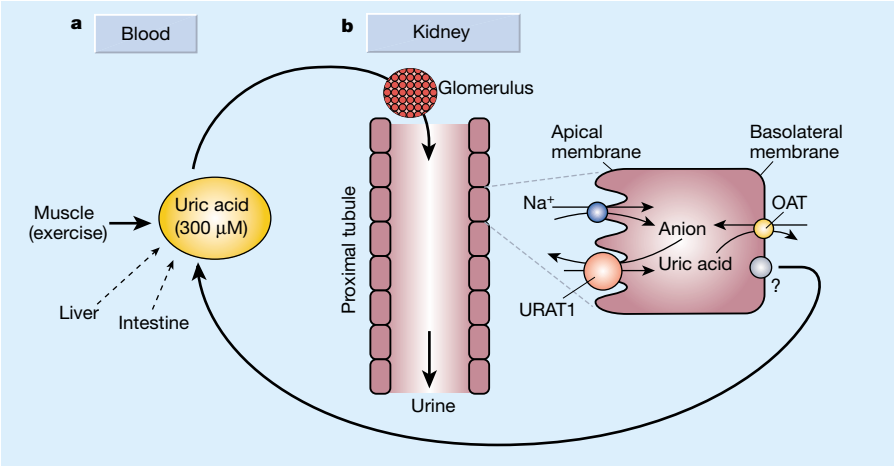


Figure 1 **Pathways for uric-acid transport.** a, **Uric acid is produced as the major end-product of purine metabolism by muscles, liver and intestine.** b, **After the blood is filtered at the glomerulus, the resulting fluid enters the tubules of the kidneys to allow waste substances to be excreted as urine. Many substances, however, such as uric acid, are useful and so are reabsorbed. This is achieved by the cells that line the walls of the tubules, as seen in detail at the right. As shown by Enomoto *et al.*[1], the transporter URAT1 mediates uptake of uric acid across the apical membrane, in exchange for anions, which enter cells either by $Na^+$-coupled transport through the apical membrane or organic anion transport (through OAT proteins) across the basolateral membrane. Uric acid leaves the cell across the basolateral membrane through an unknown channel or transporter, possibly in exchange for anions through an OAT protein.**

oxygen species, causes death of tubule cells. Without exercise, these patients can live normally, except for an increased occurrence of kidney stones. Enomoto *et al.* find that these patients have defects in the URAT1 gene — yet more evidence that this indeed encodes the uric-acid transporter.

These results[1] have several implications. For example, natural person-to-person variations in the URAT1 gene might contribute to certain forms of gout, if such variations lead to greater reabsorptive activity. The prevalence of gout is known to increase with blood uric-acid concentration, along with several other factors including age, body weight, blood pressure, alcohol intake and consumption of purine-rich foods such as meat[4]. There is also evidence that higher blood levels of uric acid are associated with a greater risk of heart disease (although it is unclear whether uric acid contributes directly[5]), so natural variations in URAT1 might be important here, too.

Finally, URAT1 might contribute to human longevity. An important factor in the lengthening of primate lifespans has been the evolution of mechanisms that protect against reactive oxygen species. Such mechanisms include antioxidant compounds such as vitamins A, C and E[6,7]. Uric acid is thought to be another antioxidant, as suggested by the fact that birds are very long-lived for their body size — despite high metabolic rates, body temperatures and blood glucose levels[8] — and also produce uric acid as the major end-product of the metabolism of protein-derived nitrogen.

In contrast to birds, mammals produce urea rather than uric acid as the end-product of such metabolism. But uric acid is still produced, from purines, and notably it accumulates in humans to about ten times the levels in most other mammals[2]. Blood uric-acid levels in humans are also about six times those of vitamin C (about 300 μM compared with some 50 μM)[9]. So uric acid is thought to be a primary antioxidant in human blood. The evolution of URAT1, and the loss of the ability to secrete uric acid and of the liver uric-acid-degrading enzyme, was presumably important in producing these levels. It will be interesting to see whether variations or mutations in URAT1 correlate with variations in human lifespans.

Uric acid clearly has many beneficial effects. But, in combination with genetic or environmental factors, it can also be detrimental when it accumulates at high levels. So the human uric-acid transporter URAT1 may prove an interesting target for future drug development. ■

*Matthias A. Hediger is in the Membrane Biology Program at the Brigham and Women's Hospital and the Department of Biological Chemistry and Molecular Pharmacology, Harvard Medical School, Boston, Massachusetts 02115, USA.*
*e-mail: mhediger@rics.bwh.harvard.edu*

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Daedalus

## Vegetarian meat

**Last week Daedalus was enlarging birds' eggs by adding an expanded ceramic shell. DREADCO biologists are now extending this idea. They recall the old trick of making an egg plastic with vinegar, and re-setting it inside a bottle. This suggests that the nucleation of an egg shell depends on special proteins which can be interfered with. DREADCO sees fowl as rather primitive egg-formers, ripe for improvement. Hens will accept almost any source of calcium for egg shells, even calcium carbide, which is lethal to them. Inside the hen, the hard shell is put on the egg last. It can be coloured brown, by a special dye fed to the birds. Hens even waste their resources on eggs if these are not fertilized.**

**There is, of course, a commercial target: the 20% of the British population who are vegetarians. As an egg develops, its proteins change to meat, and DREADCO wants to sell meaty vegetarian eggs. A plastic shell would let the chick inside develop almost to adulthood still unconscious. It never has to wake up, emerge or grow feathers. It can breathe, for an egg is porous, even more so if it is plastic and as it stretches. The egg could be partly immersed in a nutrient broth, or maybe injected with one, so that a small initial chick could get bigger.**

**So the DREADCO team hope to make their hens lay stretchable, plastic eggs. They see the brittle, rigid, calcium carbonate egg shell as an evolutionary step backwards. Birds are descended from reptiles, whose eggs are leathery. Genes from closely related reptiles might make birds' eggs plastic again. Alternatively, simply feeding the birds on calcium salts of plastic acids, such as polyacrylic or polymethacrylic, might do the trick. And if the resulting eggs are incomplete or somehow unviable, like the usual unfertilized eggs, this doesn't matter if the hens can be bred some other way.**

**Eggs as currently sold are very remote from life. The DREADCO team hope to produce a bigger but equally artificial plastic egg. The ideal product would contain not a bird, but the meat elements from which one might be constructed. The most committed vegetarian should accept in a plastic envelope meat that had never been conscious. But for how long should the egg be grown? Should a nutrient broth be injected? Ideally, the consumer will open the egg, dissect out the meaty, edible section and reject the rest, without even thinking of the bird that might have been: any more than we think this of an egg.**

David Jones