

indebted to Roger Penrose's controversial ideas about how the quantum world might impinge on the neurobiology of consciousness.

As a thought experiment in examining the relationship between science and society, and as a cautionary tale about the consequences of its breakdown, *Anathem* provides much to ponder. In one scene, a scholar quizzes her students about the various stereotypes of the avout that society has harboured. The images are familiar: scientists as loveable, dishevelled Einsteinian boffins; as mystics hoarding the Universe's secrets; as criminally insane desperadoes in white smocks with schemes to take over the world; as highly strung, meddling know-it-alls who simply don't understand the realities of modern life. Although details of the catastrophes that caused the avout to be sequestered are not made clear, it is hinted that tinkering with genetic information, with the structures of atoms and with space-time itself were all factors. *Anathem* is a shrewd exploration of what might happen if the fear of scientists meddling with things they were never meant to know becomes entirely justified. ■

Jennifer Rohn is a cell biologist at University College London, London WC1E 6BT, UK, editor of LabLit.com and author of *Experimental Heart*. e-mail: jenny@lablit.com

view of what we now call physiology. It is also a forerunner of the systems approach to understanding form and function in living organisms. The field of systems biology today presents us with a challenge similar to that faced by Fernel — to interpret staggering amounts of data depicted in numerous pictographic forms, such as DNA microarray snapshots, proteome network displays and protein–protein interaction maps. Although causation has come to be assigned to a molecule, namely DNA, the way in which we should map from genes to the organism is far from apparent. The Physiome Project embraces the systems-biology movement by showing us how the whole is more than the sum of the parts.

Denis Noble, one of the founders of the project, proffered that “a major part of the future of physiology surely lies in returning to our roots. Higher-level systems biology is, I suggest, classical physiology by another name.” We might say that the Physiome Project began at the dawn of the scientific revolution with *Physiologia*. Fernel's Renaissance thinking pointed the way to a ‘universal medicine’ that we are now poised to attain. ■

G. Rickey Welch is professor in the departments of biological sciences and history at the University of Maryland, Baltimore, Maryland 21250, USA. e-mail: welch@umbc.edu



Mark Rothko's
Red on Maroon.

© 1998 BY KATE ROTHKO PRIZEL AND CHRISTOPHER ROTHKO

Rothko's methods revealed

Rothko: the Late Series
Tate Modern, London
Until 1 February 2009

Mark Rothko's Seagram murals, commissioned in 1958 to decorate the Four Seasons restaurant in the Seagram Building in New York, are famous for their layers of translucent and opaque paints that produce a luminous and ephemeral quality.

Rothko was notoriously secretive about his methods, refusing to let even his studio assistants watch him paint. Yet the clues he left within the murals have informed conservators of the variety of materials he used and his layering techniques that were innovative for the time.

Conservators at the Tate Modern have studied the murals using cutting-edge techniques in collaboration with researchers at MOLAB, an Italian organization that provides technical support to European conservation projects. They investigated the chemistry of microgram samples of paint using mass spectrometry, and probed the structure of layers with high-resolution electron microscopy. Ultraviolet images reveal Rothko's brush work, each layer made from a unique medium that fluoresces differently.

Their research shows that Rothko used materials far beyond the conventional range sold for artists, modifying the properties of oil paints to achieve the flow, drying time and colours he needed. He used synthetic substances such as oil-modified alkyd and acrylic resins alongside traditional materials, including egg, glue and dammar resin, which are fast-drying and allowed him to apply subsequent layers within hours. Resins increased the viscosity of the mixtures so the paints could be diluted without losing their coherence. Rothko also applied phenol formaldehyde to prevent layers from blending into one another. Each mural differs with regard to its paint mixture or the layering sequence, suggesting that Rothko constantly experimented.

The paintings are fragile, prone to damage by handling, and various components in the layers may react and age differently. Rothko chose not to apply varnish, which would have destroyed his subtle effects of gloss and matt variation, and he did not want to exhibit his creations framed behind glass. Knowledge of the materials present in the murals will help conservators develop bespoke techniques to protect them for future generations. ■

Jane Qiu is a writer based in Beijing and London. e-mail: jane@janeqiu.com