that certain basic methods of algebraic topology can unfailingly recognize a (three-dimensional) sphere — curiously, the problem has been solved in all other dimensions. The sixth is about a remarkable conjecture in algebraic number theory, not far from the circle of ideas that led Andrew Wiles and Richard Taylor to the solution of Fermat's Last Theorem. The final problem returns to algebraic topology, but with a more technical question about the closeness or otherwise of algebraic and geometric ideas in versions of that theory. These last three are harder to 'sell' to a broad audience, but they each point to something quite specific in a major branch of mathematics which for some profound reason we do not understand.

I believe that mathematics should set out its stall in the way that the Clay Mathematics Institute has done, but it would be a valuable educational task to make mathematics graduates aware of what these problems say. The longer accounts of each problem on the Clay Mathematics Institute website (http://www.claymath.org/index.htm) presume a considerable amount of background knowledge. But the problem of exposition is much more acute when, as Devlin has done, the decision is to aim for the largest audience possible.

Devlin's solution was to write a very elementary chapter on each problem, sometimes with a slightly harder set of short appendices. The result is a series of superficial remarks largely intelligible to schoolchildren over 16, followed by a selection of more insightful remarks, followed by some vigorous hand-waving in the direction of the summit. These last are often of a motivational kind, supported by loosely accurate historical remarks, and aimed at amplifying the claim that the problems matter. The quality of the mathematical exposition is high, a sense of excitement is strongly conveyed, and the summits are at least glimpsed while the difficulties in approaching them remain rightly shrouded in mist. There will be other books, by other authors, aimed at readers who already know more mathematics.

Devlin has grappled openly and honestly with the problems of reaching his chosen audience. He is frank in admitting that it is easier to hint at some of the problems than others, and this accounts not only for the order in which he presents the problems but the sort of things he says about them. Full marks for trying. I hope, however, that readers of *Nature* will find this book too easy and want to read something deeper. It would be a poor reflection on scientists' education if they did not, and worse if they could not.

But I hope that bright, mathematically inclined school children will read this book and turn to mathematics. They might even go on to solve one of these problems, which would be magnificent. Even if all seven problems are eventually solved, mathematics contains many more problems that are at least as intellectually rewarding. ■

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### More on mathematics

**Dr Riemann's Zeros: The Search for the $1 million Solution to the Greatest Problem in Mathematics**
by Karl Sabbagh
*Atlantic Books, £14.99*

## Science in culture

### A physical response to architecture

**Two Swiss architects design rooms to change your hormone levels.**

*Alison Abbott*

Architecture is about space and light, usually considered in the abstract. But Swiss architects Philippe Rahm and Jean-Gilles Décosterd are fascinated with how the these properties affect us physically. In a series of projects over the past four years, they have examined the relationship between the external environment and human physiology, for example by modifying the composition of the air, or the wavelength of the light, that fills their architectonic space. They are aware that this is bringing architecture to an ethical crossroads.

This year they were selected to represent Switzerland at the Eighth International Architecture Exhibition at the La Biennale de Venezia, which closed recently, for which they designed their 'Hormonorium'. Fittingly, the Hormonorium transports a high-Alpine environment to sea level, in much the same way that an urban swimming pool might be considered to be bringing the environment of a lake into a city.

The Hormonorium is a plain white room containing four white sofas. The visitor enters through a system of air-tight double doors. The floor of the room is imbedded with long rows of bright, full-spectrum fluorescent lights. Lit from below, the extreme brightness of the room evokes the snow-reflected light on a mountain-top on a sunny day. The ultraviolet part of the spectrum tans the skin, the infrared part could burn it. The level of oxygen in the air is reduced from the normal 21% at sea level to just 14.5%, as it would 3,000 metres up a mountain. After 10 minutes, the visitor experiences the pleasant light-headedness that accompanies a successful climb.

Playing further with the invisible parameters of the environment, the architects fill the room with 'music' of such low frequency (40–80 Hz) that it is felt through vibration, rather than heard. Visitors must wear blue plastic overshoes that crunch on the glass floor, adding to the sensation of being surrounded by snow.

The Hormonorium is so-called because the low-oxygen environment raises levels of erythropoetin, a hormone that stimulates the production of red blood cells, at least after a few hours. This is the basis of high-altitude training, where athletes train in the mountains to pump up the concentration of their red blood cells, so they can use oxygen more efficiently during a race.

This is not the architects' first engagement with hormone manipulation. Their 'Melatonin Room', exhibited last year at the San Francisco Museum of Modern Art, was alternately filled with an intense green light and a weak ultraviolet light, which suppress the production of the sleep hormone melatonin to different degrees. But if all this sounds like installation art rather than architecture, Rahm would disagree. He considers himself an architect first and foremost: "I want to work in the real world," he says.

Together with Décosterd, Rahm is designing a 'winter house', commissioned by a French artist and to be built near France's Atlantic coast. The house recreates a tropical environment in a very literal way. The lighting will mimic, in intensity and timing, the natural day-and-night cycle of French Polynesia. The air will be as warm and moist as in Tahiti — and also just as scented, because the room that heats the house's circulating air will be packed with Tahitian plants. With its sealed and dislocated environment, the house will be used for just a few winter days at a time.

Rahm and Décosterd are moving ahead faster on the philosophical, rather than the practical, front with their physiological architecture. "There are ethical barriers to the wide use of architecture to modulate mood," says Rahm. ■

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JEAN-MICHEL LANDECY

**Mountain high: the Hormonorium's Alpine oxygen level boosts erythropoetin production.**