

exception of rhodopsin, the most stable GPCR known, structural data for these proteins are hard to come by. Now several collaborating research groups, publishing in this issue of *Nature* and also in *Science*, have exploited a raft of different techniques, including the use of the inverse agonist carazolol to stabilize the receptor structure, to determine the crystal structure of the human  $\beta_2$ AR adrenaline receptor. Its structure contrasts markedly with that of 'dark' rhodopsin, which helps explain why it is so hard to prepare diffraction-quality crystals of most GPCRs. [Article p. 383; News & Views p. 355]

## Heisenberg's the limit

At the fundamental level, measurement precision is limited by the number of quantum resources (such as photons) involved, and standard phase measurement schemes lead to an uncertainty (the standard quantum limit) that scales with this number. In theory, it should be possible to achieve a precision limited only by the Heisenberg uncertainty principle. A few experiments have beaten the standard quantum limit, but none have achieved Heisenberg-limited scaling until now, largely due to the need for difficult-to-generate exotic quantum entangled states. Higgins *et al.* adopted an alternative approach using unentangled single-photon states, allowing them to achieve Heisenberg-limited phase estimation. This marks a drastic reduction in the complexity of achieving quantum-enhanced measurement precision. [Letter p. 393; News & Views p. 362]

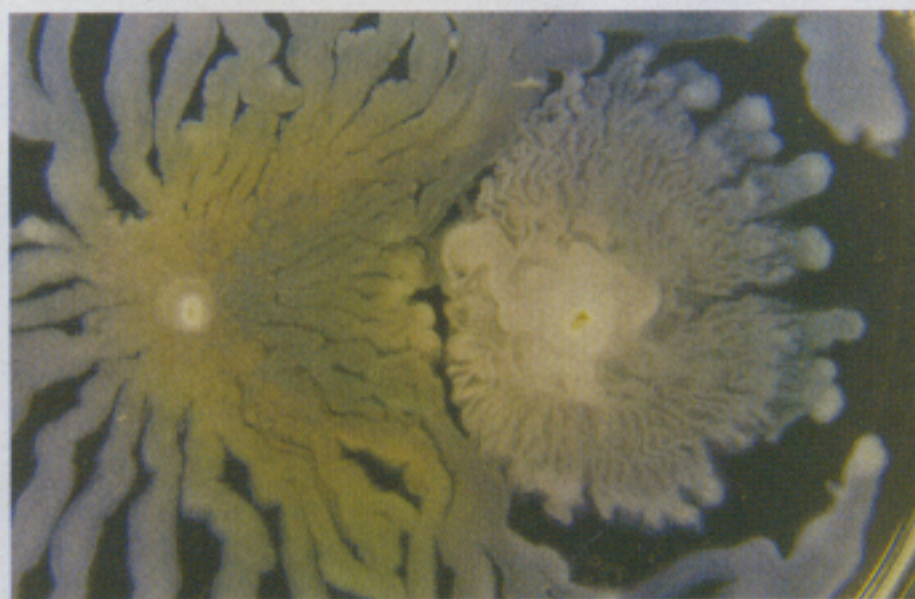
## Rainbow's end

Metamaterials — transparent materials containing tiny metallic inclusions of various shapes and arrangements — cause light to propagate in unusual ways. Now a new, theoretical metamaterial architecture is proposed, with the potential to bring light to a complete standstill. In contrast to previous methods of decelerating and storing light, this scheme simultaneously allows both high in-coupling efficiency and broadband, room-temperature operation. At a critical point a light ray is prevented from propagating; each frequency component (or colour) of the wave stops at a slightly different place, leading to the formation of a 'trapped rainbow'. This work bridges the gap between two important contemporary realms of science, metamaterials and slow light, and may lead to applications in optical data processing and storage or the realization of quantum optical memories. [Letter p. 397; News p. 330]

## Communication cheats

Communication between bacteria via the release and sensing of small diffusible signal molecules, or quorum sensing, is

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A cooperating population (left) avoids a colony of cheats.

thought to be a way of coordinating cooperative behaviours at the population level. Evolutionary theory predicts that individuals who communicate and cooperate are vulnerable to cheaters, who either do not signal or fail to respond to signals. Experiments in colonies of the pathogen *Pseudomonas aeruginosa*, which signals between cells to regulate virulence factor expression, now confirm that both signal and signal-receptor mutants (or 'cheats') do have a fitness advantage. But a solution to the cheating problem does exist in the form of kin selection — 'honest' communication is favoured when it is between close relatives. The findings provide an explanation for the spread of cheats that has been observed in bacterial infections of humans. [Letter p. 411]

## Sleepers awake

A paper published in *Nature* in April raised the intriguing possibility that optical therapies might be developed to treat neurological disorders. That work, in tissue slices and in *C. elegans* roundworms, showed that brain cells can be genetically engineered to alter their activity in response to pulses of different colours of light. A follow-up study now shows that behaviour can be modified in a living mammal by similar means. Hypocretin (Hcrt)-producing neurons in the hypothalamus are active during transitions from sleep to waking states. Optical stimulation of mouse Hcrt neurons engineered to respond to light increases the likelihood of transition from sleep to wakefulness, with higher frequencies causing more abrupt awakening. As Hcrt deficiency is linked to narcolepsy, these results may provide insights into sleep disorders. [Letter p. 420]

## Apoptosis on the menu

During programmed cell death in multicellular organisms, a large number of cells are engulfed by macrophages, thus avoiding the release of noxious materials from the dying cells. These 'apoptotic' cells expose phosphatidylserine (PS) on their surface as an 'eat-me' signal. Miyanishi *et al.* show that the receptors Tim4 and Tim1 are implicated in phagocyte recognition of PS, while Park *et al.* show that the BAI1 protein is a receptor for PS in mammalian macrophages. [Letters pp. 430, 435]



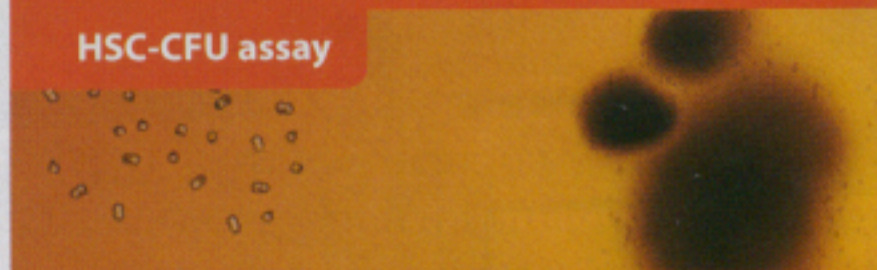
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## Working with stem cells?

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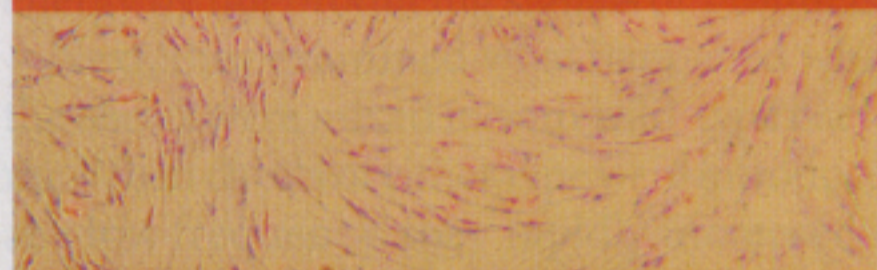
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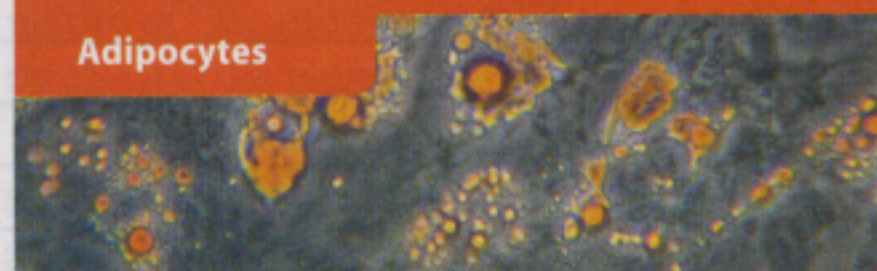
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#### MSC expansion

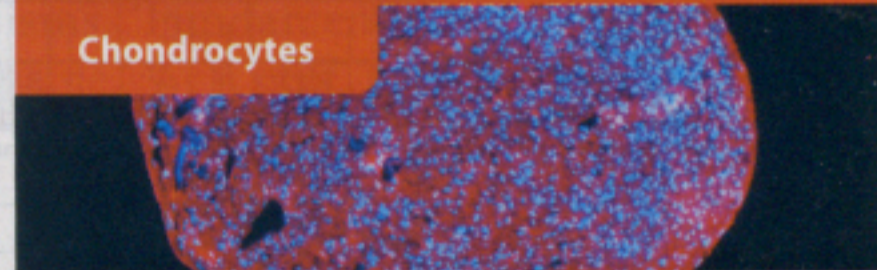


#### MSC differentiation

##### Adipocytes



##### Chondrocytes



##### Osteoblasts



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