

### 2011: International Year of Chemistry

2011 is the International Year of Chemistry, and the Brazilian Journal of Pathology and Laboratory Medicine takes part in the celebrations. The covers of volume 47 present texts about researchers who were awarded the Nobel Prize in Chemistry during the last decade. Their works somehow contributed to the better scientific knowledge in the area of medical diagnosis.

The Nobel Prize in Chemistry 2006 was awarded to Roger David Kornberg, a North American biochemist and professor of structural biology at Stanford University School of Medicine, for his studies of the process by which genetic information from DNA is copied to RNA.

Roger David Kornberg was born on April 24, 1947, in St. Louis, Missouri, to a Jewish family. He was the first of three children of Arthur and Sylvie Kornberg, both biochemists.

Roger graduated at the University of Harvard in 1967 and got his Ph.D. from the University of Stanford in 1972. His post-doctoral studies were undertaken at the Laboratory of Molecular Biology in Cambridge, England.

All organisms are controlled by their genes, which are coded by DNA. When information contained in the DNA is transcribed to RNA, this last one commands protein synthesis. DNA resides in the cell nucleus. When a cell expresses a gene, it transcribes a sequence present at the DNA onto a messenger RNA (mRNA), which is transported out of the nucleus to ribosomes. Ribosomes read mRNA and translate the message to the right sequence of amino acids for the synthesis of a specific protein for that gene.

DNA is transcribed to mRNA by enzyme RNA polymerase II, with the participation of other proteins. Kornberg's studies identified the role of this enzyme and other proteins in DNA transcription, besides having permitted the creation of three-dimensional images of the protein cluster using X-ray crystallography.

Roger Kornberg and his research group made several significant discoveries about the mechanisms and the regulation of eukaryotic transcription. During post-doctoral studies, when he worked with Aaron Klug and Francis Crick, at the Medical Research Council (MRC), in the 1970s, Kornberg identified the nucleosome as the protein complex involving chromosomal DNA in the nucleus of eukaryotic cells.

Kornberg's research group at Stanford managed to develop a reliable transcription system based on baker's yeast (a simple unicellular eukaryote), which was used to isolate and purify the numerous proteins necessary for the transcription process. The works of Kornberg and others made evident that these protein complexes are well conserved across the whole spectrum of eukaryotic organisms, from yeasts to human cells.

Using this system, Kornberg discovered that the transmission of gene regulatory signals to the RNA

polymerase machinery is accomplished by an additional protein complex, which they named "mediator".

In parallel with biochemical studies of the transcription process, Kornberg dedicated two decades of research on methods to visualize the atomic structure of RNA polymerase and the associated protein components. At first, he made use of the knowledge about lipid membranes acquired when he studied a technique for the formation of two-dimensional protein crystals in lipid bilayers. These crystals were analyzed by means of electron microscopy, to derive low-resolution images of the protein structure.

Using X-ray crystallography, Kornberg explained the three-dimensional structure of RNA polymerase at atomic resolution. This is the most complex structure of proteins solved so far. He has recently carried out further studies to obtain structural images of RNA polymerase associated to accessory proteins, thus creating a real image of how transcription works at molecular level.

His father, Arthur Kornberg, was awarded the Nobel Prize in Physiology or Medicine in 1959 for his studies on how genetic information is transferred from a DNA molecule to another, in a process called DNA replication. Arthur Kornberg isolated the first enzyme able to synthesize DNA (bacterial DNA polymerase I), which was then the first known enzyme to receive instructions from a template, thus guaranteeing the conservation of genetic information during cell growth and division.

In 1970, Thomas Bill Kornberg, Roger Kornberg's youngest brother, discovered the enzymes DNA polymerase II and III. Nowadays, he works as a geneticist at the University of California, in San Francisco.

Roger and Arthur Kornberg were the sixth pair of father and son to be awarded Nobel Prizes.

#### References

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Press release: The Nobel Prize in Chemistry 2006. Royal Swedish Academy of Sciences.