Supporting Text

In the main text, we have focused on binding events after transport processes, and membrane shape fluctuations have brought a receptor and its ligand in close apposition and head-to-head. While Bell (1) and others (2) have considered how transport processes in membranes bring receptors and ligands to be head-to-head, to our knowledge, the role of membrane elasticity in bringing a receptor and a ligand in to close apposition through thermal fluctuations has not been considered heretofore. Here, we briefly consider this issue. We imagine that the free energy associated with membrane shape changes is determined by two physical effects. An interfacial tension suppresses shape changes that result in an increase in area, and a bending rigidity makes high curvature shapes unfavorable. We then solve a Langevin equation for the continuous field representing intermembrane separation [Model A dynamics (3)] to obtain the first passage time distribution for two membranes to approach within a certain distance that is sufficiently close for head-to-head apposition of receptors and ligands. The mean first passage time is a measure of the time it takes for close apposition to occur and is analogous to the mean diffusion time in solution for receptor–ligand collisions to occur. The specific equations we solve are as follows:

$$\frac{\partial z}{\partial t} = -M_z \frac{\partial U}{\partial z} + \xi_z,$$
$$\left\langle \xi_z(t)\xi_z(t')\right\rangle = 2M_z K_B T\delta(t-t'),$$
$$U = \frac{1}{2}\int dxdy\left[\gamma(\nabla z)^2 + \mu(\nabla^2 z)^2\right],$$

where *z* is the distance between the two membranes at a given two-dimensional position, *U* is the free energy of the membrane, M_z is a “friction coefficient” (a parameter whose value we do not know for real cell membranes), and $\zeta_z(t)$ is uncorrelated thermal noise. The values of the interfacial tension and bending rigidity are provided in the legend of Fig. 4.

1. Bell, G. I. (1978) *Science* **200,** 618–627.

2. Delisi, C. & Wiegel, F. W. (1981) *Proc. Natl. Acad. Sci. USA* **78,** 5569–5572.

3. Hohenberg, P. C. & Halperin, B. I. (1977) *Rev. Mod. Phys.* **49,** 435–479.