ISOLATION AND INSULATION OF SPECIAL CELLS

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IN unicellular green motile walled algae such as *Chlamydomonas,* during reproduction or cell division, the entire protoplast withdraws sooner or later from the surrounding cell wall. The connections between the external flagella and the internal organelles are severed. The protoplast divides longitudinally. This severance of connections with the external flagella is more obvious when the plane of division is at right angles to the longitudinal axis, and is preceded by a rotation of the entire protoplast by 90°. In some species of *Haematococcus,* where the flagella are not dropped and the rotation of the protoplast is not obvious, careful studies have revealed that the neuromotor apparatus gets disjuncted inside the protoplast at the base of the flagellum and instead of the whole protoplast rotating, there is a rotation of the internal organelles by 90° so that the cell division which appears tranverse is really longitudinal *vis-a-vis* the internal organelle arrangement and its symmetry (Pocock, 1960). What is more interesting is that even in multicellular algae, a withdrawal of the contents from their walls is very common or universal during reproduction. It is often described as a method of eliminating sap vacuoles and the other functional impulses, if any, are missed.

Similar rotation of protoplasts are seen in *Prasiola* during reproduction when areas of the monostromatic thallus becomes polystromatic. The cell division is longitudinal to the symmetry of the protoplast and at 90° to the normal plane of division (Friedmann, 1959). Such thalli, often described as parenchymatous, must be considered as making really a palmelloid organization, an ordered or unordered aggregate of individual cells. The same holds good in the case of some ulotrichalen genera. These lack a fixed polarity, morphologically speaking, and probably behave like palmelloid organisms. It is not surprising that in these cases the life-cycle involves unicellular growing somatic phases as against resting conditions. In other ulotrichalen and chaetophoralen algae protoplasmic connections are known and in these also the protoplasts withdraw from the cell walls before the formation of swarmers or reproductive elements. The protoplasmic connections between sister cells probably function as channels for transport of metabolites and messages and an expression of polarity, controlling activities of the plant body and its contained cells. During reproduction the contents of a differentiating cell contract from the wall all around, thus breaking off the protoplasmic connections with the neighbouring cells and escaping from the restrictive influences or effects from their presence. The fact that internal changes in the location of organelles, especially the nucleus needed for further development, follows such a break from the constraints placed on it, by the presence of protoplasmic connections is significant. The purposiveness of such a withdrawal seems to be more evident when we observe that in some cases the protoplasts of such cells may refill the cell cavity. Such an isolation may sometimes be postponed till the time of shift in the position of the nucleus in male and female cells preparatory to flagellation or fertilization.

In many cases, the withdrawal of cell contents from the cell wall is accompanied by material secretion around the protoplast, a feature seen in some genera even in asexually formed spores or parthenospores or azygospores. While there is a small difference of opinion on the timing of secretion of this material in which it becomes encapsulated as such, most people consider it at least simultaneous with the withdrawal of the protoplast from the wall. In some algae the motile reproductive elements remain enclosed in a thin vesicle for some time or until sometime even after release from the parent cell. Such secretions may insulate as it were, the already directed cell differentiation and thus lead to an ordered progress of a differentiating cell against any further influence or changes detrimental to the differentiation. What functions do these and other secretions play, in generally screening off the differentiated cell after being charged with a function from further directional influence, which may ensue by their connection with the neighbouring cells ? This is not to minimize or negate other functions these may serve. Details of similar mechanisms that may exist in palmelloid aggregates or pseudoparenchymatous tissue of cells are not known.

While this is the case in autochthonously generated process of cell differentiation, allochthonously generated impulses meddling with the structure and organization also simulate these developments. We cite only two diverse examples. When cells of a prothallus are subjected to nonlethal plasmolysis the protoplasts withdraw from the walls and each of them behaves as an independent unit and forms a new plant (Nakazawa, 1963). From recent studies of the nucleus it is becoming more and more evident that the nucleus is variously anchored as as it were, to other cell organelles such as the chloroplast or pyrenoid or may be held in position by an array of microtubules. Any disturbance of this, brought about artificially, not only disturbs or dislodges the nucleus but may set in motion a chain of events or developments resembling one or the other aspects referred to above. For instance, plasmolysis may result. It is not surprising that such a plasmolyzed cell functions as a reproductive cell and forms a new plant (Walker *et al.*, 1975). This also explains the totipotency of single undifferentiated cells such as parenchyma cells when studied in isolation, as these are not subjected to directional influences as may be present in a well-knit tissue (Steward, 1968, p. 467). It is from the same influence a plasmolyzed protoplast escapes by isolation and insulation even while being embeded in a mass of similar cells.

The above examples are instances of isolation and insulation of an ordered differentiating cell in the normal process of an organism without involving any change in the genetic make-up. These same phenomena seem to occur also in differentiating cells which are accompanied by changes in ploidy. In the palmelloid or pseudoparenchymatous genus *Prasiola*, for instance, it is possible for haploid cells derived after meiosis to grow in a diploid environment and form mosaic patches of haploid cells in an apparently different, diploid environment. In the case of angiosperms when a megaspore or microspore mother cell is differentiated, it is separated from the neighbouring cells by a fresh layer of wall material such as callose, before it undergoes reduction division. A comparision of this with the early stages of formation of apomictic embryos reveals the significance of this isolation. This seems to be true of all cells which undergo reduction division, in an otherwise diploid environment or tissue. In some coenocytic conditions, a diploid nucleus becomes selected for reduction division. Such nucleii become enclosed in sporangia or cysts and the reduction division takes place inside these. In others the reducing nuclei, together with a portion of the cytoplasm, become partitioned off from the rest of the protoplast. This does not preclude the possibility of establishment later, of saprophytic or even parasitic connections by fertilized female cells with the parental tissue. In these cases the haploid nucleus of a parasitized cell may even multiply along with diploid nucleus but they appear to have no distinct function and in fact they ultimately become degenerate. How this competitive antagonism between changed nuclei (diploid or haploid) and the unchanged nuclei (haploid or diploid) works out is yet to be fully understood.

Thus it appears that isolation and insulation of a normal differentiating cell or changed cell from further directional messages or harmful or inhibitory metabolites or influences are not only essential for an orderly development of the charged cell, but such an isolation and insulation appears to be necessary in cases of cells, which have a changed genetic component, either normal to the organism or abnormal or even harmful to the organism itself. In the latter group we are inclined to include certain cancer cells. Incomplete isolation and insulation of differentiating, zygotic or embryonal cell within an organism or tissue or environment leads to either a reversal of development or may even prove lethal to the cell. This hypothesis does not apply to a differentiating cell(s) which even when fully differentiated has to remain connected to other cells for its functional activities and insulation is not necessary for differentiating changes. It applies only for such differentiating cells which are independent and need to become independent. Such differentiations can be internally directed and the cells can depend on its surface for select physiological activity as the differentiation may demand. In the establishment of a mutant or changed cell such as cancer cells it may be essential as otherwise influences detrimental to it or defence mechanisms generated by the environment may prove lethal or destabilizing.

Steward (1968, p. 485) has said that what a cell differentiate into is due not so much to what the cells are, as to where they are. The present conception is in a way a complementary (?) one and explains that a cell can become different from the rest of the cells around it or the sister cells even where they are, in other words, 'in it, yet out of it'.

How common are these two phenomena to other living organisms than those that have been dealt with in this short exposition? What is the nature of insulation in these cases and other cases? Does it involve only changes in the plasmalemma or does it involve also extraplasmalemmar secretions or coats or physico-chemical changes? These are the questions that will no doubt be studied and argued in the future.

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