Our brother, the rat

The rat genome has been mapped. We found out that we share around 90 percent of genes with them and that rats evolve quickly. We also understood why it is so difficult to poison it.

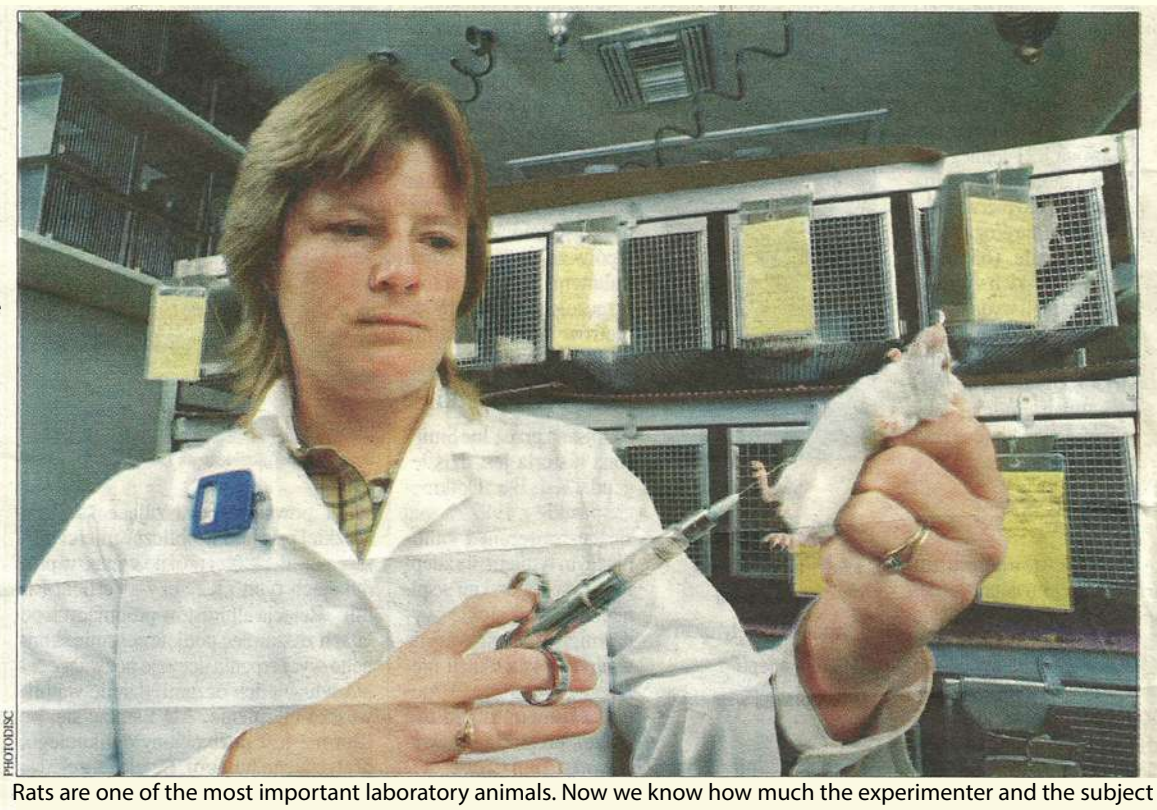
Up until now we have known the DNA structure of two mammal species – mice and humans. Today "Nature" magazine published the results of the research conducted by the international Rat Genome Sequencing Consortium (RGSC). It revealed that the rat genome is very similar to the human one, both in regard to the amount of DNA and the number and kinds of genes. But it is the differences, that are the most interesting.

It's better together

Do you remember the competition between two teams sequencing human genome? Scientists from public institutes were racing against those from the private company Celera Gemonics. This time "private" and "public" researchers decided on an alliance and quickly tackled the DNA of the Brown Norway rat (Rattus norvegicus). The material for analyses was taken from female rats.
The DNA of the rodents was cut into millions of pieces, that were then read letter by letter. Afterwards, 36 million readings with the best quality were chosen and assembled in a complete "genetic recipe for a rat". Thanks to the use of two complementary methods the resulting recording was of a very high quality. How high? Imagine that you are rewriting random letter sequences and you are allowed only one error for every 10 thousands characters.
The international team sequenced around 90 percent of the rat genome, but it is known that the entire genome consists of 2.75 billion base pairs (which are the "building blocks" of DNA chain). Fewer than in humans (2.9 billion), but significantly more than mice (2.5 billion). Some of those "blocks" build genes – rats have around 30 thousands of them, more or less the same as humans. Most importantly, the majority of the rat genome (90 percent) is very similar to ours. This fact boosts the significance of rats as laboratory animals – a model for Homo sapiens. Scientists conclude that almost all human genes which when damaged result in illness have their equivalents in rat DNA. Therefore, appropriately modified rats can serve as test subjects for human hereditary illnesses and tumors.

Legacy of one billion

The authors of the "Nature" article prove the might of genomics – a brand new discipline that develops with sequencing DNA of successive organisms. Genomics analyzes entire DNA sequences and informs about relations between genes in a specific organism, but also compares different species. The comparison of the known mammal genomes (humans, mice and rats) determines that they all have around one billion identical nucleotides in common. It is the legacy of the common ancestor to all mammals. Genomics can also offer support to paleontology – the more mammal genomes we know, the more precise we can be in describing their primogenitor. From the comparison of the current data it also appears that rodents are sprinters when it comes to evolution. The changes in their DNA happen even three times faster than in humans.



PHOTODISC

Rats are one of the most important laboratory animals. Now we know how much the experimenter and the subject of experiments have in common

The genome comparison reveals not only the similarities. Finding the differences is equally fascinating. We discovered for example that rats are far better at handling poisonous substances than humans or mice. Many of its genes codes for proteins that dissolve toxins. Most of them had appeared after the separation between mice and rats. What is more, the basic difference in exploring the environment is also encoded in the genes. Humans rely on sight and hearing, whereas rats on the sense of smell. That is why they have more than 1.5 thousand genes which carry the information about the structure of the smell receptors. Additionally, there are genes responsible for the highly complex system of pheromones – substances used to mark territory, find partners and define structure of groups. The above genes had also evolved mostly after the split between rats and mice.
A curious finding is the number of traces of viruses that were incorporated into the DNA of our common ancestors. In rat genome there are hundreds of thousands of them and they comprise almost 10 percent of the entire genome. Some of them had been turned off millions of years ago and are passed between generations as genetic junk. Others could still today break away from the host DNA and start an infection. Unfortunately, human genome dos not look any better in this regard.
Geneticists cannot wait for the next information about mammal genomes. There are many surprises in store, because the research on genetic mysteries of chimpanzees, macaques, dogs, cows and possums has started for good.

For "Gazeta": prof. Leszek Kaczmarek from Nencki Institute of Experimental Biology PAS

"The similarity of rat and human genomes is not in itself very surprising for a biologist – in truth, genetically speaking we're not so different from animals. What is surprising is the presence of genes in rats that do not have their equivalents in humans. Especially intriguing is the wide variety of genes that code proteases (enzymes which "cut" proteins). Rats have more than 100 proteases which are not present in humans. When I study a certain gene in rats, I have come to expect a similar human gene with a similar function. That high of a number of genes coding proteases which are exclusive to rats is a huge surprise to me!
There is one more reason why the sequencing of the rat genome is exciting for me, since I myself study rats. A certain rivalry between researchers who study rats and mice. Now it was revealed that rats are genetically closer to humans. Besides that, one of the arguments about the superiority of mice was the fact that their genome had already been sequenced. Now we have the same amount of information about rats.

Menace and godsend

Rats have been our companions for thousands of years. Mostly as a menace. They are walking petri dishes full of viruses, bacteria and parasites which cause at least 70 serious diseases – cholera, typhoid and smallpox, among others. Together with other rodents they are also one of the causes of world hunger, as they eat approximately one fifth of the produced food supply.
On the other hand, they are a source of meat in many countries. However, this is not their greatest benefit to mankind. For about 200 years rats have been one of the most important laboratory animals. They have allowed us to discover many facts about how our bodies work. Because of them breakthroughs in surgery, neurobiology, cancer, diabetes and mental illness (including addiction) treatments have been possible. Nowadays, it is difficult to imagine creating a new drug without testing its effectiveness and toxicity on rats. Carefully selected (or modified by geneticists) rats are models for human diseases. That is why now, while we discover genetic causes of a growing number of illnesses, sequencing rat DNA carries special significance.