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V. POLAR CELL MOVEMENTS

Cell motility, recently surveyed in a new book (Bray, 1992), involves a type of polarity which is largely an *extrinsic* consequence of structural and hence developmental polarity (chap. VII-VIII and synopsis in our Epilogue).

B. Cell movements

1. *Cilia-flagella*

The polar flagellar motor of *Vibrio alginolyticus* is known to be powered by the sodium-motive force (Chernyak *et al.*, 1983 and Tokuda *et al.*, 1988 in Atsumi *et al.*, 1992) as is also that of *Vibrio parahaemolyticus*, whereas its lateral flagellar motors are driven by the proton-motive force (Atsumi *et al.*, 1992).

3. *Amoeboid motion (transient polarity)*

The bipolar cellular organization of *Amoeba proteus* is stabilized by high external Ca^{2+} concentrations (~100 mM) which induce the polar propagation of Ca^{2+} waves from the uroid to the front region (Gollnick *et al.*, 1991).

5. *Taxis*

a) *Chemotaxis*: Stimulation with the chemoattractant cAMP induces a transient membrane hyperpolarization which is consistent with the opening of potassium channels (van Duijn and Wang, 1990). Changes in internal $[Ca^{2+}]$ during polarization and chemotaxis have been observed by imaging both calcium and eosinophil cell morphology: following chemotactic stimuli, the new leading edge had the lowest $[Ca^{2+}]_i$ (Brundage *et al.*, 1991).

Myosin modulates chemotaxis, posssibly by affecting cell polarity in the slime mold and a model for polarity generation has been proposed (Spudich, 1989). During chemotaxis of *Physarum polycephalum*, a two-layer coupled oscillator system composed of endoplasm and ectoplasm may play important roles for information integration (Miyake *et al.*, 1991).

Amoeboid chemotaxis of *Dictyostelium* involves a regulated increase in actin nucleation activity that is correlated with an increase in actin polymerization occurring seconds after chemotactic stimulation (Carson *et al.*, 1986 and Hall *et al.*, 1989, ref. in Sauterer *et al.*, 1991). An agonist-regulated capping protein, aginactin, has been isolated and characterized by Sauterer *et al.* (1991) that may regulate these changes in nucleation activity. Coronin, a newly isolated actin-binding protein of *D. discoideum* might be implicated in the transmission of chemotactic signals from cAMP receptors in the amoebial plasma membrane (De Hostos *et al.*, 1991).

b) *Phototaxis:* Intracellular pH and ammonia might play a key role in the thermo- and phototaxis of migrating slugs of *D. discoideum* (van Duijn and Inouye, 1991).

c) *Galvanotaxis:* Motile cells frequently respond to imposed fields, and in most cases they migrate toward the negative pole or cathode (see Table 1, in Nuccitelli, 1988).

6. *Structural basis of directionality*

Cell polarization is generally microtubule-dependent essentially for long-range polarization (Vasiliev and Gelfand, 1976 in Gelfand and Bershadsky, 1991). However, there are examples in which polarization of the motile activity of the cultured cells per se may be achieved without microtubules (see Gelfand and Bershadsky, 1991).