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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  $\text{Ca}^{2+}$  concentrations (~100 mM) which induce the polar propagation of  $\text{Ca}^{2+}$  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  $[\text{Ca}^{2+}]$  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  $[\text{Ca}^{2+}]_i$  (Brundage *et al.*, 1991).

Myosin modulates chemotaxis, possibly 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).