The world's leading physiologists gather in Britain next week to consider the eternal mystery of what it is to be human

Such a fine body of evidence

Tim Radford

WHAT a piece of work is a man, said Hamlet, who didn't even have the advantage of an hour with Professor Denis Noble at Oxford University's physiology laboratory. Take for a moment the human heart. It beats for roughly 70 years at an average of 60 thumps per minute.

"And it manages that, in most cases, pretty faultlessly," says Noble, who has spent most of his working life watching the cardiovascular system, and who next week will play host to 5,000 scientists at the 32nd congress in Glasgow of the International Union of Physiological Sciences, meeting in Britain for the first time since 1947.

"It's a phenomenal performance. No engineered pump ever manages anything remotely comparable to that. A really good athlete can get it down to close to 20 beats a minute, and the highest is about 200 per minute. Which means a really good athlete can increase the rate of flow of oxygen to the muscles by a factor of 10. That's a huge change in output."

He thinks it is possible to imagine that one day science will make sense of the heart. It is a self-organising system. Although it is made up of four parts — two atria, two ventricles — in a sense there is only one heart muscle, because the several hundred million cells that make up the heart all talk to each other. "Their excitation is connected together, so that once the pacemaker region of the heart sets the whole thing off, it spreads through the atria and into the ventricles on both sides, as though one is dealing with a unified structure. It is a marked example of a system in which co-operativity — the ability of cells to perform as an integrated whole — is of crucial importance, and with even a minor disturbance of that, you have trouble."

The curious thing is that the heart is a piece of engineering with huge safety margins. Most people have four or five times as much heart muscle as they need: only superb athletes get close to using all of it. Suppose you have a heart attack: a massive one, which results in an infarct, or permanent damage to the heart muscle. If you survive the instant of attack, you can put up with the loss of 20 per cent of the heart tissue, and the heart goes on beating, despite the scarred muscle. The trick, for science, is not simply to understand what is happening in the cells, but in the organisation, the higher level of hierarchy, that makes up a whole heart.

Professor Noble thinks that one day science will solve the problem of the heart attack. The nervous system is something else. "Think of the immensity of what we are trying to do. We are talking of a system that has 10 billion cells in it. Each of those has connections to another 1,000 maybe, so in terms of connections, we are talking about 10,000 billion; and there may even be information stored at a lower level than that, at the molecular level. This is like looking at a system that is at least as complex — in terms of total numbers of things to be looked at — as the universe itself. It would be utterly astonishing if we had got anywhere near understanding such a complex organ."

In his work on the heart, he can imagine an endpoint: it may be 100 years hence, but it is conceivable. "With the nervous system, that is totally inconceivable. This organ is, after all, the means with which we have generated our culture. Our culture has an aspect which is impossible for scientists to deal with, which is that it is history-dependent."

Humans have what he calls "intentionality" — what the Church used to call "free will". It is a characteristic of humans that they can

In the quiet war going on in the biomedical sciences Professor Noble has turned the idea of the selfish gene on its head

choose to do things: they can choose to view themselves; an understanding of the nervous system would be inseparable from the choice to examine and understand it.

All that cannot be reduced to machinery. Professor Noble calls himself an arch anti-reductionist. When he says this, he is declaring sides in a quiet war going on in the biomedical sciences, between those who maintain that ultimately, humans are prisoners of their genes, and those who argue that they are not.

But then Professor Noble is used to taking sides. Seven years ago he and others founded an organisation called Save British Science, and since then has kicked the shins of successive cabinet ministers for their neglect of an important part of human culture. He is used to the notion of culture. When in the south of France he can pass as a Parisian, and he is one of the handful of Britons at home in Occitan, the old language of Languedoc, the tongue of the Troubadors. He plays the guitar and collects the songs of Gascony.

He insists, when in those countries, on delivering at least part of his lectures in Japanese and Korean. Congress delegates will be welcomed in 70 languages — including Occitan. When the encounter ends, he heads off to Oxford to buy a thicker brush to paint another welcome in Korean ideograms.

His argument against reducing humanity to the message of its genes has much to do with ideograms: the three Chinese characters for physiology stand separately for words that could also be translated as The Logic Of Life, the title of a book he has co-edited for the conference. He thinks it impossible to separate human physiology from the culture that makes us human. The seeming inability of the Chinese to digest milk products is only a matter of the precise stomach fauna created by their traditional cuisine which reinforces the cuisine culture. All land vertebrates have the same number of bones but the musculature is vastly different. The advantage to humans of being able to execute fine movements with their hands would have been one of the driving forces of evolution, and also of the development of the nervous system.

In that sense, the nervous system is dependent on human history, and the human culture that led to the ideograms for the logic of life, and it would be pretty hard to disentangle a gene for that. He speaks in a week in which there has been a furore about the discovery of a gene or genes for a predisposition to male homosexuality, but he sidesteps that issue and chooses a simpler example. Even the zebra's stripes present a problem of the logic of life.

"It is obviously not the case that there is a genetic code for each stripe. What must be programmed is the ability to form a pattern. There must be ways in which the system organises itself from fairly minimal programming of the information required to put it all together. In the whole of the genetic code, there cannot be all the information that is, at the moment, in our nervous systems. A lot must be left to the properties of self-organising systems which have got minimal coding to get them going. On that, we have a very long way to go."

He also thinks that one of the things that alarms the public about science is simply the idea of the selfish gene: of the human as a vehicle for the survival of the genes and their passing on to another generation. "I have turned that on its head. I am saying, no, that is wrong. Genes are not free-roving selfish individuals: they are prisoners of the successful physiological systems that carry them. Put that way, no one is frightened. I am not using biological information in a different way from the selfish gene material. I am putting it in a different way that respects the hierarchy of orders."

Marvels of the human body . . . Vesalio's 16th century view of human musculature structure BRIDGEMAN ART LIBRARY

So, he argues, it is implausible that humans should be able to understand themselves just by understanding the human genome. "It is a bit like thinking that somebody who understands the machine code of a computer understands what the computer is doing."

He chooses a text from Pascal as the theme of the conference: "I find it impossible to understand the parts without understanding the whole, and to understand the whole without knowing the parts in detail."

So the congress will have room for everybody: there exist so far 15 tons of printed paper, containing 3,000 abstracts of papers he has yet to examine. It is likely to touch on all the issues of what it is to be human: from the behaviour of the human physique in zero-gravity to the capacity of human divers to work at depths of up to 1,000 metres.

It will also tackle what he sees as one of the great problems facing modern man: his longevity. The heart — and most of the other human organs — have colossal safety margins simply because of human evolutionary history. Modern human life is the profoundest, wallowing luxury compared to the privations of most hominids through recent millions of years. Humans are adapted to survive in harsh conditions, and tend to expire from heart attacks brought on by sugar, fats, tobacco and alcohol.

"We are not really well adapted to being well off. Nor are we well adapted, most of us, to living to 80, because why should evolution worry about it? Apart from the evolutionary value of a few survivors to pass on the culture, it isn't obvious why the majority should have survived, and of course they didn't. The majority were dead by 30. Those who survived to 60 or 70 were very rare. Why are we complaining that because we die of heart attacks at 65, that we are badly off? By God, compared to our predecessors, we are doing very well indeed."

Hamlet, on the other hand, died young, as did many of his contemporaries.

The Logic Of Life: The Challenge Of Integrative Physiology, edited by C. A. R. Boyd and D. Noble (Oxford, £8.95)

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