$$\mathbf{v}_i = -\sum_{j \neq i} \overbrace{A_{i,j} \nabla \phi}^{\text{adhesion}} - \sum_{j \neq i} \overbrace{B_{i,j} \nabla \psi}^{\text{repulsion}}$$

originally: all agents are same $A_{i,j} = A$ for all i and j
more recently: soem agents are "stickier" than others $A_{i,j} = \sqrt{A_i A_j}$
newest: subcells prefer sticking to subcells of same cell

$$A_{i,j} = \begin{cases} \alpha & \text{if } i \text{ and } j \text{ are same cell} \\ f\alpha & \text{if } i \text{ and } j \text{ are not same cell} \end{cases} \qquad 0 < f < 1$$

more newest: subcells prefer sticking to subcells of same cell of same type

$$A_{i,j} = \begin{cases} \alpha & \text{if } i \text{ and } j \text{ are same cell} \\ f_1\alpha & \text{if } i \text{ and } j \text{ are not same cell but same type} \\ f_1 f_2 \alpha & \text{if } i \text{ and } j \text{ are not same cell, and are different type} \end{cases} \qquad 0 < f_1 < 1, 0 < f_2 < 1$$

$$\nabla \phi(\mathbf{r}) = \left(1 - \frac{||\mathbf{r}||}{R_A}\right)^{n+1} \frac{\mathbf{r}}{||\mathbf{r}||}$$

$n = 1$
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3322268/

0.1 Cell to membrane, distance-based

Suppose cell i has formed a string link at position $\mathbf{x}_B$. Let:

$$\mathbf{d} = \mathbf{x}_B - \mathbf{x}_i$$

$$\mathbf{v}_i = \cdots + s_i \, ||\mathbf{d}|| \, \frac{\mathbf{d}}{||\mathbf{d}|| + \epsilon} + \text{ repulsion}$$

$$\mathbf{v}_i = \cdots + s_i \mathbf{d} + \text{ repulsion}$$

0.1.1 alternative form

Let R_i (cell radius) be the "resting length" of the spring.

$$\mathbf{v}_i = \cdots + s_i \left(||\mathbf{d}|| - R_i\right) \frac{\mathbf{d}}{||\mathbf{d}|| + \epsilon} + \text{ repulsion}$$

0.2 membrane repulsion

Let d be the signed distance function, and $\nabla d = \mathbf{n}$ be the unit normal, pointing into the lumen.
$d > 0$ on the "lumen" side, and $d < 0$ on the stroma side.

$$\mathbf{v}_i = \cdots + \left(1 - \frac{d}{R_i}\right)^{m+1} \frac{d}{|d| + \epsilon} \mathbf{n}.$$

$m = 0$?
https://journals.plos.org/ploscompbiol/article?id=10.1371/journal.pcbi.1005991