normal tissue. The basal membrane is often missing. These observations confirm previous findings [5, 7].

We do not know whether the observed increase in staining for actin reflects an increased synthesis of actin in cancer cells or whether it is due to a change in configuration of the actin already present in the cells. In the case of actin, we could imagine a shift of the polymerization equilibrium in favor of filamentous actin. It is tempting to assume that the observed increase in actin staining and the abundance of microfilaments in peripheral and metastasizing cancer cells are related to the ability of these cells to move and thus reflect their invasive activity.

REFERENCES

1. M. Abercrombie and E. J. Ambrose, The surface properties of cancer cells: a review. *Cancer Res.* **22,** 525 (1962).
2. W. Rosenau, The nature and mechanism of metastasis. *Oncology* **24,** 21 (1969).
3. S. Wood, Jr., R. R. Baker and B. Marzocchi, Locomotion of cancer cells *in vivo* compared with normal cells. In *Mechanisms of Invasion in Cancer.* (Edited by P. Denoix), Springer Verlag, Berlin (1967).
4. G. Gabbiani, G. B. Ryan, J. P. Lamelin, P. Vassalli, G. Majno, C. A. Bouvier, A. Cruchaud and E. F. Lüscher, Human smooth muscle autoantibody: its identification as anti-actin antibody and a study of its binding to 'non-muscular' cells. *Amer. J. Pathol.* **72,** 473 (1973).
5. G. Gabbiani, J. Csank-Brassert, J. C. Schneeberger, Y. Kapanci, P. Trenchev and E. J. Holborow, Contractile proteins in human cancer cells. Immunofluorescent and electron microscopic study. *Amer. J, Pathol.* **83,** 457 (1976).
6. P. Schenk, Microfilaments in human epithelial cancer cells. *Krebsforschung* **84,** 241 (1975).
7. N. S. McNutt, Ultrastructural comparison of the interface between epithelium and stroma in basal cell carcinoma and control human skin. *Lab. Invest.* **35,** 132 (1976).

Locomotion of Cancer Cells *in vivo*

P. STRÄULI

Abteilung für Krebsforschung, Institut für Pathologie, Universität Zürich

Very few experimental models, among them the rabbit ear chamber, allow the microcinematographic recording of the motile behavior of cancer cells within living tissues [1]. Considerable progress is now being achieved with the mesentery model, in which locomotion of cancer cells, initiated *in vivo*, goes on *in vitro*, where it can be filmed [2]. By comparing the behaviour of cancer cells, e.g., V2 rabbit carcinoma cells and L5222 rat leukemia cells, under *in vitro*- and *in vivo*-conditions, we can conclude that on principle, the mode of locomotion and the shape of the cells are identical. Thus, *in vitro*-data on cancer cell locomotion are not, *a priori*, misleading. They are, however, incomplete, as they cannot demonstrate the adaptation of locomoting cells to the texture of their environment.

It is easily conceivable that cells migrating *in vivo* use the pathways of least resistance. In the mesentery, these are the compartments that appear unstructured in phase contrast and in sections. We know that this space is neither empty nor just a container of fluid, but filled by a network of molecular order made up by the proteoglycans of the extracellular matrix. What is the nature of the encounter between locomoting cells and this material? We are now accustomed to assume that cell propulsion is generated by the dynamic interaction of contraction and adhesion. In all likelihood, adhesive sites are provided by the more stable parts of the matrix, fibers and cell surfaces. Can the contractile elements, emanating from these temporary attachment points, pull the cell through the matrix by mere compression and/or displacement of the latter? There appears to be no theoretical objection, but the problem is practically unexplored.

Whatever the nature of this mechanism, its functioning is facilitated by shape adaptations of the translocating cells. We are inclined to interpret these configurational changes as

coordinated with the generation of the driving force, i.e., as an active achievement of the cell. The question is whether passive deformation also plays a role. To what extent are cancer cells passively shaped by pulling forces or by a *vis a tergo*, e. g., the blood pressure in transcapillary passage? In the latter instance, a contribution of contraction or polymerization–depolymerization has neither been proven nor disproven, In general, the relation between active shape adaptation and passive deformation may rather be inversely proportional than proportional [3], but here again our experience is very limited.

In conclusion, we have to admit that we do not know whether the functional system consisting of propulsive force generation, selection of suitable pathways, and shape adaptation enables a cancer cell to locomote at all within a living tissue. It might be that lytic effects on host structures, possibly at the subcellular level only, are an indispensable prerequisite for any display of cell migration within the organism.

REFERENCES

1. P. Sträuli and L. Weiss, Cell locomotion and tumor penetration—report on a workshop of the E.O.R.T.C. cell surface project group. *Europ. J. Cancer* **13,** 1 (1977).
2. G. Haemmerli and P. Sträuli, Motility of L5222 leukemia cells within the mesentery. A study by time lapse cinematography. *Virchows Arch. B. Cell Pathol.* **29,** 167 (1978).
3. M. A. Lichtman and E. A. Kearny, The filterability of normal and leukemic human leukocytes. *Blood Cells* **2,** 491 (1976).