FIG. 1 Hypothetical role of MCC (mutated in colorectal cancer) protein as a G-protein inhibitor. The MCC binds the G protein (G), sequestering it from receptor (R), thereby preventing activation of the effector (E).

lamins, the *Drosophila* BicD protein, vimentin and other intermediate-filament proteins. Although functionally diverse, these proteins share the ability to form rod-like homodimeric complexes (and often higher-order oligomers) in which long regions of α helix wrap around each other in a coiled coil configuration^{6,7}. The amino-acid sequences of proteins in this family reveal long stretches of 'heptad repeats', in which the side chains of the first and fourth residues are hydrophobic; lacking prolines, these stretches of sequence can form uninterrupted α helices. The repeated hydrophobic side chains form a hydrophobic streak on one side of the helix; by allowing hydrophobic interaction between similar streaks on parallel α helices of two polypeptides, these repeats promote association of the two helices into a coiled coil^{6,7}.

This tell-tale structural motif appears in MCC as well (Fig. 2): the protein contains at least five proline-free stretches of heptad repeats, 42–133 amino acids in length. The two largest stretches are similar in size to the coiled coil regions of nuclear lamins⁶. As in the lamins, these putative α helices connect relatively hydrophilic regions, of varying size, whose proline residues and lack of heptad repeats make them unlikely to form coiled coils.

The distribution of heptad repeats suggests a kink-and-rod structure (Fig. 2). Each end of an MCC molecule would be a globular protein domain; these would be connected by a series of rods (the α helices) interrupted by small kinks (the short proline-rich regions between the helices). The rod regions of known coiled coil proteins extend approximately 15 nm per 100 amino-acid residues⁷. By this yardstick, the putative coiled coils in an imaginary extended MCC homodimer (Fig. 2c) could add up to 54 nm.

What does the structure proposed in Fig. 2 tell us about the function of the MCC protein? Coiled coils seem to serve as relatively stiff structural 'spacers' that specify distances between other proteins, which bind to the

globular domains at either end of the protein, and perhaps to some of the kinks in between. By associating into higher-order oligomers, they may form macromolecular structures that organize the cytoplasm (intermediate

filaments) or the nuclear membrane (lamins). They may be stable structures (muscle myosin) or fall apart and come back together in a precisely regulated fashion (as with the nuclear lamins before and after mitosis). The diversity of other members of the coiled coil protein family does not point to a specific function or cellular location for MCC. Nonetheless, cell proliferation is often regulated by cell shape and physical constraints imposed by other cells, making it easy to imagine that genetic disruption of a filamentous structure might somehow derepress a mitogenic signal.

The proposed coiled coil structure for MCC may help to explain the relation between 5q21 deletions in sporadic colon cancer and inheritance of polyposis — without evident deletions — in FAP. Because the MCC protein functions as a homodimer (or even a higher order multimer), recessive and dominant mutations in MCC can create functional deficits of widely differing severity. Point mutations that impair association between normal and mutant MCC polypeptides might cause mild deficits; large deletions of a single MCC allele could

Seeing through the fruits of deception

THE practice of deception is by no means confined to sentient organisms, but it rarely reaches the sophistication claimed by A. R. Zangerl and colleagues for the wild parsnip (*Evolutionary Ecology* 5, 136–145; 1991). This plant (*Pastinaca sativa*) produces fruits that lack viable seeds within the inflorescence (termed parthenocarpic) and the authors propose that the advantage to the plant of this apparent profligacy is that predators eat them rather than the viable fruits.

The regular occurrence of parthenocarpic suggests that the practice has some selective value for the plants that indulge in it. One proposal is that the rejection by the parent plant of certain of the fertilized ovules in the inflorescence provides it with a degree of mate choice, permitting the selective survival of favoured seeds. But observations on the fruits of the wild parsnip have led to an alternative idea, based upon the behaviour of larvae of the parsnip webworm (*Depressaria pastinacella*). This specialized lepidopteran fruit predator is shown by Zangerl *et al.* to prefer the parthenocarpic fruits to the viable ones, even though the former contain no embryo and no endosperm, and their consumption results in larval growth rates only one third of those that are possible when viable fruits are eaten.

Evidently there is some characteristic of the parthenocarpic fruit that makes it more attractive to the webworms. Visually it is difficult to distinguish between the two (except when lit from behind artificially, when the parthenocarpic fruits are seen to be empty — see picture), but the webworm selects its food by tasting the surface of the fruit and is particularly sensitive to deterrent furanocoumarins. These are about twice as abundant in the viable fruits, thus making the parthenocarpic ones more palatable.

The production of defunct fruits by the parsnip is energetically expensive and is unlikely to be the outcome of herbaceous altruism. Some plants produce non-functional fruits that serve to sustain insects (as in the case of figs and fig wasps) but only when the insect has some clear value to the plant (such as pollination). In this case, there is no evident advantage to the plant in maintaining webworm populations. Zangerl *et al.* conclude that the empty fruits serve as decoys, and perhaps the most remarkable feature of their observations is that the plant gains selective benefit from the allocation of its energy reserves in this way. The evolutionary path of deception is clearly a profitable one and some plants have not been slow to follow it.

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