SCORPION VENOM
TO FIGHT CANCER

By: Lisa Jancarik

Scorpion and bee venoms may seem unlikely to improve anyone’s health. However, venoms have been prescribed through the centuries by healers around the world. Pliny the Elder prescribed bee venom for baldness, and Charlemagne endured bee stings for the sake of his gout in the 700s. In the East, traditional Chinese medicine has a place for frog venom in the treatment of various cancers, ranging from lung to colon and pancreatic cancers. Cuban alternative healers have also used venoms to treat brain tumors. However, these treatments all have had the same problem: the side effects can be murder.

For example, bee venom contains melittin, the protein responsible for the inflammation and pain associated with the sting. It can cause blood to clot, plus it damages nerve cells and heart tissue. In other words, melittin is the protein that made Charlemagne probably not look forward to those gout treatments. It also destroys cell membranes, which has made it interesting for cancer research. However, melittin’s broad effects illustrate why venom from any species—insect, frog, snake, etc.—is perhaps not ideal in its natural form.

Venoms have the additional problem of not containing uniformly the same substance. A given venom may be composed of multiple elements, and some may not be of interest for their healing properties at all.

The Buzz about Nanoparticles and Cancer

A nanoparticle is defined as 100 nanometers or smaller, making them not visible with a light microscope in most cases. To be useful, the nanoparticles need to be small enough to pass into a typical cell but big enough to carry a drug payload. In 2009, the world heard about trials in mice for delivery of a synthetic of melittin, the substance in bee venom, in nanoparticles called “nanobees.” The work was conducted by Dr. Samuel Wickline, director of the Siteman Center of Cancer Nanotechnology Excellence at Washington University in St. Louis, Missouri, and his team. His group continues to develop nanobees as an approach to prostate cancer treatment, but other researchers are studying ways to use nanoparticles as a means to deliver therapeutic agents to specific targets.

Taking the Sting Out of Scorpion Venom

In vitro studies of a synthetic form of the venom from the Brazilian yellow scorpion have recently shown considerable promise in fighting two kinds of breast cancer. Until recently, peptides in this scorpion venom have not been developed into cancer-fighting agents because these biochemicals also unsurprisingly harm healthy cells, like erythrocytes (red blood cells).

Now, bioengineer Dipanjan Pan and his research team at the University of Illinois at Champlain have shown that a modified scorpion venom is not only toxic to cancer cells, but it is especially toxic to them. In fact, their synthetic peptide has killed tumor cells with a potency of ten times that of venom alone, still sparing erythrocytes and other normal cells.

As a first step, the team determined which elements of the venom were important to their work. They have since developed techniques for creating a version of the most important of these, a protein called TsAP-1, entirely in the lab. Pan says that because the derivative TsAP-1 peptide is entirely synthetic (i.e., no scorpions being milked), its content is entirely unambiguous in terms of what substance is delivered.

Pan’s team of researchers has inserted the peptide of interest inside nanoparticles to deliver them to the tumor cells specifically. These spherical, polymeric nanoparticles bind to receptors only found on the tumor cells. His team calls this nanoparticle construct and its venomous payload NanoVenin.

Venom Versus Chemotherapy

So why venom at all? Interestingly, the answer is that synthetic venom agents are still potentially less toxic to healthy cells than chemotherapy because they are more targeted. Traditional forms of chemotherapy kill all kinds of cells, cancerous and healthy, but rely on the principle that they will kill faster-growing cells faster—and tumor cells typically grow faster than healthy cells.

The nanoparticle approach bypasses the healthy cells to deliver them directly to the cancerous ones with the right receptors. In fact, Pan hopes to specifically hone in on the cancer cells responsible for metastasis and growth. There is some promise here, as particles of interest in bee venom have specifically targeted cancer stem cells in other work. However, whether or not these nanoparticles can deliver a sufficient quantity of the active peptide to have therapeutic practicality remains an open question.

Pan and his coworkers have founded a company called VitruVian Biotech so they can carry out in vivo studies as a next stage in research. They plan to study their nanoparticle system in rats and pigs with a goal of human testing in three to five years. They join a field of dozens of companies using nanoparticles as possible therapeutic agents.