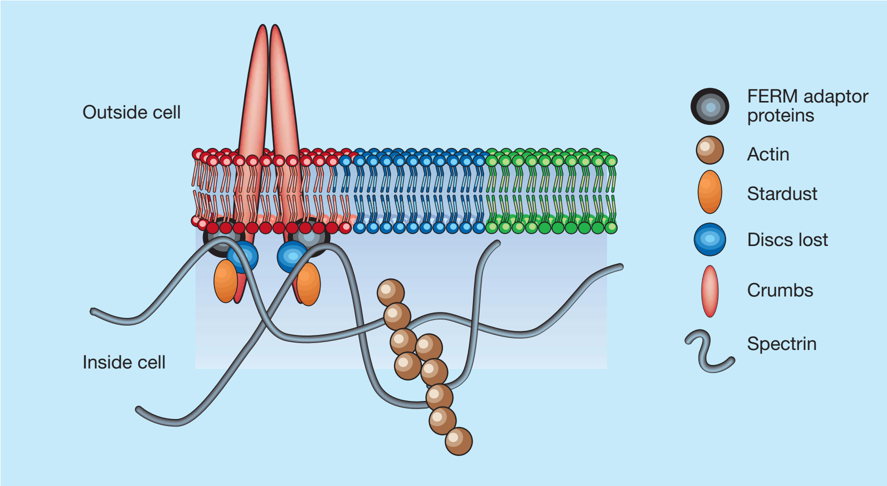


Figure 2 **How the unusual architecture of the photoreceptor apical membrane might develop (based on refs 1, 2). The photoreceptor plasma membrane is divided into stalk (red), zonula adherens (blue) and basolateral parts (dark green). Here, two Crumbs proteins interact through their extracellular domains. When the complex is attached to the membrane, the regions just inside the membrane can recruit FERM proteins and spectrin, anchoring the membrane to the actin cytoskeleton. This might lead to stalk elongation by decreasing the rate of membrane internalization. The intracellular regions of Crumbs also recruit the Stardust and Discs lost proteins; together, these three proteins contribute to the other function of Crumbs — specifying the apical membrane.**

the other hand, appears to be involved in modulating stalk length[1]. Pellikka *et al.* found that overproduction of a truncated version of Crumbs lacking the intracellular domain could increase stalk length in a dose-dependent manner. This is particularly exciting as the extracellular domain is not needed for Crumbs to determine apical–basal polarity.

How does Crumbs recruit extra membranes to lengthen the stalk? Although they were not looking at stalk formation, Izaddoost *et al.*[2] might have uncovered a mechanism. They studied a region of Crumbs known as the juxtamembrane domain, which is found just inside the cell[13]. Izaddoost *et al.* show that this domain is responsible for allocating material such as the cadherin–catenin complex to the photoreceptor's zonula adherens, independently of an effect on apical–basal polarity. They also suggest that the juxtamembrane domain could be a binding site for a certain 'adaptor' protein, which in turn would recruit components of the cellular skeleton such as spectrin. Interestingly, Pellikka *et al.* show that one form of spectrin does form a complex with Crumbs and Discs lost.

So we propose the following model. As mentioned above, Pellikka *et al.* found that overproduction of the membrane-bound extracellular region of Crumbs leads to stalk extension. We suggest that Crumbs interacts with itself through this extracellular region (Fig. 2). The complex produced could then signal through the juxtamembrane domain and recruit the spectrin cytoskeleton, which would in turn decrease the rate at which membrane is internalized in the cell and so favour stalk extension[14]. Consistent with this model, the stalk is shorter when one particular form of spectrin is mutated[1].

What light do these results[1,2] shed on the forms of the human disorders retinitis pigmentosa and Leber congenital amaurosis in which CRB1 is mutated? In vertebrate photoreceptors, CRB1 is localized to the inner segment[1], as is Crumbs to the stalk in *Drosophila*, pointing to these membranes as being functionally equivalent. So it will be interesting to see whether CRB1 defines the length of the inner segment in vertebrates, as Crumbs does in fruitflies. Moreover, some patients with retinitis pigmentosa type 12 have mutations that affect only the extracellular domain of CRB1, which is intriguing given that this portion of Crumbs is only crucial in stalk extension[1]. It seems that doctors are in a position to cast a fresh eye over these debilitating retinal diseases. ■

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Daedalus

# Electric waves

**Wave power is one of the renewable sources of energy that the British government wants to develop. Yet many gates and nodding ducks, which are used to capture energy from the surface waves, have been destroyed by a furious sea; only devices with no moving parts seem to have a future. Daedalus recalls that waves are not merely a surface effect. Much of their energy is stored deep under the water, in the form of circular or elliptical closed currents that reach right down to the sea bottom (which is why waves gain height in shallow water). And because sea water contains salt, it conducts electricity. So a fully submerged, static, electrical device should be a good bet.**

**Electrochemists hold that a piece of metal dropped in an electrolyte gives off positive ions. They dissolve; it takes up the opposite negative charge and attracts them. The result is a double layer, the negative metal sheathed in positive ions.**

**So, says Daedalus, imagine two pieces of metal held apart in the water by an insulator. Ions would be released from both sides. If the ions are pushed from one side to the other by a current in the water, the arrangement should gain energy. DREADCO engineers are now designing webs of such electrical conductors to be implanted on the sea bed, out beyond the low-tide mark. Much of the technology has already been perfected by gas-drillers and other marine engineers. Each unit will damp the wave over it and generate rather a lumpy alternating current. Rectifiers will turn this into direct current; all the units will be coupled in series. Statistically the final voltage should be fairly smooth, its intensity depending on the vigour of the incoming sea. It will be led ashore directly, through delivery leads.**

**To the waves above, this steady loss of energy will 'feel' like an energy-absorbing sea bed. A big distributed damping installation should steal so much energy from the seas that only safe little waves will hit the shore. If so, the new system will not only provide energy, but will also reduce the need for sea walls and other marine defences. Even the wildest sea will give safe, useful energy.**

**Considerable cunning will be needed to find the best layout for the system. Daedalus likes the idea of close pairs of conductors aligned to cut the most likely wave ellipses; but the final design must depend on empirical insights. Ships should also welcome the system — it will damp rough weather. Anchoring would not be advisable, however; it would damage the system.**

David Jones