in clear, nontechnical language, [Hayflick's book] is an excellent introduction to the scientific and demographic literature on this multifaceted subject." Tom Kirkwood, *Nature* 373, 484–485 (1995).

Lord of the flies

Time, Love, and Memory: A Great Biologist and His Quest for the Origins of Behavior

by Jonathan Weiner

Alfred A. Knopf: 1999. 290 pp. \$27

Yadin Dudai

William of Occam preached that "entities should not be multiplied beyond necessity", but did not forget to add: "there are many things that God does with more that he could do with fewer." The interplay between bold and cautious Occamism is the secret of successful science. This book is about a scientist who for the past six decades has navigated his way in a marvellously idiosyncratic style on the edge of Occam's razor, and swept biology, once and again, into new territories.

In the 1950s, in his adventures into the genetics of a virus, Seymour Benzer tore a window to the microcosm of the gene. In the late 1960s, toying with fruitflies in test-tubes, he altered neurobiology. Hundreds of hectic investigators at this very moment run knock-out mice in watermazes, slice the brains of transgenics or compose a paper to convince the world that their

mutant is the only clue to dementia. Many of them may not even have the faintest idea how it all started. Such is the fate of success: E. O. Wilson, cited by Jonathan Weiner, commented: "progress in a scientific discipline can be measured by how quickly its founders are forgotten." *Time, Love, and Memory* may hence be prescribed as an anti-amnesic potion to generations of neuroscientists.

Weiner's book is about Benzer and his quest for the origins of behaviour; it is also about a fascinating chapter in the history of science that, because the investigator and his organism played it low-key, was protected from attention for far too long — including probably the attention of the jury in Stockholm.

Benzer's lab at its most intensive period was off-off-Broadway, but it is there that a dominant scientific culture was founded. *Time, Love, and Memory* navigates us through Benzer's career with great detail, encompassing both scientific and personal life. We learn about the early days in physics (Benzer was among the discoverers of transistor technology); about the fascination with Erwin Schrödinger's *What is Life?*; and about the influence of another physicist, Max Delbrück, who started modern molecular biology by focusing on the tiny viruses — bacteriophage — as atoms of inheritance.

Benzer was drafted into the reductionist revolution. After years of almost manic research, he was able to present the world

with the first fine physical map of a gene. This turned him into the legendary 'atom-breaker of biology'. Other scientists would have probably capitalized on the success past retirement well into afterlife. Not Benzer. A loner by nature (a mutant?), Benzer consistently shies away from the crowds, especially when they attempt to join him. He is a scout, not a general, an obsessive wanderer into uncharted terrain.

Indeed, for a while he drifted into the more tranquil waters of RNA research. Delbrück, who started getting reprints, was quick to react: "Please ask Seymour," he wrote to Benzer's first wife, Dotty, "to stop writing so many papers... If he must continue, tell him to do what Ernst Mayer asked his mother to do in her long daily letters, namely, underline what is important." Benzer learned a lesson that should be included in the curriculum of every biology programme: 'beware of falling into the biochemical drain'.

He traded phage for fruitflies. The rest is history. In 1967 he published his first neuro-genetic paper: "Behavioural mutants of *Drosophila* isolated by countercurrent distribution". It is the epitome of an ingeniously simple approach to an extremely complex problem. The basic idea behind it all is: treat flies as atoms of behaviour. Induce single gene mutations. Devise a simple behavioural assay. Isolate mutants that flunk in the test. You now have an entry point into the dissection of behaviour.

Over the years, hundreds of mutants were identified. Weiner concentrates on three classes: *clock* mutants, which disrupt biological rhythms; *love* mutants, which disrupt courtship; and *memory* mutants. Nowadays, mainstream neuroscience mutates mice. Because scientists hate to learn from experience, in its infancy mouse neurogenetics fell into some of the pitfalls that *Drosophila* neurogenetics escaped from long ago, such as artefacts caused by genetic background, pleiotropism and hidden developmental lesions.

Weiner's book is well written and fun to read, although the question arises, who is the audience? This is scientific reportage and as such should not be expected to provide in-depth analysis of tenets and conclusions. Therefore, those who wish to find a critical assessment of neurogenetics should look elsewhere.

Many questions do deserve serious consideration. For example, what is the price of over-simplification? And what do genes tell us about behaviour? Consider, for example, the remarkable *memory* mutants. Those isolated so far affect the nuts-and-bolts of cellular plasticity. They are therefore 'plasticity mutants'. Memories are experience-dependent internal representations whose analysis must involve circuit and system levels. The expectation that neurogenetics *per se* would explain 'memory' thus neglects levels of

Dance at sea

Many seahorses form faithful long-term pair bonds which are reinforced by greeting rituals. The male and female may swim towards each other and dance together before changing colour and mating. The female plants sticky strings of eggs in the male's pouch, and he broods the embryos for up to six weeks before going into labour to produce fully independent young. It is no wonder that these bizarre creatures have fascinated people since at least the time of the ancient Greeks. The first guidebook to the world's seahorses does justice to their beauty and extraordinary biology, while being a user-friendly identification handbook and offering practical advice on the urgent need for conservation. *Seahorses: An Identification Guide to the World's Species and their Conservation* is by Sara A. Lourie, Amanda C. J. Vincent and Heather J. Hall (publisher, Project Seahorse, £19.95, \$32.95; distributed by NHBS; e-mail: nhbs@nhbs.co.uk).

complexity. With time, Benzer himself realized that *Drosophila* are not behavioural atoms but rather intricate individuals. He abandoned behavioural for developmental analysis.

No doubt, Weiner was captivated by the eccentric style of Benzerism, and this encouraged him to recite scores of amusing anecdotes. Whether all appeal to the general public, or only to a small cult, is a different question.

Another caveat is also appropriate: students who read the book should not expect mainstream science to follow Benzer's model. Most laboratory work is much more boring than the hunt for bizarre mutants in the forefront of science. Most mentors are much less imaginative, daring and permissive than Benzer. And, unfortunately, the days are long gone when an enthusiastic investigator shared plans without fear, and mutants without a lawyer. This was before business killed fair play.

As for Benzer himself — at the age of 77 he has just discovered a new mutant, *Methuselah*, that refuses to age. □

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Hitting the target

The Elusive Magic Bullet

by John Mann

Oxford University Press: 1999. 202 pp.

£18.99, \$29.95

Stephen Neidle

The use of medicines to combat disease almost certainly predates recorded human history. One can imagine our prehistoric ancestors, during the course of foraging for food, finding that whereas some plants and fruits were harmful, others could have beneficial effects. The Chinese developed particular expertise with herbal remedies, a tradition that is at least 5,000 years old and still thrives today.

The science of drug discovery has its origins in this tradition. Many subsequent cultures also contributed, with primitive pharmacy arising from the ancient Greeks, and notably from the Arabic world. The Dark Ages onwards saw these elements intertwining with the pseudo-science of alchemy, a combination that dominated materia medica until the onset of modern science at the end of the eighteenth century. All this and more was the subject of John Mann's earlier book, *Murder, Magic and Medicine*, which focused on the use of natural products through the ages, for both base and noble purposes. Mann, a distinguished natural product chemist himself, succeeded in the difficult task of writing an entertaining yet

Tracing the development of lines

The artistic development of talented and less talented children was compared over a ten-year period by the developmental psychologist Constance Milbrath. She assessed the ages of development of different elements of drawing, including form, spatial relationships and composition. The study has been written up in a technical book, *Patterns of Artistic*

Development in Children: Comparative Studies of Talent (Cambridge University Press, £40, \$59.95). Milbrath describes the development of artistic talent as being dependent on both figurative and cognitive abilities. Here, a talented 11-year-old has drawn the back views of two people and a dog.

erudite book, with appeal to readers across a wide spectrum of backgrounds.

His new book continues and expands on this theme and approach. Its focus is the discovery of twentieth-century medicines for the treatment of bacterial and viral diseases and cancer, and their historical context. Its style is a beguiling blend of science and historical detail, liberally spiced with anecdotes and accounts of the wider impact of these discoveries.

The "magic bullet" concept originated with Paul Ehrlich. Mann pays fitting tribute to Ehrlich as the true father of modern approaches to drug discovery, since he also effectively devised the concepts of therapeutic index, chemoreceptors and combination therapy. But it is the idea that there exist perfectly specific drugs to combat human disease that grabs the public imagination. One real strength of this book is Mann's critical examination of this idea, especially in the context of anti-cancer therapies, where public demand for magic bullets is a potent force.

The survey of biological approaches to cancer therapy succinctly covers such topics as interleukins, Ras farnesyltransferase inhibitors, angiogenesis and antibody-directed enzyme prodrug therapy. As Mann points out, this last approach probably comes closest to Ehrlich's original concept, even though it still awaits full verification in the clinic.

It is difficult to envisage a world without

even the simplest antibacterial agents to ensure that we don't succumb to a brief encounter with pathogens in our everyday life. Average life expectancy was only about 45 years at the turn of this century, when Alexander Fleming started as a medical student. One child in six did not survive beyond five years. Mann has provided a vivid account of the devastating impact that bacterial diseases had on the populace, right up to the Second World War, and the dramatic effects of the widespread availability of antibiotics such as penicillin and streptomycin. Some topics, such as the discovery of penicillin and its subsequent development into a clinically available drug, are rightly given extensive coverage. The problems of drug resistance and superbugs are also discussed in brief, but adequate, illustrated descriptions of antibiotics' modes of action and the molecular basis of resistance.

Surprisingly, in a book written by a chemist, there is not a single chemical structure to be found, even though there are numerous descriptions of them and their significant features. Perhaps the publishers felt that the inclusion of chemical formulae would intimidate potential purchasers.

Following the Second World War, the search for further chemotherapeutic agents with selective activity against particular organisms became the mainstay of much of the pharmaceutical industry. Many companies were effectively vast palaces of organic