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M-cells in the epithelium of the nasopharyngeal tonsil

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SUMMARY

Electron-microscope investigation on the epithelium was carried out in 23 nasopharyngeal tonsils. Adenoidectomy was performed on the ground of recurrent adenoiditis in the interattacks period in 13 boys and 10 girls between the ages of 2 to 4. The presence of five characteristic cellular types was found on the surface of the adenoid epithelium: tall cylindrical ciliated cells; cylindrical cells covered only with microvilli; secretory cells with the predominance of the so-called "dark granules"-producing cells; flat epithelial cells; cubic cells with microvilli on the surface and many vesicles in the cytoplasm. The last type of cells rank together with the M-cells, described by Owen and Jones in the epithelium of Peyer's patches in human beings and found in the palatal tonsil by various authors. A discussion is made on the pinocytary and secretory activity of the M-cells that is being linked with the immunogenesis of the nasopharyngeal tonsil. It is pointed out that in normal conditions the reticulation of the epithelium of the adenoid is found only in the zones that had their surface covered by M-cells.

INTRODUCTION

The nasopharyngeal tonsil is a constituent part of the lymphogenic throat ring. It is well known that the basic morphological differences between the different components of the lymphogenic throat ring refer to the structure of the covering epithelium. On account of that many authors have directed their investigations to the clarification of the ultrastructural characteristic features of the epithelium of the palatal and the nasopharyngeal tonsils both in normal or in a pathological state (Friedmann et al., 1972; Mootz and Falk, 1973; Lenz, 1974; Hiraide and Nomura, 1974; Olah, 1978; Schmedtje et al., 1979; Howie, 1980; Karchev and Kabakchiev, 1982).

We have been doing systematic research work on the ultrastructure of the palatal and nasopharyngeal tonsils at the Scientific Institute of ENT-diseases, to the Medical Academy, Sofia since 1975. This report is an effort to show the results of our electronmicroscope observations on the epithelium of the nasopharyngeal tonsil in a normal state.

MATERIALS AND METHODS

Twenty-three nasopharyngeal tonsils, removed on account of recurrent adenotonsilitis during the interattack periods have been examined. The interventions were performed under general anaesthesia in 13 boys and 10 girls at the age of 2 to 4. Immediately after the adenotomy 1 mm^3 samples were taken from the surface of the tonsil and fixed in 1.6% gutaraldehyde in phosphate-buffered saline, and following a postfixation with osmium tetroxide and dehydratation through alcohols, they were embedded in Durcupan. After cutting on an ultramicrotome (Reihert OmU3) the sections were stained with uranil-acetate and lead citrate, and the observations were carried out by electron-microscope Hitachi HU11A and Zeiss-SEM 3-2.

RESULTS

In the superficial layer of the adenoid epithelium by means of the electron-microscope were found the following characteristic types of cells:

1. Tall cylindrical cells having cilia and microvilli on their apical surface (Figure 1).

Figure 1. Microvillous cell (MVC) surrounded by ciliary cells (CilC) on the surface of the adenoid epithelium. LUM-lumen with mucus. × 2000.

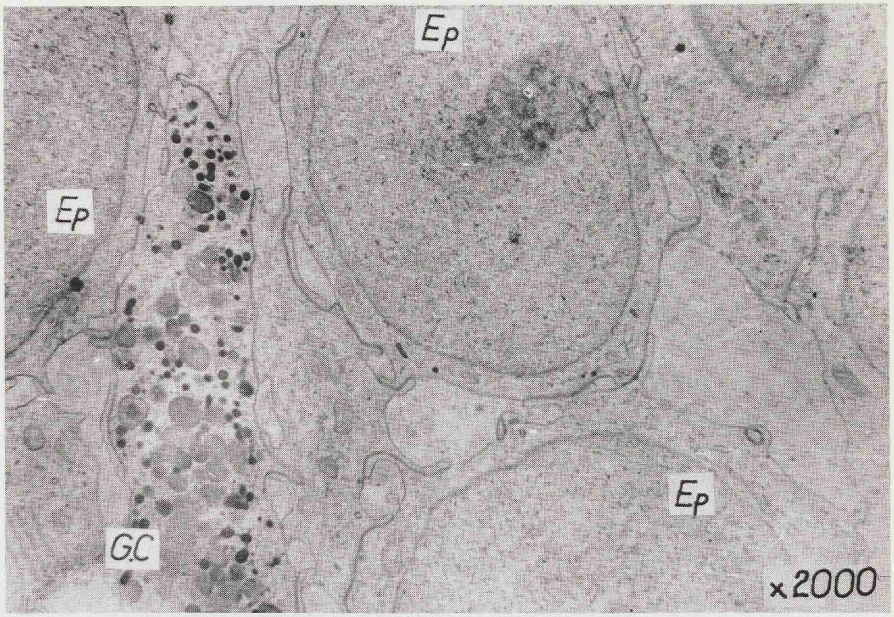

Figure 2. Transversal section of the epithelial cells (Ep) precursors of the ciliary cells and granulated cell (GC) contains dark secretory granules. × 2000.

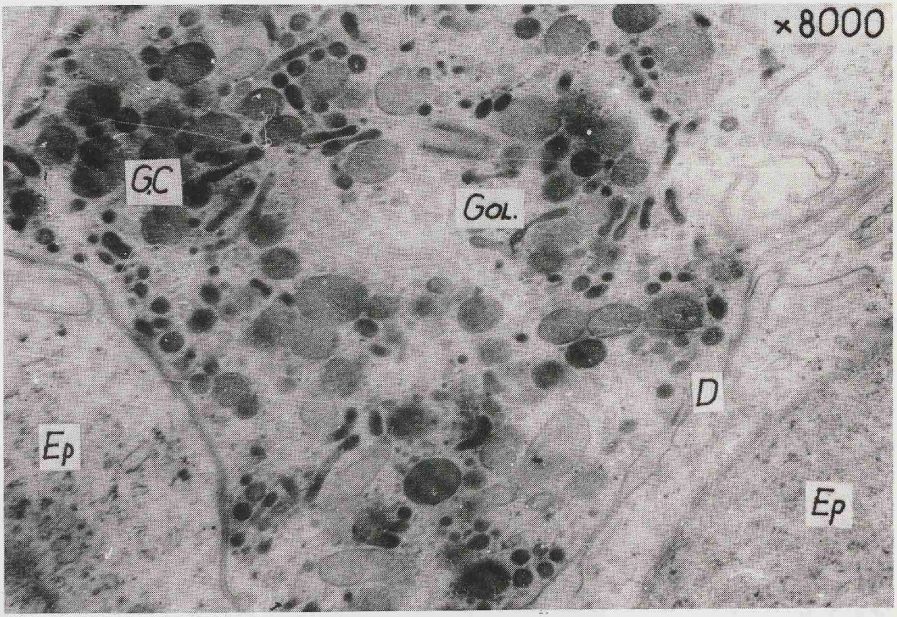

Figure 3. Granulated cell (GC) with numerous dark secretory granules and well developed Golgi-apparatus (Gol), connected by desmosomes with the neighbour epithelial cells, precursors of the ciliary cells. Ep- epithelial cells ; D- desmosomes. × 8000.

2. Cylindrical cells covered only by microvilli (Figure 1).
3. Secretory cells, producing light or dark granules. Our observations showed that the cells secreting the so-called "dark granules" (Figure 2) were dominating in the epithelium of the nasopharyngeal tonsil. Those cells possessed the well displayed Golgi apparatus, which was in close contact with the secretory granules (Figure 3).
4. Flat epithelial cells. They occurred rarely close to the microvilli cells. They sowed signs of a considerable metabolic activity (Figure 4).
5. Cubic cells having growth similar to the microvilli growths on their apical surface (Figure 5). Many vesicles were found in the cytoplasm of those cells. One can assume the majority of them are pinocytotic (see the square), but in some places one sees the so-called "covered vesicles" which suggest their secretory origin (see the circle). Characteristic of the cubic cells with the microvilli on the surface and vesicles in the cytoplasm is the abundance of ribozomes, which is a sign of their increased metabolic activity. Those cells are observed in groups, connected together by means of desmosomes next to the ciliated

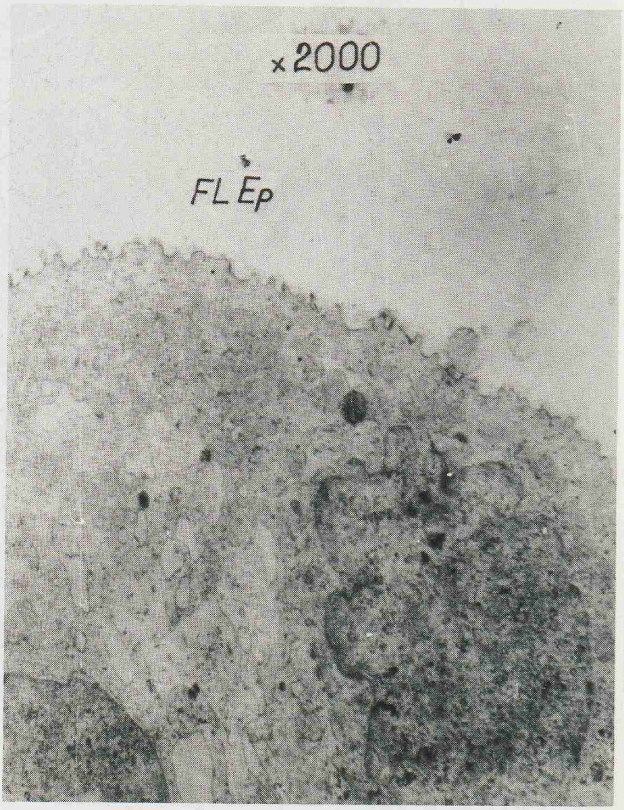

Figure 4.
Flat epithelial cells (FlEp) on the adenoid surface. × 2000.

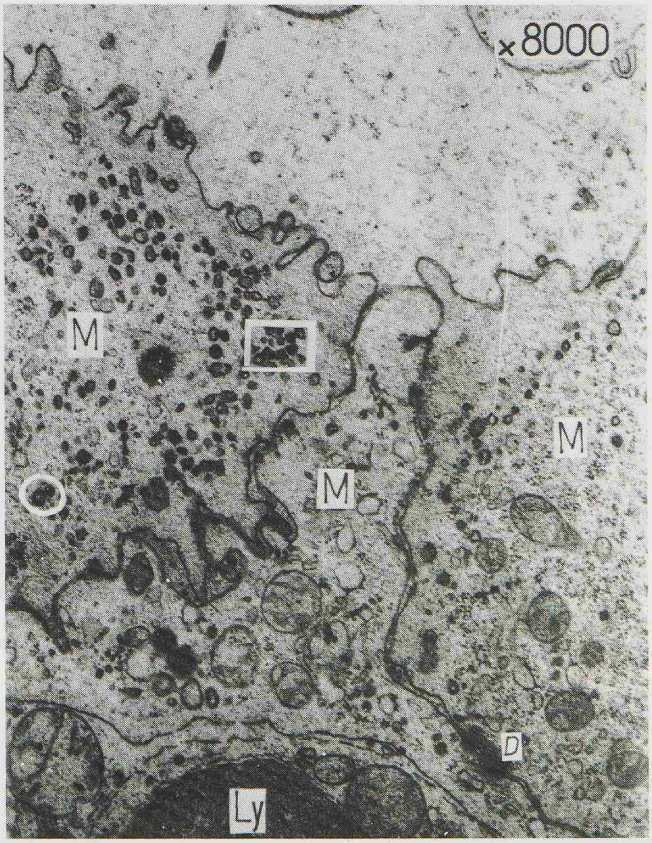

Figure 5.
M-cells (M) connected by desmosomes (D) on the epithelial surface. Some of the vesicles in their cytoplasm are pinocytotic (square); other seem to be secretory in their origin (circle). Ly- lymphocyte close to the M-cells. × 8000.

cells and the ones with microvilli (Figure 6). Immediately under the cubic cells there always were found lymphocytes. The latter are seen in groups passing along the passages between the cells of the deep layers of the epithelium in the zones where there are cubic cells on the surface (Figure 7).

Some of the cells, forming the intraepithelial passages also possess vesicles in the cytoplasm (Figure 8).

It is essential that the spaces between the cells of the deep layers of the epithelium in the zones where ciliated cells are found on the surface are narrow and there are only erythrocytes there (Figure 9). In our numerous investigations on the sections of the normal epithelium with ciliated cells on the surface, we never saw lymphocytes in the spaces between the cells precursors of the ciliated cylindrical cells.

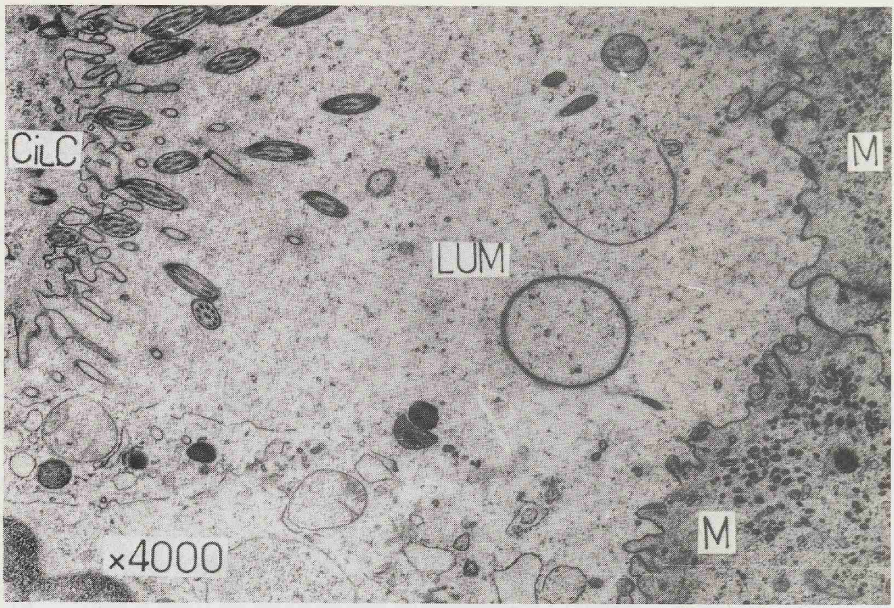

Figure 6. M-cells (M) on the surface of the adenoid epithelium. On the other side of the lumen (LUM) can be seen ciliary cell (CilC). × 4000.

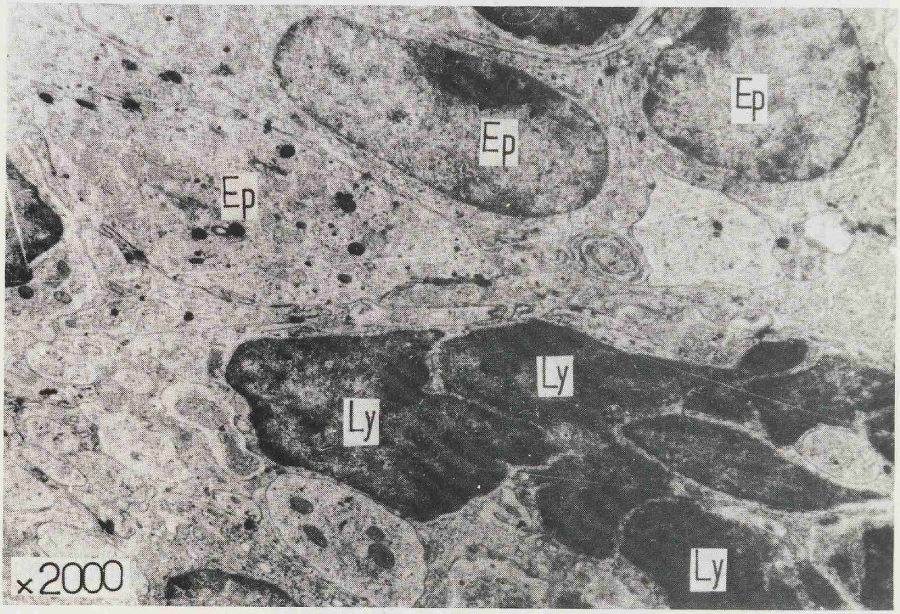

Figure 7. Lymphocytes (Ly) in the intraepithelial passage in the deep layers of the reticular epithelium (Ep) with M-cells on the surface. × 2000.

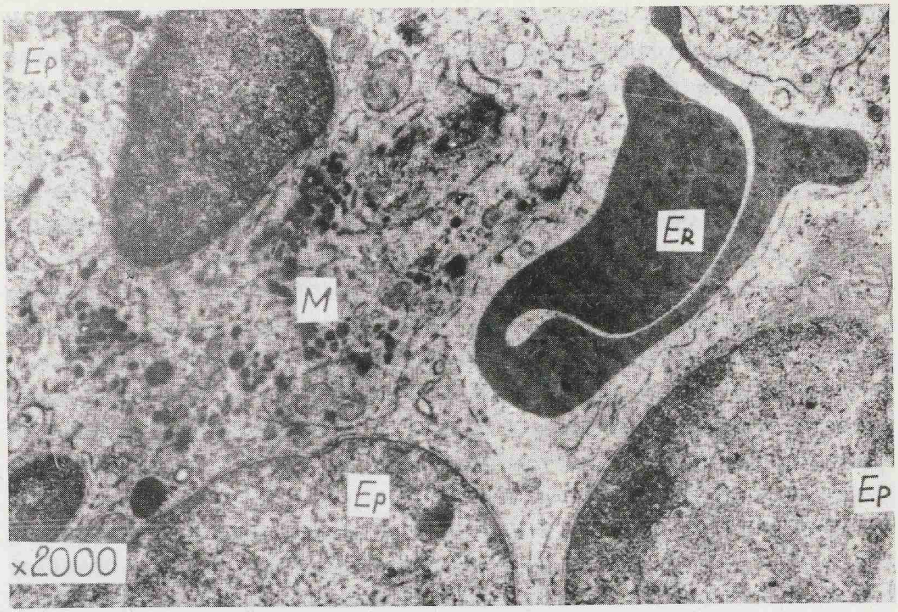

Figure 8. Transversal section of the deeper layer of the epithelium with M-cells on the surface. In the cytoplasm of the one cell (M) there are vesicles similar of that containing in the superficial M-cells. Ep- epithelial cells; Er- erythrocyte. × 2000.

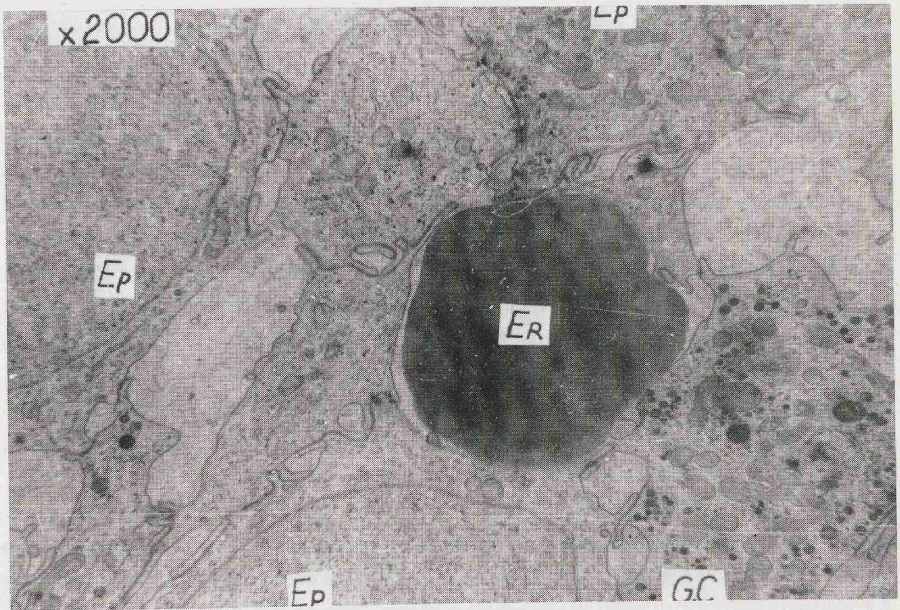

Figure 9. Erythrocyte (ER) in the space between the cells of the deep layers of the epithelium covered by ciliary cells. Ep- epithelial cells precursors of the ciliary cells; GC- granulated cell containing small dark secretory granules. × 2000.

DISCUSSION

The covering epithelium of the nasopharyngeal tonsil is an extension of the epithelium, covering the back third part of the nasal cavity and the neighbouring parts of the nasopharynx. It is named an epithelium of a respiratory type. Clifford (1979) admits that up to the tenth year on the surface of the nasopharyngeal tonsil in children only high cylindrical epithelial cells are found and after that age regions of flat epithelial cells begin to appear. Ali (1966) stated that between the ciliated cells of the epithelium of the nasopharyngeal tonsil little islands of flat epithelial cells were found, surrounded by cubic cells. It is considered that in the course of growth, the zones with flat epithelial cells on the surface of the adenoid increase but the cause of the metaplasia of the ciliated cells is not known.

In 1972 Friedmann et al. made an announcement of their light microscope observations of the parts of the adenoid epithelium, where the high cylindrical cells were replaced by lower ones. The authors considered that "flattening" of the epithelium with the effect of a viral infection.

Our observations show that the cubic cells are found near the cylindrical cells covered with the microvilli or cilia in the adenoid epithelium in parts without any morphological signs of cellular injury. The ultrastructural characteristics of those cells give us ground to place them together with the so-called M-cells, described for the first time by Owen and Jones (1973) in the epithelium of the Peyer's patches in human beings. Later such cells were found in the epithelium of the palatal tonsil (Owen and Nemanic, 1978; Howie, 1980; Surjan Jr., 1980; Karchev and Kabakchiev, 1982).

We are convinced that type of cells are entirely normal components of the nasopharyngeal tonsillar epithelium. Especially significant from an immunological point of view are our observations on the penetrating of the lymphoid cells in passages between the cubic M-cells. According to our opinion the reticulation of the epithelium in the zones where M-cells were observed on the surface, proved the immunological specialization of that cellular type, of which it is accepted that the main physiological function consists of accepting and transferring antigens from the surface into the lymphoid parenchyma. Alongside with this our observations give ground to revive the first suggestions of Owen and Jones (1973) that the M-cells have a secretory activity. Now it is rather difficult to discuss the physiological rule of this phenomenon but probably the substances of the secretory vesicles are involved directly or indirectly into the immunogenesis.

Howie (1980) announced the existence of M-cells on the walls of the intraepithelial passages of the palatal tonsil. Our observations showed that in some of the cells, forming the intraepithelial passages of the nasopharyngeal tonsil also found vesicles in the cytoplasm. We accepted those cells as precursors of the M-cells. Nevertheless it is rather difficult to explain how the vesicles were formed in their cytoplasm. One may suppose that they were first of all the result of the intracellu-

lar activity since those cells had not yet been in contact with the surface of the adenoid. However, one cannot leave out the possibility that the vesicles were the result of the absorption of antigens, penetrating into the intraepithelial passages. We suggest that the presence of M-cells is characteristic for the ultrastructure of all lymphoepithelial organs that are in contact with the external media. To the nasopharyngeal tonsil they concretely appear to be an obligatory epithelial component as in normal state the access of antigens to the surface of the ciliated cells is quite strongly limited on the account of the constant activity of the mucociliary system. On the other hand, the support that the ciliated cells display to one another is particularly important for the effectiveness of the cilial vibration. It is not accidental that they are firmly connected on the surface by means of the terminal bar. It is obvious that for the realization and maintaining of the mucociliary clearance it is not desirable for lymphocytes to penetrate between the ciliated cells and their precursors in the depths of the epithelium. That can happen only in pathological states linked with the invasion of microorganisms or allergy. Such an idea raises the M-cells of the adenoid epithelium to the position of key cells for the immunogenesis of the nasopharyngeal tonsil.

We should like to make a note at the end that different from Friedmann, we did not find any increase in the frequency of meeting goblet-cells in the adenoid epithelium in recurrent adenoiditis. In that respect our data coincides with the observations made by Hiraide and Nomura, regarding the rarer meeting of secretory cells in adenoids submitted to recurrent infections. Besides that we made a note of the domination of cells, secreting dark granules. Perhaps that fact is in connection with the necessity of an adequate correction of the rheological qualities of the mucous blanket that allow transportation through the adenoid to the mesopharynx.

ZUSAMMENFASSUNG

Es wurden elektronenmikroskopische Untersuchungen des Epithels bei 23 Rachenmandeln, erhalten nach Adenotomie, gemacht anläßlich eines rezidivierten Adenoidit bei 13 Jungen und 10 Mädchen im Alter von 2 bis 4 Jahre durchgeführt. An der Oberfläche des Rachenmandelepithels wurde den Bestand von fünf charakteristische Typs von Zellen festgestellt: höhe zilindrische Zellen mit Wimpern; zilindrische Zellen, die nur mit Mikrovillus bedeckt sind; Sekretorenzellen von denen dominieren diese, die sogenannte "dunkle Körnchen" produzieren; platte Epithelzellen; würfelformige Zellen mit Mikrovillus an der Oberfläche und zahlreiche Bläschen in der Zytoplasma. Der letzte Zelltyp gehört zu den M-Zellen, die von Owen, Jones im Epithel der Peyersche Plaques des Menschen beschrieben sind und von einigen Autoren in der Rachenmandel festgestellt sind. Es wird um die mikrovesikuläre und die sekretorische Aktivität der M-Zellen diskutiert, die mit der Immunogenese der Rachenmandel verbunden werden. Es

wird die Meinung mitgeteilt, daß die Retikulierung des Epithels der Rachenmandel wird nur in den Gebieten festgestellt, wo an der Oberfläche M-zellen zu sehen sind.

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