Rhythm 'n' biology

What happens if cell biology and techno music meet?

Beauty is in the eye of the beholder. Peering down a microscope, what a layperson may regard as strange fuzzy structures could be an exciting discovery for the trained scientist. On the other hand, while the scientist might only see useful information, the layperson may marvel at the hidden beauty of the microscopic world. To watch bacteria swim towards a food source or an amoeba slowly crawl

even music such that the speaker is redundant. This approach was demonstrated to the auditorium of the *Cinema of the Cell* session at this year's ELSO conference, organised by the European Life Science Organisation in Nice, France. A dozen young cell biologists showed their best film clips, some of them set to music (some of the clips can be seen at <http://www.bioclips.com>). The results ranged

the whole aggregation transforms into another structure called a 'slug' that crawls around until it finds an appropriate position where it transforms again into a sporophyte.

The complex behaviour of this seemingly simple amoebae is the reason why *Dictyostelium* became a popular model organism to study cell movement. But, uniquely, Miura's light microscopy films show how cAMP pulses radiate from various aggregation centres (Figure 1). Fluorescent labelling allows the viewer to follow the path and movement of single cells during the aggregation stage or their responses to the cAMP pulses. Miura's whole sequence features minimal explanation so as not to divert the viewer's attention from the sequence of films he has compiled and synchronised with music. The end result is striking, and was clearly appreciated by the audience at the ELSO meeting.

Indeed, this beauty is precisely why Miura became a biologist. 'I was attracted to this cellular slime mold research when I saw a video as an undergraduate and was fascinated,' he said. To work on this organism, he moved from Japan to Munich in Germany and, when his advisor there left academic research to found a company, Miura went to the EMBL in order to continue his studies of *Dictyostelium* movement. And the fascination stayed

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toward and digest an unfortunate bacterium does hold a certain fascination of watching life taking place at the smallest level. By granting access into these minute worlds, the scanning electron microscope, for instance, has not only allowed scientists to study the surfaces of many cells and organisms at high magnifications, but has also produced many of the images that have graced the covers of or have been featured as full-page illustrations in non-scientific magazines.

Similarly, fluorescently tagged antibodies and the green fluorescent protein (GFP) have revolutionised light microscopy, and many biological publications today contain familiar images of brightly labelled intracellular structures. And it does not stop at simple pictures; conferences on microbiology or cell biology feature an increasing number of presentations that rely on movies of cellular events. But the colourful patterns produced by immunofluorescence or confocal laser scanning microscopy also have a striking beauty that goes beyond the scientific content they represent. This awareness led some scientists to develop a new concept of depicting their work: a form of multimedia presentation that relates a biological story through text, animation, sound, video and

from 'standard PowerPoint presentations to really imaginative presentations', as described by Christian Sardet, president of the Société de Biologie Cellulaire de France and organiser of the event. 'Some people really didn't understand,' commented Rémi Dumollard, one of the scientists who presented his films in Nice. 'Some did and introduced music because it is so new.'

One who understood was Kota Miura, a Japanese post-doctoral fellow at the European Molecular Biology Laboratory (EMBL) in Heidelberg, Germany. His presentation depicted his work on the aggregation of *Dictyostelium discoideum* amoebae into sporophytes. At a specific

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stage in their life cycle, individual *Dictyostelium* cells secrete cyclic AMP (cAMP), which triggers the aggregation of neighbouring cells into larger, more complex structures. The first of these is a heap of cells, known as a 'mound'. The mound grows a tip that eventually falls over, and

with him. When friends or even strangers ask him about his work, he fires up his laptop and shows them various films he has made of *Dictyostelium* behaviour. The response is always fascination, he said, no matter if it is a waiter in a restaurant or his friends, some of whom-

Fig. 1. cAMP pulses in a colony of *Dictyostelium* cells and cell aggregation from Kota Miura's presentation.

work as disc jockeys or musicians. 'My research seems to be very understandable for non-scientists,' Miura commented.

Making artistic films of the microscopic world is not a recent phenomenon. The pioneer of such 'microcinematographies', as it was called at that time, was Jean Comandon, a French scientist working in Paris at the beginning of the 20th Century. Comandon used the then recently invented 'ultramicroscope', a predecessor of today's dark-field microscopes, to observe the movement of bacteria. He noticed that one particular species of spirochetes,

Treponema pallidum, the syphilis-causing bacteria, had a characteristic movement pattern that distinguished it from other spirochetes. Faced with the problem of presenting his observations, he had the idea of using a film camera to record and replay the movement of *Treponema*. He was also aware that such a film could be useful in teaching medical doctors how to diagnose syphilis under a microscope.

But at that time there was no camera available that could be used with a microscope, so Comandon contacted Charles Pathé, the owner of the first French cinema company, Pathé Frères. Together they set up an ensemble in Pathé's studio in Paris and, in 1909, produced the first microcinematography of *Treponema*, which they later presented at the French Academy of Sciences. Working at the Pathé

Making these movies is more appealing to younger scientists who are keen to explain their work to their friends

studios for more than 17 years, Comandon and Pathé produced all kinds of biological and medical films, ranging from surgical procedures for teaching medicine to the movement of plants using time-lapse cinematography.

In 1930, Comandon moved to the Institut Pasteur and, together with Pierre de Fonbrune, developed the first micro-manipulation tools. Up until Comandon retired in 1966 at the age of 87, they filmed all kinds of cells, microbes, protozoans and fungi. Among the films he produced is one showing a sporozoite passing through various blood cells as easily as a ghost moves through walls (Figure 2). Unfortunately, their work was forgotten for many years until Olivier Touchard, the Institut Pasteur's projectionist, discovered their movies in an attic of the institute a decade ago. Indeed, the observation that sporozoites, including the malaria-causing *Plasmodium*, traverse several blood cells before they reach one they actually infect was lost and only rediscovered in 2001. Comandon's work was clearly revolutionary, but his movies also later became known for their artistic value—the Museum of Modern Art in New York showed Comandon and de Fonbrune's 13-minute movie *Le Mouvement des plantes* as part of a festival celebrating French films in 2000.

Fig. 2. A hemogregarin traversing through a frog blood cell from Jean Comandon's movie.

Comandon's successors today use much more sophisticated equipment together with a variety of technologies that allow them to study not only single cells *in vivo*, but also individual proteins and molecules. One successor is Rémi Dumollard, who is now taking a step beyond science by applying for a grant from The Wellcome Trust to produce artistic films about his work. A postdoctoral fellow at University College London, UK, he is studying calcium pacemakers in fertilised oocytes using fluorescence markers and

confocal laser scanning microscopy to visualise the calcium oscillations (Figure 3 and the cover of this issue) that guide the reorganisation of the endoplasmic reticulum and early cell divisions. Outside the laboratory, Dumollard meets with friends to set the images of calcium pulses in the cell to music, which they then show at parties. 'My idea was to make movies of calcium waves and make music to it that has the same rhythm as the calcium waves,' said Dumollard, describing the presentation he gave in Nice. The result is striking, because the viewer relates the pictures to the music and is left with the impression that the cell is pulsing with the rhythm and not vice versa. And it is not only the music but also the images he generates that make this effect more impressive. 'These images are not scientific at all because I use all kinds of filters to make the colours more intense,' he added.

The result, he thinks, steps outside the boundaries of pure science and as such holds a fascination for the lay viewer and the expert alike. 'What makes these images very interesting is the story behind them,' he said. 'And the story behind them is how life is happening.' Such an emphasis on the beauty of processes taking place at the cellular and molecular level may be more accessible to the public than other, more serious or traditional approaches, he thinks.

Elsewhere, students of media sciences at the Technical University in Brunswick, Germany, are learning to produce such video clips. As part of their curriculum, they visit Göttingen for a week, where they use the microscopes, cameras and video processing equipment at the IWF Knowledge and Media, one of Germany's leading institutes that produces scientific films for education. Their efforts have featured the circulation of chloroplasts in plant cells, the movement of *Volvox* algae and protozoans, and the movement of stomata in plant leaves, all set to music. 'This is a lot of fun after we have worked only on these dry scientific projects for decades,' commented Jürgen Kaeding, one of the two IWF engineers responsible for the microscopic photography. In actual fact, the emphasis is less on the microscopy itself and more on the video and music processing, he said.

Yet, immunofluorescence or GFP-tagged proteins are still out of reach for the media students. Although the IWF has all the material and equipment, it would be too

Fig. 3. Stills from Rémi Dumollard's presentation based on calcium oscillations in ascidian oocytes.

much to use in a 1-week course, Kaeding said. And requests from scientists to use the IWF's infrastructure and expertise are still few and far between. 'The fact is that many scientists try to do this themselves because it is still so new,' Karl-Heinz Seack, Kaeding's colleague, explained. 'We produce [these clips] in a way so they are optically very good,' he said. 'This is quite a puzzle and also needs a lot of creativity.' Kaeding added, 'We know how to present such things effectively.' Obviously, such projects can occupy several months and come with a high price tag and since most scientific grants do not include funding for the

professional presentation of results, most scientists shy away.

But there is a demand for such films, albeit from an unexpected source. The IWF regularly receives requests for biological and other movies from artists and music agencies, said Uwe Sander, Head of the IWF's department for online and multimedia production. Most of these films are used to produce the videos that are screened on music channels.

Scientists such as Miura and Dumollard, who see the artistry of what they observe under the microscope and combine it with music to enhance the effect, are still the exception. But this may change, thinks Dumollard. 'A lot of scientists would be interested, but there is the limitation of time,' he said, pointing out the major problem. Furthermore, it is often more appealing to the younger scientists who grew up with the new microscopic techniques and the ability to visualise single molecules and at the same time are keen to explain their work to their friends. These young scientists are also familiar with MTV and techno music, the music of choice to accompany biological movies, all of which can make them see what they observe under the microscope in a completely new way. 'I think this is much more interesting for the younger generation,' Sardet concurred.

And it may even change the way of presenting science in due course. Already, many biologists arrive at conferences armed with laptops to show their favourite movies of their objects of study. Yet the classical method of publishing science in print, even when these are transferred to the internet, does not allow for this new medium. The artistic work of scientists such as Miura or Dumollard, together with the new technical possibilities of the internet, might change this in the near future, Sardet thinks. '[A film clip] is much more than just an abstract,' he said. 'An abstract already tells you a lot about the science, but it is clearly not the same as a visual presentation.' It might also help to increase public interest in science if such film material were easily available on the internet. 'Videos are more attractive, so it is easier to get the audience involved,' Miura said.

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