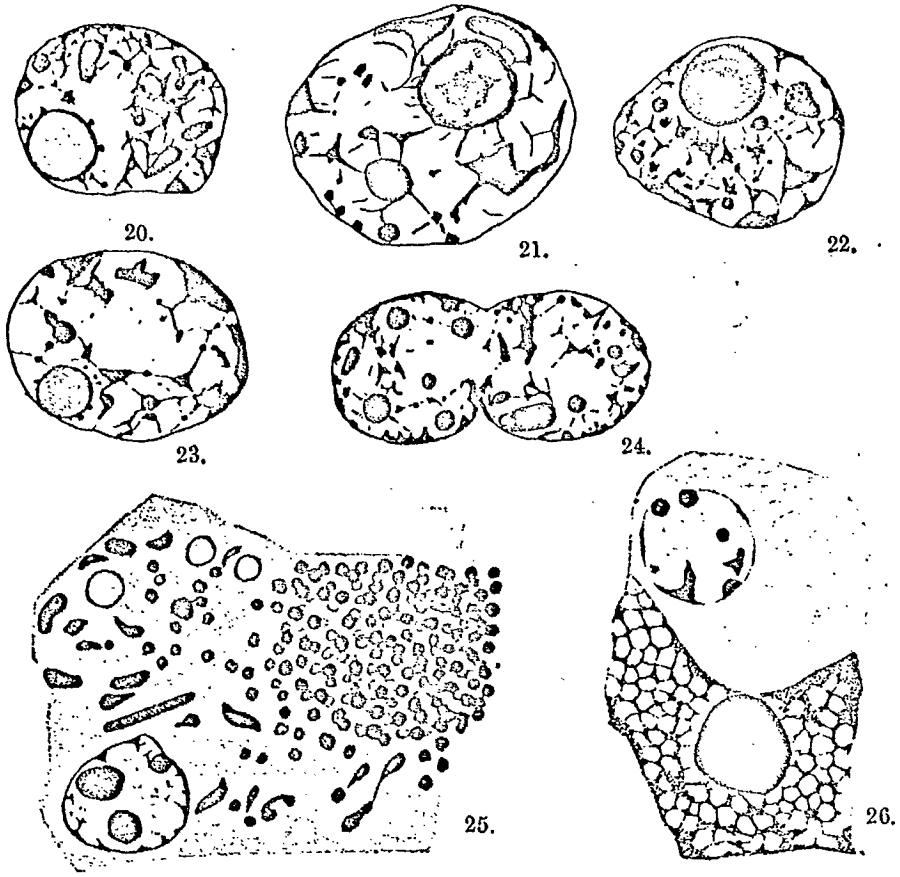

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PAR A. J. CHURA: Les changements cytologiques postmortaux.

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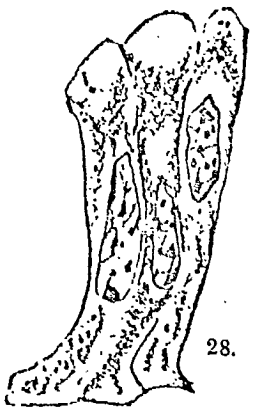

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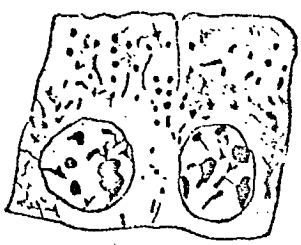

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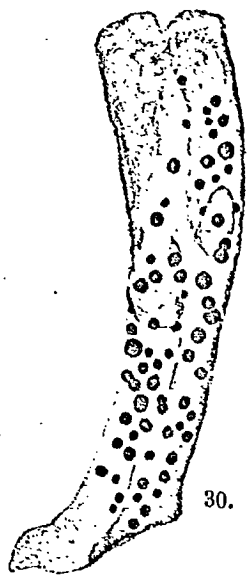

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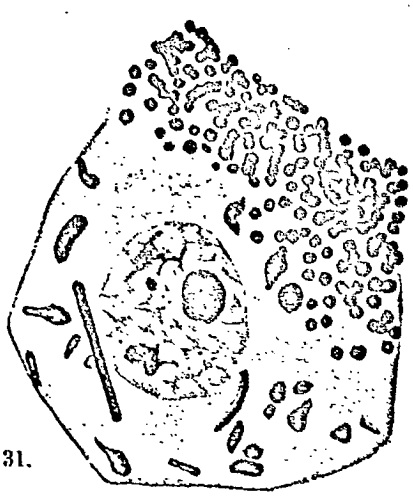

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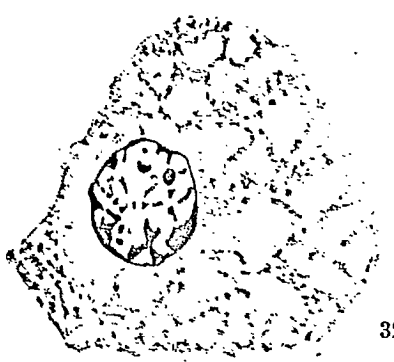

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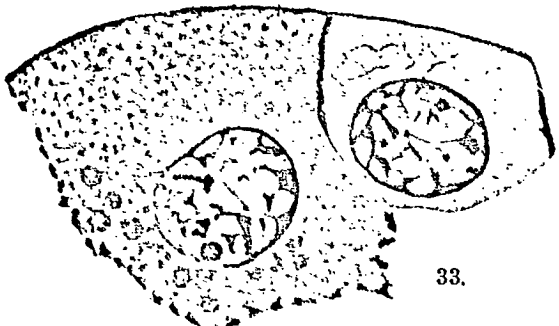

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In the liver, the appearance of the lobule, as described by Noël, is seen quite distinctly one hour postmortem. While the chondriosomes remain in the same position, they very quickly change in shape and configuration. Following staining with iron hematoxylin, cell boundaries are seen as thin lines. Two such lines belonging to neighbouring cells run in parallel directions like the walls of a canaliculus. The collagenous connective tissue network (Gitterfasern) is more clearly visible. Later, different areas of the section stain differently: some areas stain very well while others , not at all. In the first instance, narrow well defined chondriosomes occur at the periphery, as with hypertonic solutions of NaCl (Anitschkow) and rounder, bigger forms in the middle, as with hypotonic solutions. The chondriosomes clump together giving the cytoplasm in between an irregular shape. Disintegration begins approximately seven hours postmortem although well preserved chondriosomes are still found much later; they begin to dissolve fourteen to sixteen hours postmortem. There is an increase in the number of binucleate cells, and in other cells, the nuclei increase in size. The nucleoli also increase in volume and later reduce osmium (twenty-two hours postmortem). At that time, constricted nuclear forms are often seen, suggestive of amitosis.

The chondriosomes of pancreatic cells lose their ability to stain as early as one hour postmortem. The zymogen granules tend to aggregate and form clusters; at the same time, the entire cell decreases in size - possibly due to loss of water. Cell boundaries can no longer be easily distinguished. Rod-shaped chondriosomes do not dissolve in the cytoplasm but become transformed into spindle,

club; oval-shaped particles before they convert into globular masses. Their staining power is reduced. Occasional vacuoles are found in the cytoplasm. Long chondriosomes are practically no longer found seven hours postmortem. The nuclei remain for a long time and even stain well ten hours postmortem. Round chondriosomes and the very occasional well preserved chondriocont later dissolve in the cytoplasm which still does not disintegrate into an amorphous mass even twenty-five hours postmortem. The rods in the cells of the islets of Langerhans undergo very slow changes: even twenty-two hours postmortem, some of the chondrioconts are still intact. The other chondriosomes become round with a lighter central portion. The nuclei retain good staining power.

Lastly, in the adrenal glands, lipid droplets in the cells of the cortex show the greatest ability to reduce osmium. In other cells, this reduction occurs in the cytoplasm surrounding the droplets and the latter occur as vacuoles devoid of any reducing power. These vacuoles go from round to polygonal shapes with ill-defined outlines. Cell boundaries appear more clearly. Approximately four hours postmortem, the intercellular space begins to disappear and seven hours postmortem, most of the cells have begun to merge. Staining power is considerably reduced and ten hours postmortem, there are only a few pale granular lumps. In these cells, the nuclei are either hyperchromatic or fail to stain at all. All the elements are markedly shrivelled in size. In the medulla substance, wherever the fixative has penetrated, all the elements stain either green or gray; only the largest granules take on a typical coloration. The connective tissue does not undergo any changes and stains well. The cytoplasm is finely granulated or reticulated. As late as seven

hours postmortem, the chondriosomes of medulla cells are well preserved while rod forms cannot be found. They dissolve in the cytoplasm which becomes increasingly lumpy in appearance and, in fact, looks as though it has precipitated - perhaps as a result of having absorbed water.

(The Institute of Histology and Embryology of Komensky University, Bratislava).