variation is analysed in terms of quantitative trait loci). This connection is a positive thing, although it is perhaps limited in scope because it may not solve what many perceive as the *raison d'être* of evo-devo. As Wagner says: "One of the main sources of intellectual excitement in devo-evo *(sic)* is the prospect of understanding major evolutionary transformations." Whether these end up being unique events or long-term accumulations of the mundane remains to be seen, but either answer will be exciting in its own way.

Overall, then, the book is a mixed bag, but contains many important contributions to the past, present and possible future of evo-devo. It is definitely a reference book rather than something to read from cover to cover. Its 'haystack' nature is off-putting at first, but the best strategy is to dive in (with the aid of the short introductory chapter) and see what you can find — including those needles that space has not permitted me to discuss. ■

Wallace Arthur is European editor of the journal *Evolution & Development*. He is in the Department of Zoology, National University of Ireland, Galway, Ireland.

A singular view of ageing

Aging of the Genome: The Dual Role of DNA in Life and Death
by Jan Vijg
Oxford University Press: 2007. 372 pp.
£70, $114.50 (hbk); £32.50, $65 (pbk)

Linda Partridge

There is no shortage of theories of ageing. Confronted by the terrifying realization of mortality, human ingenuity has created an interesting array of explanations, including toxins produced by gut bacteria (curable by eating yoghurt) and reduced secretions from the testicles (curable by transplants of testicular tissue from monkeys). There is now general agreement that ageing is caused by the accumulation of damage. Key issues are the exact types of damage responsible for functional impairment and death, and the processes that generate this damage and protect against it. Jan Vijg's excellent book *Aging of the Genome* makes no concession of equal space for the many candidates subject to current scrutiny. Rather, it critically examines the case for one — somatic mutation.

First formulated in the 1950s, this theory suggests a key role in ageing for the accumulation of random alterations to DNA in somatic tissues (all tissues other than the reproductive germline cells). DNA is being constantly bombarded with chemical and physical challenges that induce random alterations, including structural damage and changes in nucleotide sequence and organization. But unlike other biomolecules, such as proteins and lipids, the damaged DNA cannot be simply broken down completely and remade, because it holds unique information. Instead, cellular pathways detect alterations and, contingent on the type of cell and the nature of the changes, this variously leads to DNA repair, arrest of the cell cycle (preventing cell division), cellular senescence or death, or toleration of the change. In some cell types, some forms of DNA alterations accumulate with age, with evidence for genomic hotspots and considerable variation between individuals. Cancer is a clear case where DNA alterations can give rise to age-related pathology; their role in other aspects of functional decline is less clear, with the exception of mutations in DNA within mitochondria, the organelles that power cells. As well as leading to ageing directly, DNA alterations could lead to ageing as a result of cellular defence mechanisms, such as selective cell death, although there is little evidence for this.

Vijg gives a clear and thoughtful account of this complex, and potentially confusing, body of work and its limitations: little work has been done on non-dividing cells; most evidence has come from cells in dishes rather than in tissues; measuring DNA alterations is difficult; a net change in levels of DNA alterations can be attributable to several different events including

EXHIBITION

A painful pleasure

Three bodies writhe in agony. Their limbs are distorted, their features unrecognizable, their entrails burst out. The *Crucifixion* triptych by Francis Bacon (the central panel of which is shown here) had no religious meaning for the painter, for whom the work was simply about the expression of extreme sensation. In Tiepolo's painting of the martyrdom of Saint Agatha, the young woman's ecstatic gaze is thrown heavenwards as she awaits the blow of her tormenter's sword. These two paintings are the artistic highlights of the exhibition *Schmerz* (*Pain*), which runs until 5 August at the Medical History Museum of Humboldt University and the neighbouring Hamburger Bahnhof Museum in Berlin.

The exhibition brings together artistic and medical views of pain. Opposite Bacon's *Crucifixion* is a glass cabinet containing pathological preparations of organs. Under the title 'The pleasure of pain', Tiepolo's Agatha is displayed along with forensic photographs showing fatal accidents that occurred during masochistic sex. The borders between art and documentation begin to blur, which makes the exhibits all the more disturbing. Video interviews with people who self-mutilate, by German film director Valenska Griesebach, could easily be from the files of a psychiatrist. And what differentiates a display in a vitrine from a pathology lab or an art installation?

The exhibition aims to show pain in all its forms, rather than to understand it, and plays with superficial similarities between different depictions. A video by Bruce Naumanns in which a violin string is repeatedly plucked appears next to chattering patch-clamp recordings in the only exhibit that gives a nod to neurophysiological research on pain. That's not enough to justify the exhibition's claim to build a bridge between science and art. Rather, wandering through this labyrinth of abominations, the question that comes most immediately to mind is why Christianity really needed to glorify this most ugly of all human sensations into the pinnacle of mystical experience. Stefan Klein

PINAKOTHEK DER MODERNE, MUNICH

cell death; and pinning functional decline to altered DNA is a major challenge.

How can we tell if a theory of ageing is correct? If one underlying process is key to loss of function and death, then slowing it down should also slow down ageing. Vijg points to excitement about one successful application of this approach. The trail-blazing work of Michael Klass, who isolated the first long-lived mutant animals in the nematode worm *Caenorhabditis elegans*, culminated in the discovery of evolutionarily conserved mechanisms for increasing healthy life span. A critical test of a key role for DNA alteration in ageing, would therefore be to reduce it, by increasing the activity of pathways that combat it. For biochemical reasons, this is going to be difficult, however. Vijg gives a fascinating account of single-gene mutations, such as those causing Werner's syndrome, that seem to accelerate some aspects of ageing in humans. Progerias such as Werner's syndrome involve lesions in pathways that sense and repair alterations in DNA, suggesting that these processes are crucial for assuring a normal life span. More telling evidence for a key role for DNA alterations in normal ageing comes from the finding that some types of change in DNA accumulate more slowly in mutant long-lived mice, or when life span is extended by dietary restriction.

If this clear and insightful text has a cloudy patch, it is the account of the evolutionary basis of ageing. Contrary to Vijg's account, a solid mathematical foundation in theoretical population genetics and dynamics has revealed that, despite the loss of fitness it causes, ageing can evolve, through just two routes. Germline mutations with deleterious effects at later ages in adulthood, such as Huntington's disease in humans, can accumulate in populations through mutation pressure. Mutations that cause a benefit earlier in life, such as high fecundity, but at the cost of a higher subsequent rate of ageing, can also enter populations, by natural selection. Vijg points out that detection and repair of DNA alterations is costly, potentially leading to a trade-off between reproduction and somatic maintenance. Mutation pressure could also be important; small, life-long effects on maintenance of the integrity of DNA could lead to variation in the rate of ageing.

This is a work of real scholarship, a critical account of a huge swathe of work with no fewer than 879 references. It will nonetheless be enjoyable for non-specialists, and the opening chapters are a brisk walk through much of modern biology. The sharp focus on one type of damage, the excellent writing style and the well argued, personal perspective of the author contrive to keep the reader going. As Vijg acknowledges, the jury is out on the role of alterations to DNA in ageing, and this text points the way to the kind of research that will be needed to resolve the issue. ■

Linda Partridge is in the Department of Biology, University College London, Gower Street, London WC1E 6BT, UK.

A man with prosopagnosia uses a grid to appreciate his girlfriend's face in the film *In Vivid Detail*.

D. BRATT

FILM

An unfamiliar face

In Vivid Detail
directed by Dara Bratt
presented by the Alfred P. Sloan Foundation at the Tribeca Film Festival, New York, in spring 2007.

Emma Marris

Prosopagnosia is a neurological condition often referred to as 'face blindness'. Individuals with this condition cannot recognize other people by their faces, which look about as uniform to them as two stones do to everyone else. It is a disorder with rich cinematic implications, as film stars often have beautiful or glamorous faces, and films rely on the audience's ability to identify characters by their faces.

In the short film *In Vivid Detail*, a man falls in love with a conventionally pretty woman, and she reciprocates, only to feel snubbed when he apparently ignores her when she has put her hair up and changed her shoes. He explains his condition, and she must decide whether she can date a man who can't really 'see' her face. In the end, he makes a special effort to show that he can comprehend her face, albeit in a different way to most people.

The man's disorder is revealed in subtle ways before he explains it. Talking about two chocolate-shop owners, he tells his new love "Those guys are brothers," when it is obvious to the viewer that they are identical twins. And the film almost overdoes it with scenes that reveal his excellent eyesight and attention to detail in other areas.

Student film-maker Dara Bratt spoke with scientists and prosopagnosia patients to do her research, but she admits that she is not sure whether the final conceit, in which the man comes to understand the woman's face by sketching it in a grid and appreciating it as an abstract pattern, would work for people with the condition.

Bratt says she chose a conventional beauty to play the woman so the character would be more startled and upset when the man fails to respond to her pretty face. But this casting choice also puts the audience in the same precarious position of potentially failing to recognize her when she changes her accessories and hairstyle — she could be just another generically pretty blonde. The man's inability to 'see' faces might have been more poignant if the woman's face had more character.

Short films are often used as calling cards in the industry, screened at festivals to introduce a film-maker's work. *In Vivid Detail* was premiered in this year's Tribeca Film Festival in New York. Bratt says she hopes to do more work on neurological topics, and is already working on feature-length ideas. ■

http://www.tribecafilmfestival.org

Emma Marris is a reporter for *Nature* based in Washington DC.