

## On the Epithelial Covering Tissue of the Alveolar Walls of Human Lung

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The present author reported that the so-called alveolar wall-cells named by him were rather numerous observed on the alveolar walls of the lungs of guinea-pigs, rabbits and dogs, in his treatise.....Electron Microscopic Observation of Pulmonary Alveolar Structures of Laboratory Mammals, Acta Tuberculosea Japonica, Vol. 6, No 1-2, 1956. As this kind of cells are observed rarely on the alveolar walls of the human lungs, he did not allude to it in his previous report.....Electron Microscopic Observation of Pulmonary Alveolar Structures, Acta Tuberculosea Japonica, Vol. 5, No. 1-2, 1955.

To supplement the previous reports, therefore, the present author will touch upon the epithelial covering tissues on the alveolar walls of the human lung, together with the above-mentioned alveolar wall-cell.

The first and fundamental problem is whether the epithelial covering tissues really exist or not. If they are supposed to exist, there arise the questions whether they are continuous or discontinuous and whether there is only one kind of the epithelia or there are two or more than two kinds of them, and again if they are supposed not to exist, there come the questions to be answered whether the capillaries are exposed to the air in the air space and whether some other tissues than the epithelial tissue.....for instance, interstitial tissues.....cover the surface of the capillary wall.

The assertions with regard to the epithelial covering tissue of the alveolar walls, such as those of Kölliker, Oppel, Lang, Ogawa, Majima and Seemann etc. in old time and those of Akasaki, Miller and Hayek in recent times, are all in the same category and the differences in their opinions are chiefly due to the fact that they had to rely upon light microscopes. Quite recently, F. N. Low and R. H. Swigart have reported the results of their observations of the morphology of the alveolar wall by electron microscopes, but the present author has found some doubtful points in their reports as mentioned in his previous reports.

The present author made it clear in his previous reports that the epithelial covering tissue existed continuously over the surface of the alveolar walls, that they were the cytoplasm of the nucleated epithelia abruptly attenuated around the nucleus and elongated membranously and were nothing but the cytoplasm of the nucleated alveolar epithelia and accordingly there was only one kind of the alveolar epithelium, which was the nucleated one, and there was no evidence to prove the existence of the so-called non-nucleated plaques as asserted by Kölliker and other scholars.

He observed, however, in his later study, that a kind of the nucleated cells different from the nucleated alveolar epithelium, existed among the cells facing to the air space even on the alveolar wall of the human lung, as in the case of the laboratory mammals. This kind of cells should be distinguished from the nucleated alveolar epithelium on account of the following characteristics.

a) These cells generally are of round or oval shape and the elongation of the cytoplasm can not be seen as in the case of the nucleated alveolar epithelium.

b) Many large granules, many large round or oval mitochondria-like objects, large and small vacuoles and sometimes some foreign bodies are observable in the cytoplasm of these cells.

c) The margin of the part of them facing on the air spaces are irregular and in most cases, round or spindle-shaped and electron microscopically black dots are seen near the contours.

d) The condition of dividing lines between the cells and the adjoining epithelial covering tissues are not uniform : that is, the covering tissues are seen covering the partial surface of the air space side of the cells in varied degrees and conditions.

e) These cells are often found in a group of two or three unlike the nucleated alveolar epithelium.

f) When these cells are compared with the nucleated alveolar epithelium without the epithelial covering tissue, the former are fairly larger and much richer in cytoplasm than the latter.

These characteristics of these cells coincide with those of the alveolar wall-cells named by the present author that are often seen on the alveolar wall of the laboratory mammals. He wished, therefore, to give the name of "alveolar wall-cell" to this kind of cells on the alveolar wall of the human lung, as he did to the cells of animal lung.

When the alveolar wall-cells of the human lung are compared with those of animal lung, the above-mentioned morphological feature of cytoplasm are more remarkable in the latter, and the alveolar wall-cells are more numer-

ous than the nucleated alveolar epithelia in the animal lung, while in the human lung the alveolar wall-cells seem to be fewer than the nucleated alveolar epithelia. The number of alveolar wall-cells and the condition of the cytoplasm may be changed not only by pathological causes but also, even in normal lung, by the medium, in which human beings and mammals are kept.

It is of much interest that these cells are found here and there on the alveolar walls which are covered by the continuous covering tissues and on which the original nucleated alveolar epithelia exist. As the conditions and significance of them were discussed in detail in the report on the pulmonary alveolar structures of laboratory mammals by the present author, it would be preferable now only to say that the present author believes that the alveolar wall-cells are not to be regarded as a sort of epithelia, but perhaps the cells in the stage of pre-differentiation that have phagocytosis and occupy a portion of the alveolar wall and perform their parts of cleansing the air space, exposing themselves to the air space after they have broken the epithelial covering tissue.

### **Conclusion**

Summing up the previous reports by the present author on electron microscopic observation of the alveolar walls of the human lung and animal lung, and the studies of alveolar structures, especially of the epithelial covering tissue, including the alveolar wall-cells named by the present author, he has arrived at the following conclusion.

1) The epithelial covering tissue exists, as a rule, continuously on the surface of the alveolar wall of human lung.

2) This is the attenuated elongated cytoplasm of the nucleated alveolar epithelium, and accordingly there is only one kind of alveolar epithelium and it is of the nucleated one. There is no evidence to prove the existence of the so-called non-nucleated plaque.

3) The alveolar wall-cell named by the present author is seen on the alveolar wall of human lung, as on the alveolar wall of lungs of guinea-pig, rabbit, and dog.

4) The alveolar wall-cell is generally of round or oval shape and a part of it is exposed to the air space, but can not be regarded as epithelium. Accordingly, it is to be considered that the alveolar wall is devoid of the epithelial covering tissue only at the portion where this kind of cell exists.

5) It is supposed that, considering its morphological features, it probably has phagocytosis and perform the role of cleansing the air space.

6) The capillaries on the alveolar wall are covered by the epithelial covering tissue and not exposed to the air in the air space, as far as the normal lung is concerned.

### Explantation of the plates

Bar on electron micrographs are equivalent to 1 micron. All plates are micrographs of the sections with the embedding chemical.

[These plates were reduced in about a quarter dimension of the original size] for printing convenience with understanding of the present author (Editor)

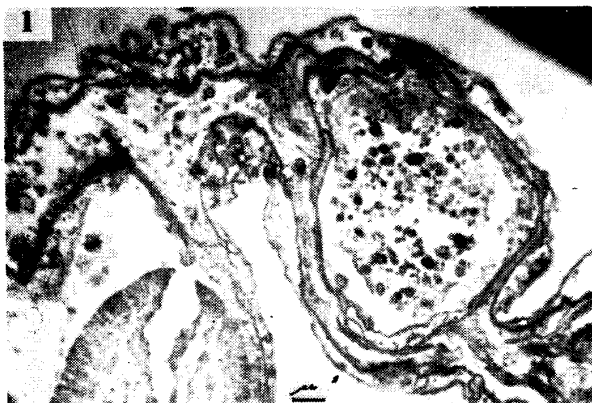


Fig. 1. Alveolar wall, lung, human ( $\times 8600$ )

The blanks seen in the upper part and the lower part of this picture are air spaces. Note the unbroken epithelial covering tissues shown here.

Two capillaries can be seen, one in the lower left corner and the other in the center, a little to the right. The relation between the epithelial covering tissue and the capillary wall as well as the structure of the basement membrane as shown in this picture are quite suggestive.



Fig. 2. Alveolar wall, lung, human ( $\times 10300$ )

This picture shows a part of the alveolar wall that is considered to connect the capillaries. The blanks in the upper and lower parts in the center are air spaces, and those that are seen in the upper left and in the lower right part are capillaries. Apart from these, the capillary that includes a leucocyte is seen in the left part and the capillary that includes erythrocytes is seen in the right part of the picture. Accordingly, the number of the capillaries are four in total.

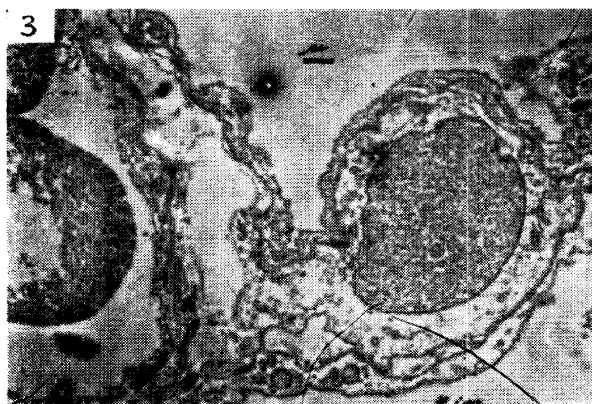


Fig. 3. Alveolar wall, lung, human ( $\times 7500$ )

The upper and lower blanks in this picture are air spaces, and continuous epithelial covering tissues are seen on the surface of the alveolar walls.

The cell in the middle belongs to a part of the stroma. Two erythrocytes are seen in the capillary that is seen in the left part of the picture.

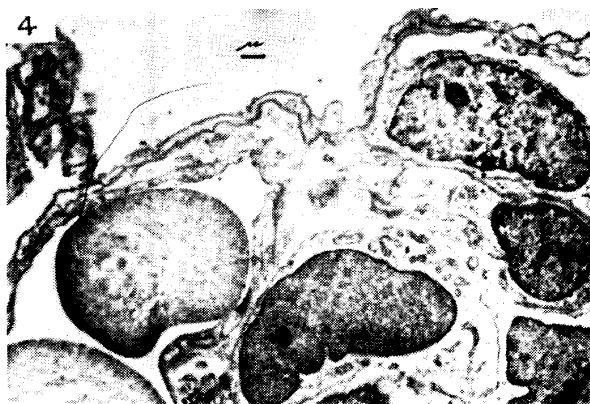


Fig. 4. Alveolar wall, lung, human ( $\times 6200$ )

The upper blank in this picture shows the air space. A capillary is seen in the upper right part and the other in the lower left corner of the picture. An endothelial nucleus is seen on the wall of the former and two erythrocytes in the latter. The cell that is observed in the central lower belongs to a part of the stroma. The unbroken epithelial covering tissue is also observed in this section.

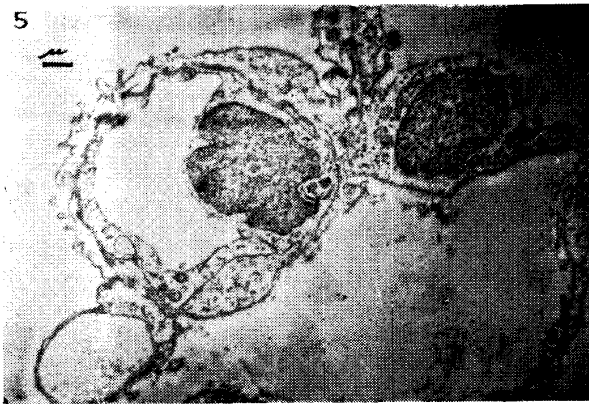


Fig. 5. Endothelium of pulmonary respiratory capillary, lung, human ( $\times 7600$ )

The two nucleated cells seen in this picture are endothelia that respectively constitute the separate capillaries. The continuous blank on the left-hand side and the blank in the lower right part of this picture are air spaces.

A comparatively large vacuole in the lower left corner is the one that is formed in the epithelial covering tissue that covers the surface of the septal stroma. It is still to be studied why such an object is seen, but the present author does not think it is of artificially made. Continuous epithelial covering tissues should especially be noted here.

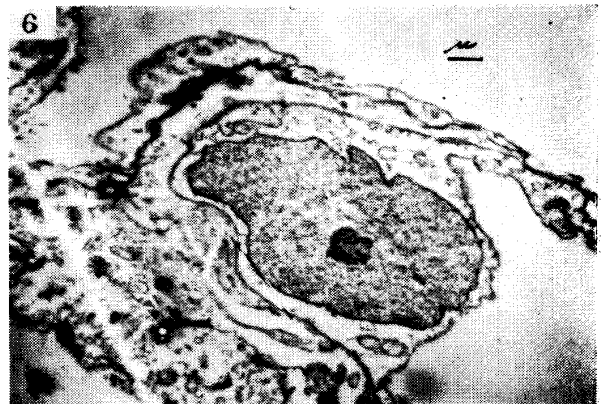


Fig. 6. Endothelium of pulmonary respiratory capillary, lung, human ( $\times 9500$ )

One nucleolus can be observed in the endothelial nucleus shown in the middle of this picture. The endothelial cytoplasm constitutes the capillary wall, thinning down and elongating itself.

The upper blank in this picture shows the air space and the continuous cytoplasmic covering tissue is seen here also. Basement membranes are seen very distinctly here.

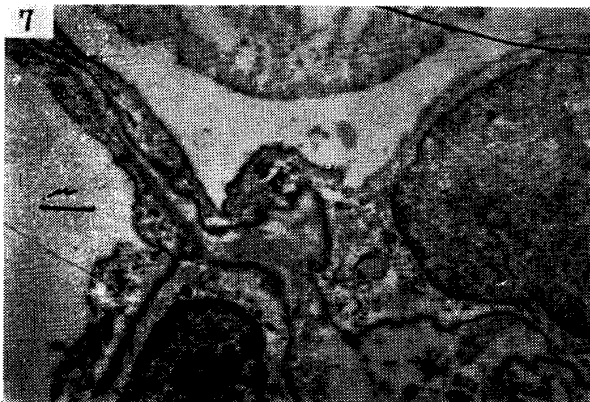


Fig. 7. Pulmonary alveolar epithelium, lung, human ( $\times 14400$ )

The nucleated cell on the right-hand side in this picture is a endothelium and the left blank shows the air space. A portion of the erythrocyte is seen in in the upper center of this picture. Note the elongation of endothelial cytoplasm.

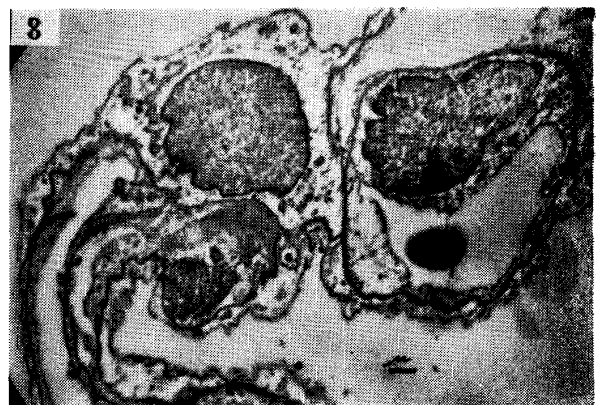


Fig. 8. Pulmonary alveolar epithelium, lung, human, ( $\times 7000$ )

Two nucleated cells are observed in this picture: the left one being the alveolar epithelium and the right one the endothelium. A capillary is seen in a long shape on the left-hand side.

It is to be noted that the cytoplasm of the nucleated alveolar epithelium covers the surface of the alveolar wall, attenuating and elongating itself on both sides of nucleus. This resembles the condition of the endothelium.

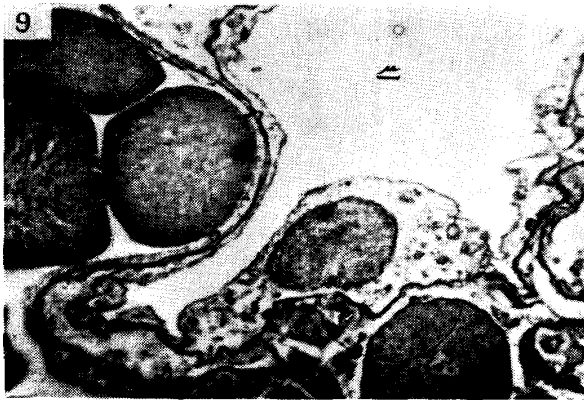


Fig. 9. Pulmonary alveolar epithelium, lung, human ( $\times 6200$ )

The air space is shown by the upper blank in this picture. The nucleated cell shown in the center is the pulmonary alveolar epithelium. Note that the cytoplasm of it constitutes the epithelial covering tissue of the alveolar wall, attenuating and elongating itself.

Three erythrocytes are observed in the left part of the picture. The nucleated cell in the lower part belongs to a part of the stroma.



Fig. 10. Pulmonary alveolar epithelium, lung, human ( $\times 6000$ )

The upper right blank and the lower left corner in this picture show the air spaces. The nucleated cell facing to the air space in the upper part is the epithelium. It is to be noted that the cytoplasm of it constitutes the epithelial covering tissue.

The nucleated cell shown in the center belongs to a part of stroma. A capillary is seen running from the upper left part down to the lower right part of the picture.



Fig. 11. Pulmonary alveolar epithelium and the alveolar wall-cells (so called by the present writer), lung, human, ( $\times 5500$ )

The two nucleated cells shown in the center are the alveolar wall-cells. Although these cells face to the air space like the alveolar epithelia, the structure of the cytoplasm of them are different from that of the epithelium. Note the peculiarity of the protruded lines of the cells that face to the air space and the condition of the joints connecting these cells with the epithelial covering tissues.

A nucleated cell in the upper right part of this picture is the pulmonary alveolar epithelium. A capillary and its endothelium can be seen in the left part.



Fig. 12. Alveolar wall-cell, lung, human ( $\times 6300$ )

The nucleated cell in the right is the alveolar wall-cell. Two nucleoli are seen in the nucleus of this alveolar wall-cell. The blanks in the upper center, in the lower right and the lower left corner are air spaces.

A part containing the nucleated cell in the left near the center belongs to the stroma. Two capillaries are seen, one in the left and the other in the center.



Fig. 13. Alveolar wall-cell, lung, human ( $\times 6000$ )

The nucleated cell in the center is the alveolar wall-cell. The dividing lines are distinctly perceived in the connecting joint between this cell and the adjoining epithelial covering tissues. The cytoplasm of this cell is not elongated like the pulmonary alveolar epithelium.

Three capillaries are seen; one in the left, including several erythrocytes, second in the upper right and another in the lower center, a little to the left. The blank in the lower right corner is the air space.

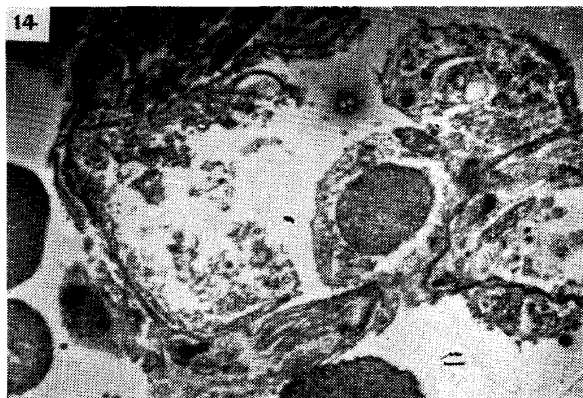


Fig. 14. Alveolar wall-cell, lung, human ( $\times 5600$ )

Three alveolar wall-cells are seen in the center. Except for a cell in the middle, the other two cells do not show any nucleus. The shape of the left cell is deformed, which may be artificial.

A capillary is observed in the left and the blank in the lower part is the air space.



Fig. 15. Alveolar wall cell, lung, human ( $\times 6000$ )

The cell in the upper center is the alveolar wall-cell. It does not show the nucleus. It is connected with the epithelial covering tissue at four places and the dividing lines between the cell and the covering tissues are seen there.

The upper and lower blanks and the blank in the center are air spaces. Three capillaries are seen in the lower left corner, upper right and lower right. The region existing two nucleated cells shown in the picture belongs the stroma.



Fig. 16. Alveolar wall-cell, lung, human ( $\times 6000$ )

The blank in the right part of the picture is the air space. Two capillaries are seen, one in the upper left corner, the other in the lower center. About a quarter of the lower left corner of the picture shows the stroma.

The alveolar wall-cell, which does not show the nucleus, is seen in the right near the center.