

DEMONSTRATION OF GLYCOCALYX IN THE SWEAT GLAND

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Abstract. Skin specimens were taken without any anaesthesia from four volunteers before and after a 1 hour's exposure to heat. No glycocalyx could be demonstrated in the resting gland, but it usually appeared, however, after one hour of thermal sweating—although not in all the sections. The possible implication of this phenomenon is briefly discussed and new problems outlined.

Key words: Glycocalyx; Ultrastructure of sweat gland

The demonstration of glycocalyx in the small intestine (1, 4, 5) of various species presented the question of its possible role in reabsorption. As reabsorption, at least of sodium chloride, is commonly admitted to occur in the sweat gland duct, it seemed of interest to learn if this subtle structure could be demonstrated there. Continuing our joint study on the ultrastructure and function of sweat glands (2, 3), we decided to look for the glycocalyx in both inactive and active glands.

MATERIAL AND METHODS

Four healthy men, all volunteers, were exposed for one hour to the environment characterized by the temperature 39°C dry bulb and 32°C wet bulb with minimal air movement. They spent this time lying naked without any physical exercise, and without replenishing their water loss. Sweating was very copious, as they lost 1.5% of their body weight.

The skin on their backs was carefully cleansed with water and alcohol before the experiment. Two skin specimens were taken without any anaesthesia with a high speed hollow drill from the back of each subject: one just before the experiment at the normal room temperature—while the patient was not yet sweating—and the other specimen just after the patient left the hot chamber—at the peak of the sweat glands' activity.

The specimens were immediately immersed in glutaraldehyde buffered with sodium cacodylate (pH 7.3) with ruthenium red (0.33 mg per 1 ml H₂O) added, according to Luft (6). Fixation was in darkness at 4°C for 1 hour. Then the specimens were washed five times and transferred to a secondary fixation in OsO₄ solution with the same buffer and ruthenium red added, for the next 2 h. in

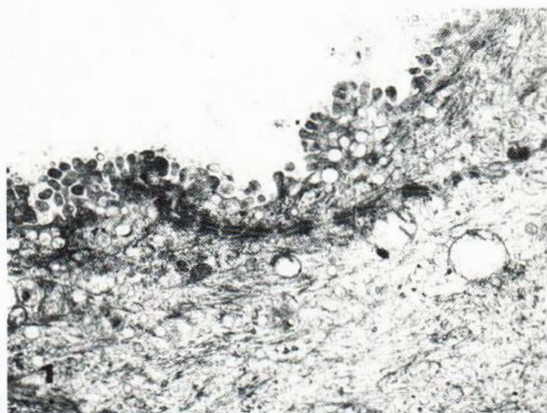


Fig. 1. Longitudinal section of the duct. Magnification $\times 5\,100$. Specimen taken before exposure to heat.

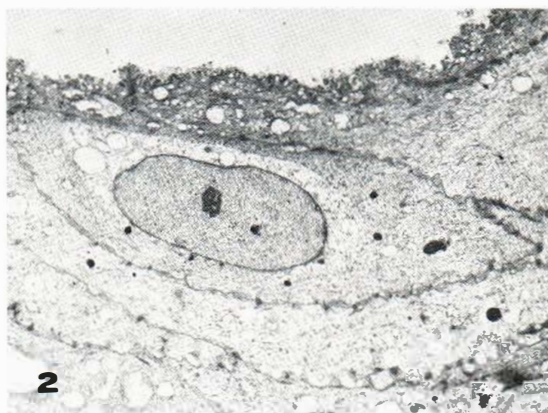


Fig. 2. Transverse section of the duct. Magnification $\times 2\,100$. Specimen taken before exposure to heat.

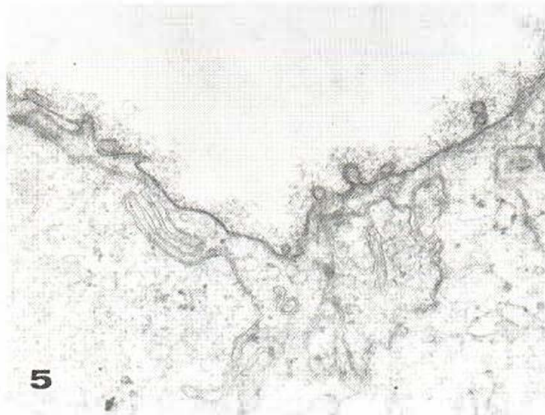
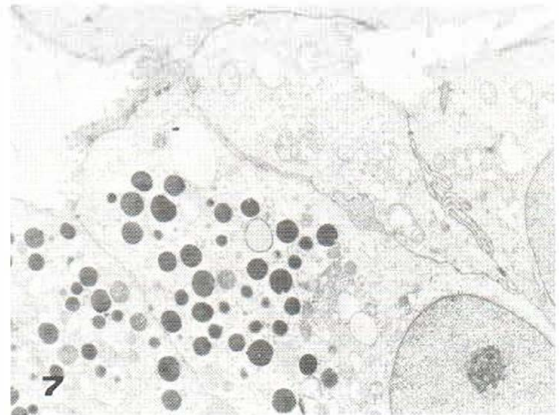
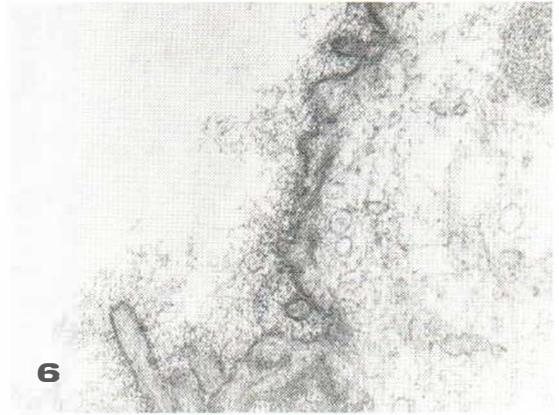
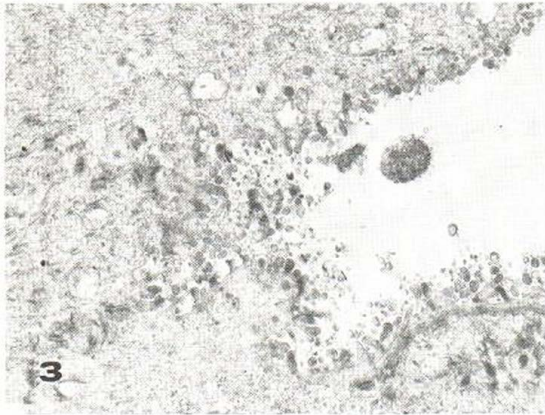


Fig. 3. and 4. Same as in Fig. 2. Magnification $\times 9300$ and $\times 14400$ resp.

Fig. 5. The sweating gland after 1 hour's exposure to heat. Magnification $\times 12000$.

Fig. 6. The same experiment as in Fig. 5. Magnification $\times 22800$.

Fig. 7. Light and dark cells in the two-layer epithelium. Specimen taken after 1 hour's exposure to heat. No glycocalyx can be seen in this section. Magnification $\times 4500$.

darkness and at room temperature. After this time the small tissue sections (1 mm^3) were dehydrated in an alcohol-propyleneoxide series and then embedded in Epon-812. Epon blocks were cut in ultrathin sections (ca. $500 \text{ \AA}$) with an OUM-2 ultramicrotome (Reichert). They were contrasted with uranyl acetate and lead citrate solution, and examined in a JEM-7 electron microscope. Electronograms were made on ORWO Eu-2 film plates.

RESULTS

The glandular ducts were found in the subepithelial layer of the skin section and recognized by the double layer of the cells as shown in the transverse and longitudinal sections (Figs. 1 and 2).

Before sweating, many microvilli could be seen

on the free border of the cells surrounding the lumen, but glycocalyx could not be clearly demonstrated even at the high magnification (Figs. 3 and 4).

The sweating glands showed very clearly the subtle network of fibrillar structure (Figs. 5 and 6) extending from the cell membrane into the lumen. This is characteristic of glycocalyx, though it is not so dense and well developed as it was seen in the small intestine. This was not a constant feature, however. In the same specimens some places could be found in the duct where glycocalyx did not develop after sweating, as shown in Fig. 7.

DISCUSSION

In contradistinction to the digestive tract, which is rarely empty, or to the renal tubuli, which under normal conditions never stop working, the sweat gland in temperate climates and under normal living conditions is mostly nearly inactive. When stimulated by heat it can deliver in a short time large quantities of fluid to the skin surface, increasing its activity many times. This affords a peculiar opportunity to study certain structural changes between the resting and the active cells. We have already been able to demonstrate some of them, in what we believed to be the morphological expression of fluid transport. The present experiment seems to offer another piece of evidence of ultrastructural changes which could be connected with either the active secretion or reabsorption of some solutes. The latter can be more easily retained or recaptured from the unstirred layer of fluid more slowly pushed through this network of glycocalyx, than through the main stream.

It would be of great interest to learn why some cells, and which cells, of the duct develop this structure when active. For how long does it persist? Is it connected with the phenomenon of acclimation? Does it appear in the secretory coil as well? One obstacle in tackling these problems is the difficulty of obtaining live human tissue for such studies.

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