Surface Ultrastructure of the Human Marrow—A Brief Note

By Sidney Trubowitz, A. Broers and R. F. W. Pease

INFORMATION ON THE DETAILED ARCHITECTURE of human marrow is still incomplete, and additional insights into the intimate relationships of the various constituents of this tissue would be welcome. The limitation of resolution of the light microscope and informational content of the transmission electron microscope directed attention to the high resolution and great depth of field of the scanning electron microscope[1] and its possible application to the examination of the intimate organizational relationships of the marrow components. Some few examples of the appearance of the human marrow, as seen by the scanning electron microscope, are presented.

Materials and Methods

Marrow tissue particles were obtained from the sternum by the usual aspiration technique from hematologically normal individuals, from a patient who had received radiation in a dosage of 3500 r. to the mediastinum, and from a patient with chronic myelocytic leukemia. The particles were separated rapidly from the contaminating blood as previously described,[2] fixed in 6.5 per cent glutaraldehyde for 60 min., and postfixed in 1 per cent buffered osmic acid for 30 min. The particles were placed on aluminum specimen stubs, coated with a thin film of aluminum metal to prevent charging, and inserted into a scanning electron microscope, built at IBM,[3] for examination. Photographs were taken on Plus-X film (Kodak) and processed in Microdol. The enlargements on the figures are given as of original screen size; the actual photographic dimensions are about 2.5 times larger.

Observations and Discussion

The scanning electron microscope produces a striking and dramatic three-dimensional image of intact cells and tissues. The technique has been applied to the study of individual blood cells. Salsbury and Clarke have described the red cell surface in a variety of diseases.[4] Clarke, Salsbury and Rowland[5] identified some of the surface distinguishing characteristics of the main types of white cells of peripheral blood, namely the granulocyte, lymphocyte and monocyte. They also found that the isolated, individual, immature white cell of the marrow is larger than its mature derivative and has a smooth surface, surface roughness apparently developing with age.

The normal human marrow (Figs. 1 and 2) appears as a loose aggregate of fat cells, about and between which the hemopoietic cells proliferate. The vascular structures' course between and about the adipose cells (Fig. 3). The

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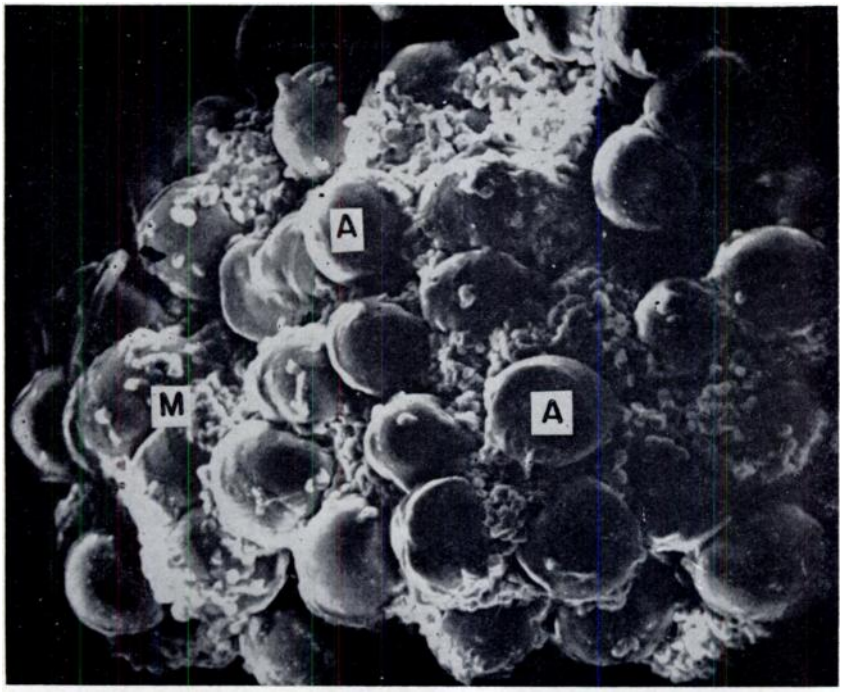

Fig. 1.—Normal human marrow (× 200). (A = Adipose cells, M = Marrow cells, V = Vascular structure.)

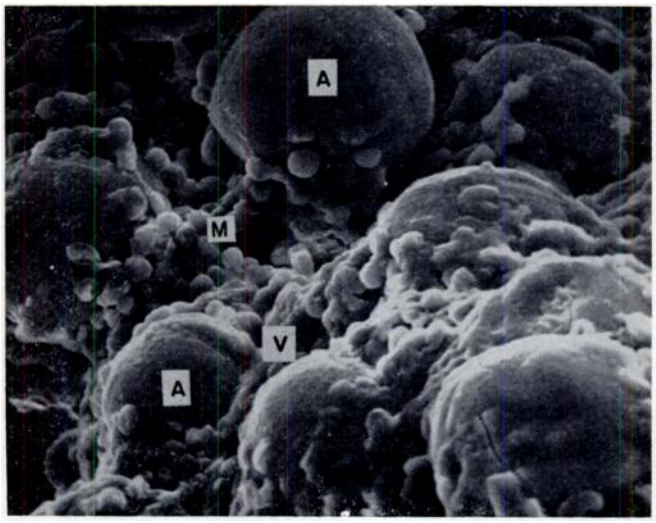

Fig. 2.—Normal human marrow (× 500). (A = Adipose cells, M = Marrow cells, V = Vascular structure.)

individual nucleated blood cells are not easily distinguished from each other, nor can the nucleated red cells be differentiated from the white blood cells. In the irradiated marrow (Fig. 4) the fat cells varied in size but, on the average, were larger than those of the normal marrow. The decreased cellular

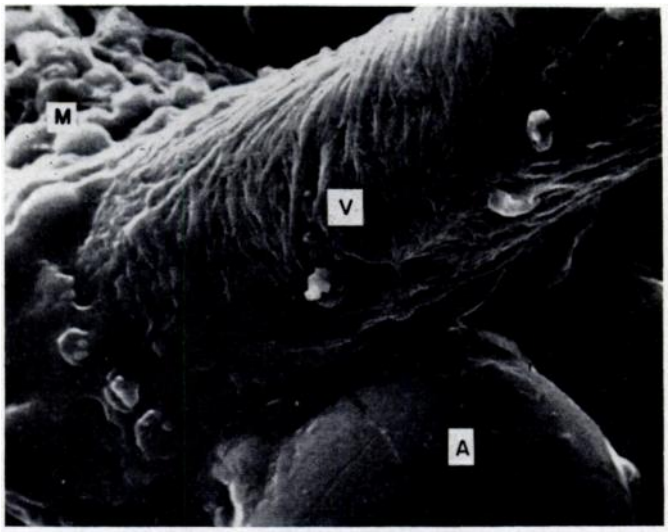

Fig. 3.—Marrow post irradiation (× 1000). Vessel above fat cell penetrating marrow. (A = Adipose cell, M = Marrow cells, V = Vascular structure.)

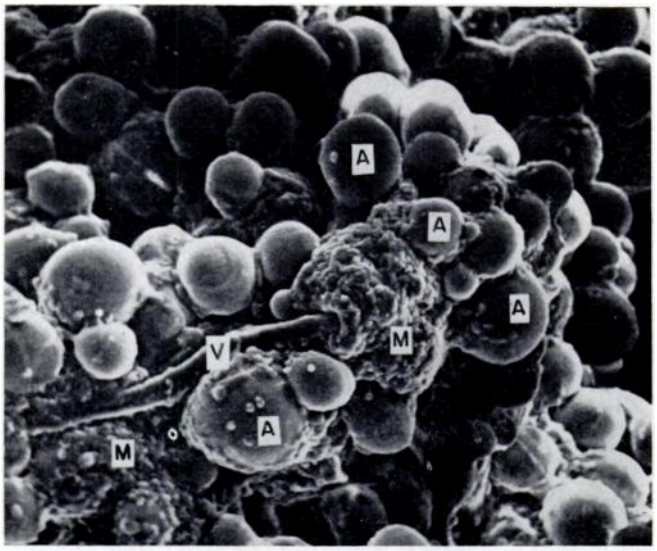

Fig. 4.—Human marrow—post irradiation (× 200). Note vessel and surrounding follicular mass of cells. (A = Adipose cell, M = Marrow cells, V = Vascular structure.)

content of the irradiated marrow, it was hoped, would unmask the vascular structures. A small vessel, presumably an arteriole, with a follicular proliferation of cells along one portion of its course was noted, apparently penetrating the marrow. The structure, vessel, and surrounding cells are reminiscent of the Malpighian follicle of the spleen. Again, the nature of the cells in the described follicle could not be determined.

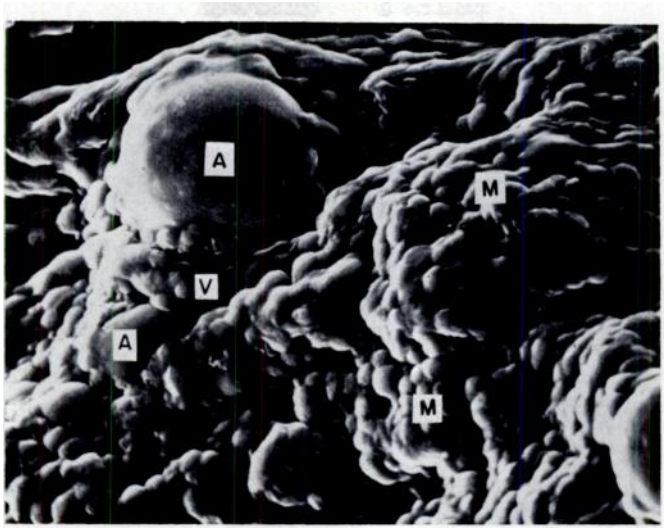

Fig. 5.—Human marrow—chronic granulocytic leukemia (× 500). (A = Adipose cell, M = Marrow cells, V = Vascular structure.)

The marrow particles obtained from the patient with chronic myelocytic leukemia showed a marked decrease in the number of fat cells with concomitant, extensive proliferation of the myelocytic cells in the form of mound-like excrescences (Fig. 5).

Despite obvious artifacts, particularly mild fracturing of the fat cell surface, the image of the marrow presented by the scanning electron microscope is apparently well preserved. Much work is needed to develop the information for cell recognition so necessary for the future exploitation of this technique. We believe that the scanning electron microscope will find useful application in the investigation of the morphology of the human marrow.

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