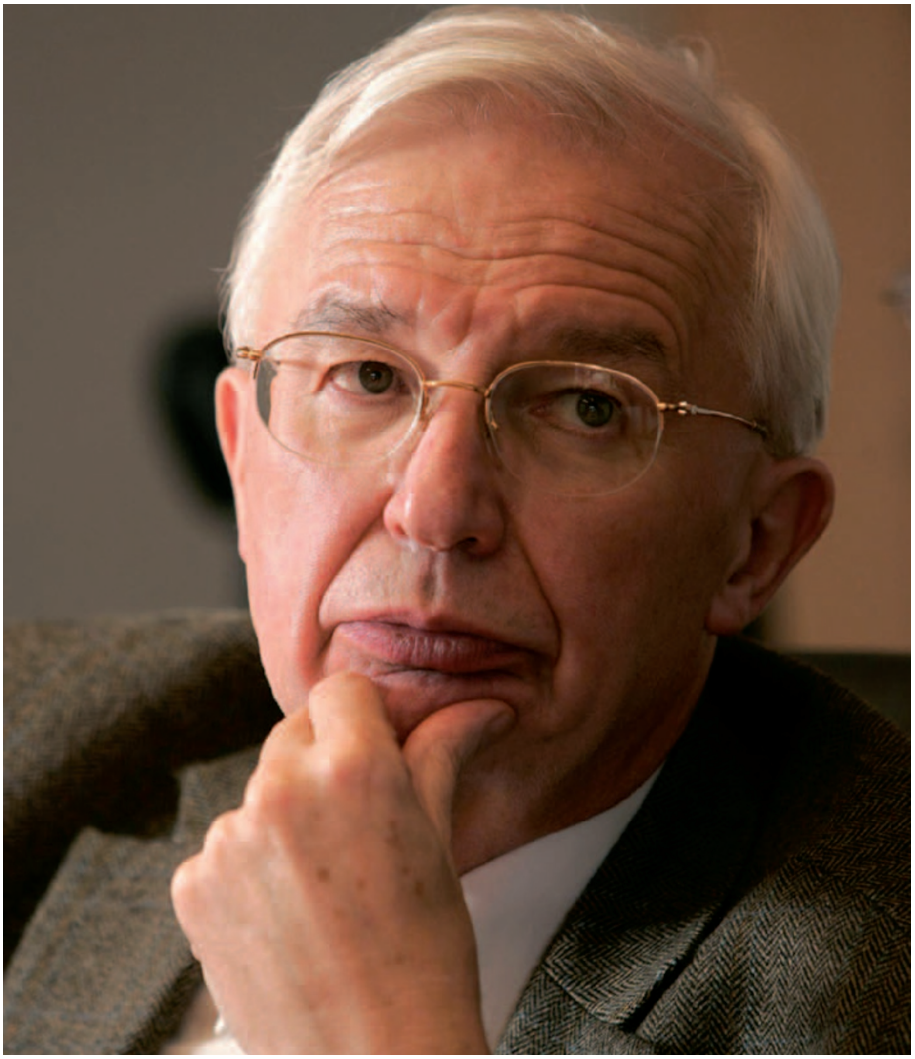

Jean-Marie Lehn
Rational enthusiasm

Chemist at the University of Strasbourg in France. Shared the 1987 Nobel Prize in Chemistry for development and use of molecules that recognize and interact with each other. Coined 'supramolecular chemistry', it is an area of chemistry that exploits non-covalent interactions. Born in 1939 in Rosheim in France, Lehn was the son of a baker who later became the city's organist. Music is Lehn's main passion other than science.

You have spoken of the responsibility of scientists to talk about the role of science in society and culture. Do you think that over the years you have achieved this?
We all try to make what we say attractive, to come across as open and to present things in an understandable way for a broad range of educated people. But it's also important that the people listening make an effort — and that takes time. Some people are receptive and interested. Others have to be hooked in to prepare them to listen. However, a scientist's first responsibilities are to science — knowledge and truth — not to society. We are here to gain knowledge and understand what's going on, but of course we are also eager to be understood and to benefit society.

Are there any parallels of supramolecular chemistry in society?
There are parallels inasmuch as sociology is the study of humans in society, and supramolecular chemistry is the study of molecules and how they bind to each other, whether that's in love or hate.

For the general public, the concept of 'molecular sociology' can be better understood and remembered. Molecules can be isolated, like an individual. Our environment can be society or the wider world, but molecules bathe in a world of other molecules: colliding and interacting. Of course, the behaviour of an entity like a human being is much more complex than molecules getting together.

"We would like to be able to analyse and be rational and try not to react to irrational inputs. But it's not easy."

A lot of science is quite reductionist. Is this better than taking a systematic, top-down view?
One has to approach it from both sides. Build from the bottom, with complex behaviours analysed from the top. I don't think one should just do only one way.

We are all made of molecules. All we do is the result of a very complex system, but we can in principle deduce from these components what we are able to do. Higher level properties and behaviours emerge from higher levels of complexity.

The example I usually give is taking an isolated molecule of water, which cannot freeze or boil, yet a glass of water can. A property has appeared at a higher level of complexity, which emerges from the fact that molecules interact in a supramolecular way and act together as a system. Thus as complexity increases, new properties and behaviours emerge at each step that cannot be reduced to what is below, but which can be deduced from it.

Biology is based on molecules; it is the highest expression of the molecular world. It is a demonstration that the simple molecular world can generate great complexity through self-organization.

Do you think that such complex life exists on other planets?
It is very probable. There are so many galaxies and planets that chances are there are similar conditions to those on Earth.

The 4% of observable matter that comprise the bricks of our Universe are composed of elements described in the periodic table. These atoms will be the same everywhere, and they will interact in the same way so that the compounds they form will be the same. For example, a carbon–carbon bond will be the same everywhere. Whether the combinations of elements will be the same is another question.

What most motivates you in your work?
Getting published is just one outcome, and not the major one. The journal in which you publish is not so important (sorry *Nature*, *Science*). What is important is that good work is recognized. It might take longer if it is published in a more obscure journal, but it still counts as being

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published. I can cite a number of papers that led to great discoveries but which were published in second-, third- or fourth-rate journals.

My motivation was simply that I was interested in science and research and in gaining new knowledge. All of the sciences are exciting. The great frustration is that one cannot do everything. You have to be selective to have an impact. Everybody has a given amount of energy, if you apply it on a small area you have a big impact. Too broad and the impact will be weaker.

I got interested in chemistry when I realized it is the basis of all matter. I also realized that chemistry enables you to transform objects of one type of matter into another, using a process that is understandable. Chemistry is able to develop methodologies to gain power over matter, and to generate new compounds that didn't exist before. I like to compare that power to a work of art. When an artist makes a sculpture out of stone, the stone doesn't contain the sculpture, it's the artist who creates it. In the same way, by taking the pieces that the Universe gives us, a chemist can express new combinations often with new, unexpected properties.

CH. FLEMMING/NOBEL LAUREATE MEETINGS

Lehn holding his lecture on supramolecular chemistry at the 2011 Lindau meeting.

Do you always think and behave scientifically?
We all try, that is our job, but we are not just pure brains, unfortunately. We would like to be able to analyse and be rational and try not to react irrationally to inputs. But it's not easy.

Many people think of science as just being a body of knowledge, but it is also a spirit — a way to approach things. And this is important to convey as it will help humans live together. Finding answers is also connected to the way you approach the question. Sometimes you stumble onto an answer, but you also have to be able to see that the answer is lying there. Just stumbling is not enough.

Should the world's leading scientific organizations be more united for practical policy planning and research funding?
Not totally united into a single organization. Any organization can make mistakes, for instance, it might be that the evaluation of a given project is not done well. So diversity is good — but too much is chaos. Usually the projects that are in the top or bottom 10–20% are easy to identify. Those in the middle are more difficult, so we need several institutions for funding and evaluation to judge these projects.

Sometimes a project appears to be terrible, but it eventually leads to something fantastic. So there is a risk that collapsing all the institutions into one would miss these outliers. It's good to have diversity; as with journals. You submit a paper, and some referees like it while some do not; you have opposing views. With research, there are common lines, ideas that come up everywhere. It would be a pity if everybody were to crystallize around the same topics.

There are three types of research: discovery work that furthers our understanding; applied work in which a scientist makes things for a given purpose; and blue sky thinking with little guarantee of an endpoint. Perhaps this blue sky should be at the beginning of bright people's careers or it could happen at a more advanced stage of their career. It would be good to free these individuals' time: not to have to worry about financing and to let their imaginations go. There are some institutes that are going in this direction, including Germany's Max Planck Society and the Institute for Advanced Study in Princeton, New Jersey. They try to give this freedom.

Should scientists take a type of global research oath at the start of their careers, as medical doctors take the Hippocratic oath?
The first aim of scientific research is to increase knowledge for understanding. Knowledge is then available to mankind for use, namely to progress as well as to help prevent disease and suffering. Any knowledge can be misused. I do not see the need for an oath and I would hope that medical doctors would behave in the same responsible way without the Hippocratic oath. With respect to weapons and the like, if everybody were to take an oath and refuse to conduct research, then that would be OK. But if other scientists do not agree to the oath, would you risk your country being at the mercy of a potential oppressor?

The other aspect of such an oath would be to protect against fraud and plagiarism. I realize there have been a number of frauds in science, but there are frauds everywhere. There are probably fewer frauds in science than the rest of society. People who commit scientific frauds are plain crazy; how could they think they would not be discovered? Other people will try to repeat the experiment and the fraud will be discovered — it is inescapable. ■

I don't agree with Laureate Lehn's answer. During the pursuit of science, we should pledge an oath and then follow it. Many scientific advancements have endangered human lives. I started as a medical doctor, and I took the Hippocratic oath to swear that I will not do anything that would harm my patients. Then I became a research scientist and I realised the potential for scientists to cause harm. A 'scientific oath' would prohibit scientists from indulging in research that could harm human life: bombs or bioterrorist agents for example.

Ehsan Ullah, Department of Morbid Anatomy & Histopathology, University of Health Sciences, Lahore-Pakistan, who posed the original question on lindau.nature.com.