THE JOURNAL OF INVESTIGATIVE DERMATOLOGY
Vol. 49, No. 6

Printed in U.S.A.

MELANIN TRANSFER: A POSSIBLE PHAGOCYTIC PROCESS*

JESS H. MOTTAZ, B.S.†, AND ALVIN S. ZELICKSON, M.D.

The actual method of transfer of melanosomes from the melanocyte to a receiving cell has not been clearly defined. Birbeck et al (1) first suggested that the transfer of pigment granules in hair might be the result of a phagocytic process on the part of the cortical cells. Birbeck and Mercer (2) again mentioned the possibility of transfer by phagocytosis, and Birbeck later stated that perhaps there is a specialized area at the end of the dendritic process of the melanocyte which is phagocytized upon contact with a cortical cell.

Swift (4) hypothesized that melanosomes are secreted to the extracellular space through small pores or openings in the tip of the dendritic process. They are then ingested either singly or in pairs by the cortical cell. Charles and Ingram (5) suggested that the melanocyte dendrite and the epidermal cell fuse and that external pressures cause a breakdown of the thin separating membranes and force the melanosome from one cell to the other. Dorchman (6) indicated that phagocytosis is probably involved in the transfer of melanosomes. He noted, however, that the melanocyte is the active cell in the exchange and that it forces its dendrite into the receiving cell. An inclusion is then formed by the membranes of these two cells after which resorption of the membranes is carried out by the receiving cell. Mishima (7) also suggested that the melanosomes are discharged into the surrounding cells.

In a recent study of human hair pigments, it appeared to us that phagocytic activity on the part of the cortical cell plays a major role in melanosome transfer, and the results of this investigation are reported here.

* From the Division of Dermatology, University of Minnesota Medical School, Minneapolis, Minnesota.
† Central Research, Minnesota Mining and Manufacturing Company, St. Paul, Minnesota.
Presented at the Twenty-eighth Annual Meeting of the Society for Investigative Dermatology, June 18–20, 1967, Atlantic City, New Jersey.
This work was supported by research grant CA-05887, from the U.S.P.H.S. and the American Cancer Society.

MATERIALS AND METHODS

The hair roots used in this study were plucked from the heads of humans and they included black, red, different shades of brown, blond and albino. The hair was immediately placed in a drop of osmic acid fixative where the bulb portion was cut off and bisected to insure rapid and complete penetration of the fixative. This tissue was then placed in larger amounts of osmic acid and fixed for three hours after which the usual alcohol dehydration steps were taken and the tissue was embedded in Epon 812.

A diamond knife and an LKB Ultratome were employed to obtain thin sections which were stained with uranyl acetate and lead citrate. The grids were then examined with an RCA EMU-3 and a Phillips 200 electron microscope.

RESULTS

Generally, melanosomes begin their development within the Golgi area of the cytoplasm, and as they mature all stages of premelanosomes find their way to the ends of the dendrites. Although the cortical cells are rather tightly held together by desmosomes, it is not uncommon to see gaps and spaces between the cortical cells. The dendritic processes, with their melanosomes, can be found traversing these spaces and portions of these processes are phagocytized by the cortical cells.

Pseudopod-like cytoplasmic projections of the cortical cell wrap around the tip of the dendrite (Fig. 1). These projections continue to enlarge until they have completely enveloped the tip of the dendrite which is then apparently pinched off. At this stage the pinched off portion of the dendrite is separated from the rest of the cell cytoplasm by the membrane of the melanocyte and that of the cortical cell (Fig. 2). An amorphous area (Fig. 3) is present surrounding this entire package and finally a breakdown of the cell membranes occurs. The absence of an intact membrane allows the premelanosomes and melanosomes to be dispersed throughout the cortical cell cytoplasm (Fig. 4).

DISCUSSION

Phagocytosis of a portion of a healthy cell by another healthy cell is in opposition to

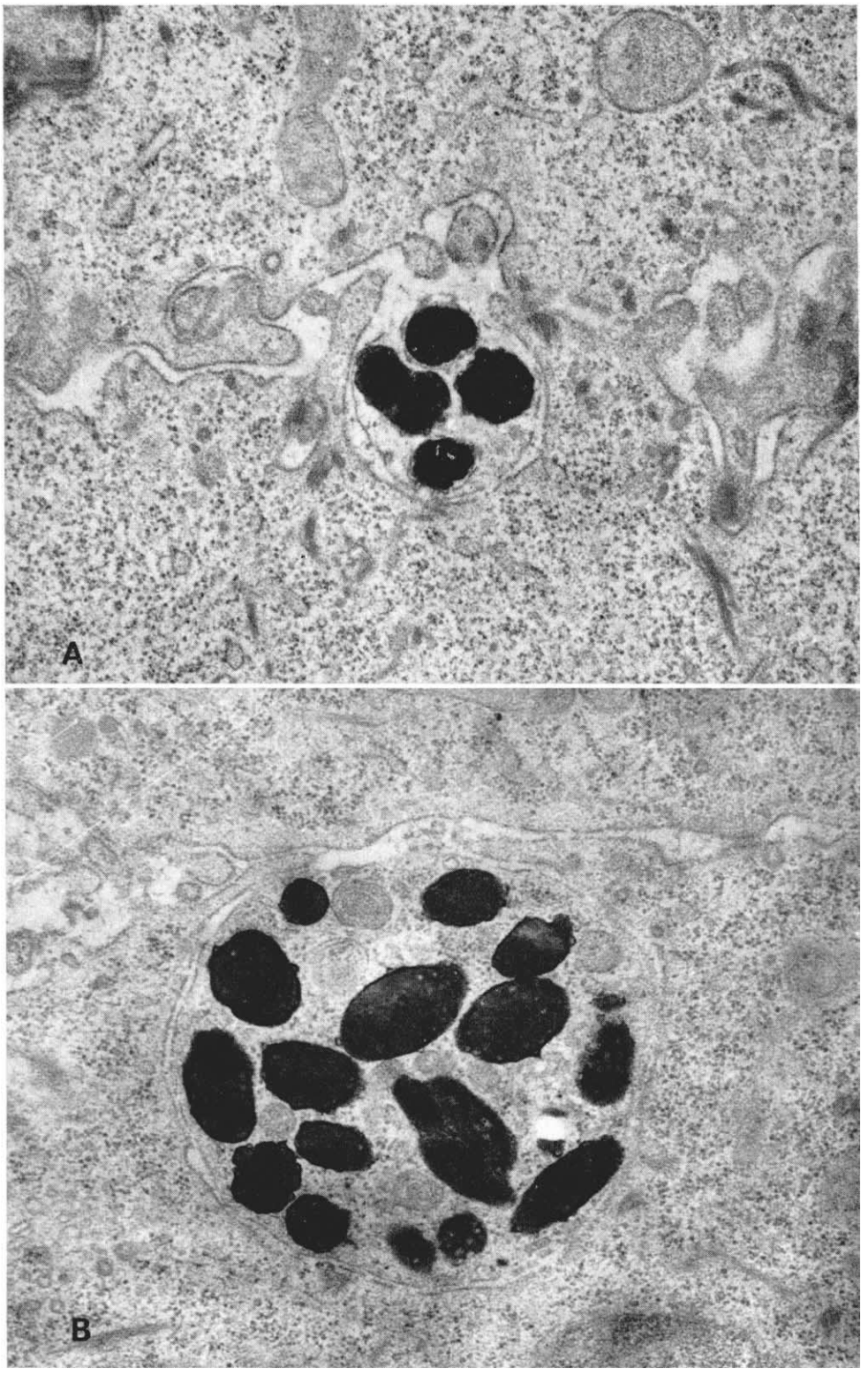

FIG. 1a and 1b. Cytoplasmic projections of the cortical cell extend from the cell body and wrap around the tip of the melanocyte dendrite which is later pinched off and completely enclosed within the cortical cell cytoplasm. × 32,000.

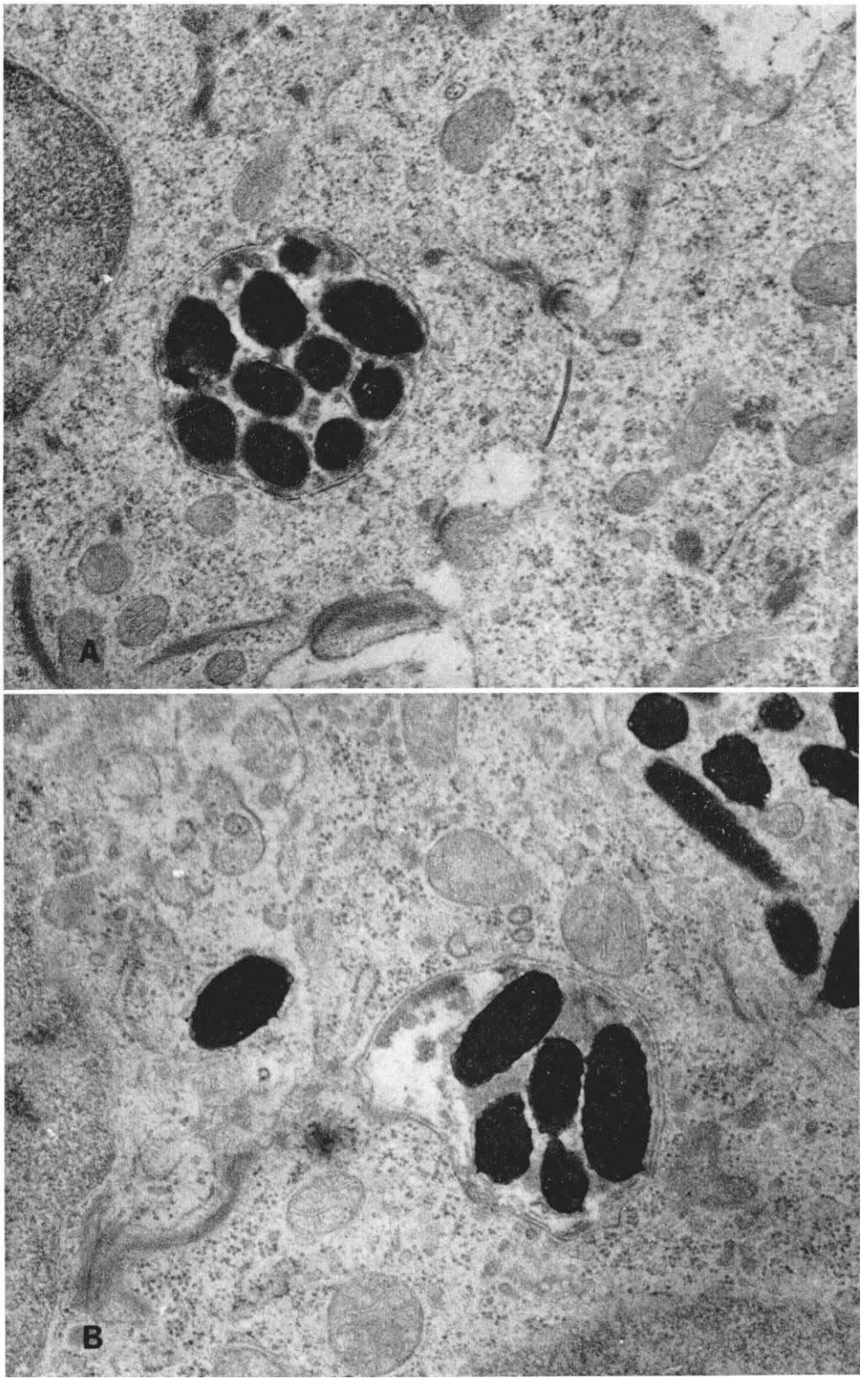

FIG. 2a and 2b. The pinched off portion of the dendrite exists for a period of time in the cortical cell cytoplasm enveloped by its own membrane and that of the cortical cell. × 32,000.

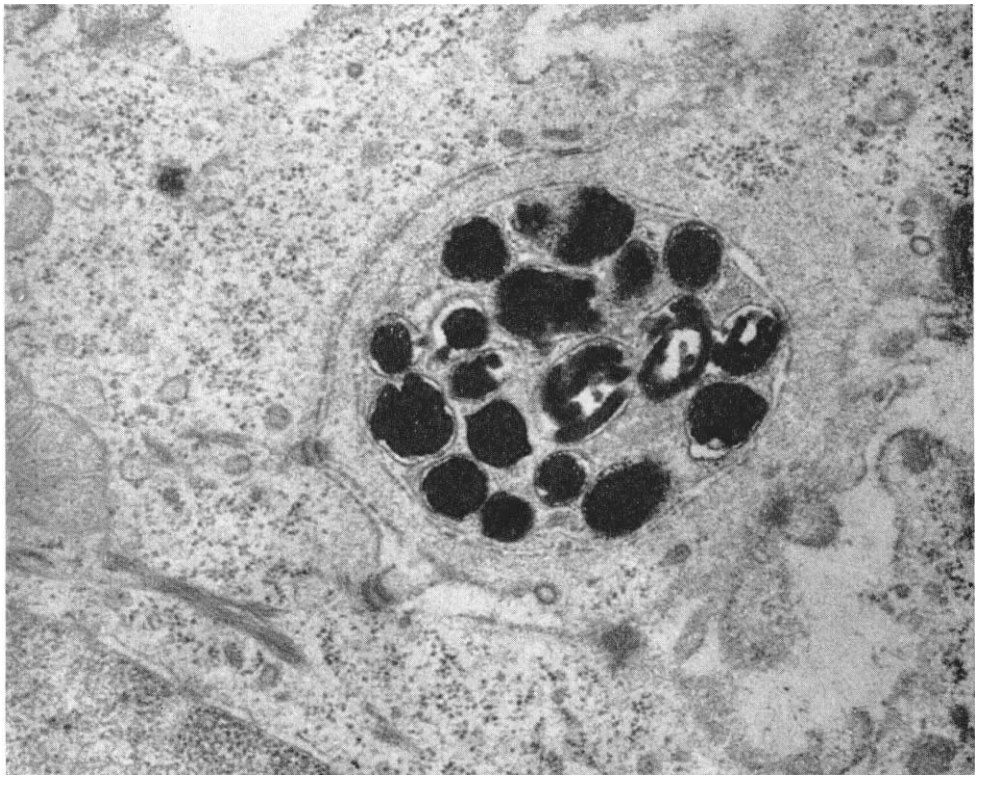

FIG. 3. An amorphous area is located around that portion of the dendrite that is being encompassed by the cortical cell. This is comparable to a stage noted in phagocytosis in general. × 32,000.

most generally accepted rules of physiology. However, the possibility of this happening must be considered. As evidenced by the cytoplasmic projections which wrap around the melanocyte dendrite, the cortical cell is probably taking an active role in this process. If the dendrite were to force itself into the cortical cell, the extensive cortical cell projections as seen in Figure one would not be necessary. All that would be required is a constriction of the cortical cell as it surrounds the dendritic process. This speaks against the melanocyte being the active cell in melanosome transfer.

We were unable at any time to see a premelanosome or a melanosome existing freely in the extracellular space or making entrance into a cortical cell.

SUMMARY

It is suggested that melanosomes are transferred from melanocytes to cortical cells in human hair by means of phagocytic activity on the part of the cortical cells. A portion of the melanocyte is included in the cortical cell by this process. Premelanosomes and melanosomes are then released and dispersed throughout the cortical cell cytoplasm.

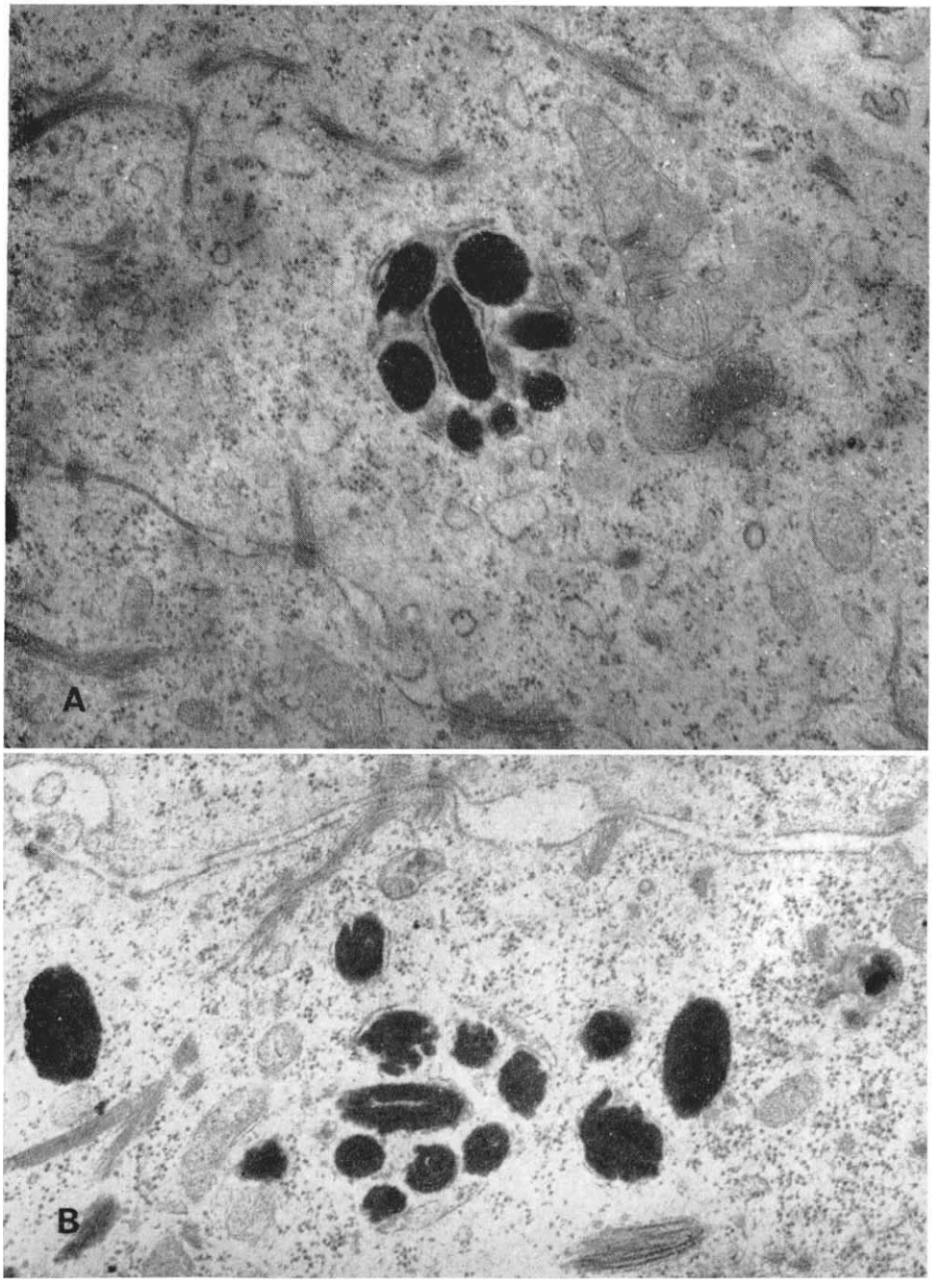

FIG. 4a and 4b. Included cell membranes apparently disappear within the cortical cell and the premelanosomes and melanosomes are dispersed throughout the cell. × 32,000.

REFERENCES

1. Birbeck, M. S. C., Mercer, E. H. and Barnicot, N. A.: The structure and formation of pigment granules in human hair. Exptl. Cell Res., *10:* 505, 1956.
2. Birbeck, M. S. C. and Mercer, E. H.: The electron microscopy of the human hair follicle. J. Biophys. Biochem. Cytol., *3:* 203, 1957.
3. Birbeck, M. S. C.: Electron microscopy of melanocytes. British Med. Bull., *18:* 220, 1962.
4. Swift, J. A.: Transfer of melanin granules from melanocytes to the cortical cells of human hair. Nature (London), *203:* 976, 1964.
5. Charles, A. and Ingram, J. T.: Electron microscope observations of the melanocyte of the human epidermis. J. Biophys. Biochem. Cytol., *6:* 41, 1959.
6. Drochmans, P.: Study by electron microscope of the mechanism of melanin pigmentation: the distribution of melanin granules in the malpighian cells. Path. Biol. (Par), *9:* 947, 1961.
7. Mishima, Y.: Melanosomes in phagocytic vacules in Langerhans cells. Cell Biol., *30:* 417, 1966.