CC/NUMBER 27
JULY 7,1980

This Week's Citation Classic

Abercrombie M & Ambrose E J. The surface properties of cancer cells: a review. *Cancer Res.* **22**:525-48, 1962.
[University College and Chester Beatty Res. Inst., Inst. Cancer Research, London, England]

The major deviations from normal of malignant cells—local invasion, metastasis, disorganisation and persistent growth—were considered as disorders of the cell surface; and the physical aspects of adhesiveness, locomotion and contacts of cells, and the biochemistry of their membranes, were discussed as background to these deviations. [The *SCI*® indicates that this paper has been cited over 470 times since 1962.]

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May 19, 1980

"The literature bearing directly on the surface properties of cancer cells is now so large that it is hard to think back to how little we had to go on when we wrote our review. There was the pioneering work of Dale Coman on the mutual adhesiveness of malignant cells.[1] There was the work of my own group suggesting a defect in contact inhibition of locomotion in malignant cells[2] (the virologists had not yet brought contact inhibition of multiplication on to the scene); studies of the surface charge of tumour cells by cell electrophoresis, begun by Ambrose and his colleagues,[3] were active at the time; and there had been a few investigations of the tumour cell surface by electron microscopy. Indeed, little was known about any aspect of the cell surface. The technical step that was to be so important, the isolation of the plasma membrane, had only just been taken by Neville[4] and the Herzenbergs.

"Nevertheless, sparse as were the data, an underlying mood of interest in the cell surface was abroad, doubtless owing a lot to the writings of such great figures in developmental biology as Johannes Holtfreter[5] and Paul Weiss.[6] The mood was felt within the world of cancer, and the editors of *Cancer Research* asked Ambrose for a review about the potentials of the field. We were both then in London, Ambrose at the Chester Beatty Research Institute and I at University College, and we had been meeting regularly for some years to talk about the cell surface. So Ambrose invited my collaboration in the review, and we decided to see what sort of case we could make for the supposition that the manifestations of malignancy were essentially the expression of a change in the cell surface, something not till then attempted. I led off with the biological evidence, putting most of the emphasis on invasion and metastasis, about which there was most to say, and Ambrose then reviewed the physical aspects that might be involved in explanation.

"The review appeared, and there quickly followed a surge of research on the cell surface in general, and its part in malignancy in particular, which has been mounting ever since. It was not, regrettably, cause and effect. Certainly we hope that our review encouraged the outburst a little, and some cancer research workers have told me that it did turn their thoughts towards the surface. It did not, as I had hoped, turn thoughts noticeably towards the problems of invasion and metastasis, which I still think, as I thought then, are relatively speaking badly neglected in cancer research. I believe in fact that the review was much less influential than its citation rate suggests. A realistic assessment would probably find that it served more as a kind of emblem of the newly popular idea than as a source of it. Whenever an author felt that he had to justify an experimental paper, with a ringing declaration that the cell surface is now considered to be important in the malignant transformation, there was our review conveniently ready to support him. It had been perfectly timed by the editors of *Cancer Research.*

"A more recent review of some of the biochemical aspects of the surface of transformed cells has been published by R.O. Hynes."[7]

1. **Coman D R.** *Cancer Res.* **4**:625-9, 1944.
2. **Abercrombie M, Heaysman J E M & Karthauser H M.** *Exp. Cell Res.* **13**:276-92. 1957.
3. **Ambrose E J, James A M & Lowick J H B.** *Nature* (London) **177**:576-7, 1956.
4. **Neville D M, Jr. J** *Biophys. Biochem. Cytol.* **8:**413, 1960.
5. **Holtfreter J A.** *Ann. NY Acad. Sci.* **49**:709-60, 1948.
6. **Weiss P.** *Int. Rev. Cytol.* **7:**391- 423, 1958.
7. **Hynes R O.** *Biochim. Biophys. Acta* **458**:73-107. 1976.