Title: Melittin

Authors: Zachary Bluestein, Rachel Maguire, Alexis Abrego, Jonathon Wenzel, Ramsey Beilke, Matthew Gargulak, & Derick Christiansen
Teacher: Bill Heeren
School: D.C. Everest Senior High School
6500 Alderson Street
Weston, Wisconsin 54476

MSOE Center for BioMolecular Modeling

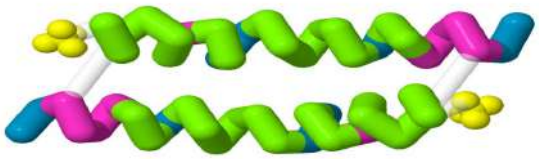
SMART Teams

Exploring the Molecular World

Each year, fifty to one hundred people die of bee stings, and countless others suffer the adverse effects of allergic responses such as pain, swelling, or anaphylactic shock. These physiological responses occur in rapid succession and are facilitated by enzymes present in bee venom. One of the multiple components that initiate these responses is melittin, a protein modeled by the DC Everest SMART Team (Students Modeling A Research Topic) using 3D printing technology.

Present in high concentrations in bee venom, melittin serves many important functions, one of which is helping to stimulate Phospholipase A_2, a separate component of bee venom that cleaves the phospholipids making up the outer membrane of cells. The cell membrane is composed of a phospholipid bilayer in which the electrically neutral phospholipid tails orient towards each other and the polar phospholipid heads point outward, creating a hydrophobic internal region with two hydrophilic borders--an arrangement whose electrical interactions stabilize its structure and prevent large and/or hydrophilic molecules from freely permeating the cell. A relatively small but effective protein, melittin has no identifiable catalytic residues; rather, the hydrophilic distal regions and the hydrophobic proximal regions enable it to fit perfectly into the similarly amphipathic phospholipid bilayer. By doing just that, melittin increases the permeability of the cell membrane to ions such as calcium and sodium along with other components of bee venom. In addition, melittin inhibits the vital membrane proteins that fascilitate the transport of potassium and adenosine triphosphate. These multiple effects of melittin cause the cell to function abnormally, often lysing the cell membrane, which, inevitably, results in cell death.

A single molecule of melittin consists of just 26 amino acid residues, yet it is not only a crucial component of bee venom, but it is also the principle component of a recently developed treatment that has an enormous lifesaving capacity. Melittin's new application is targeted toward a century long killer – HIV. In a recent test, an infant was cured of HIV using a treatment containing nanoparticles armed with melittin that were able to penetrate the double membrane surrounding the virus, thus, killing it. This same fundamental idea is being extended to develop gels with the potential to vastly reduce the risk of HIV infection, hopefully, preventing its spread as a means of eradicating the disease.



Model Description

Structure	Color Code	Color Name
Hydrophobic	[127, 255, 0]	Chartreuse
Polar	[0, 154, 205]	Deep Sky Blue
Charged	[255, 51, 204]	Hot Pink
Hydrogen Bonds	[255, 204, 255]	Pink
Struts		Transparent
Sulfate (SO_4)		Yellow

Bibliography

"Bees and Wasps." *Prevention and Control*. Illinois Department of Public Health, n.d. Web. 15 Apr. 2013. <http://www.idph.state.il.us/envhealth/pcbees.htm>.

Gribskov, M., L. Wesson, and D. Eisenberg. "Melittin." *Protein Data Base*. Research Collaboratory for Structural Bioinformatics, 16 Nov. 2011. Web. 15 Apr. 2013. <http://www.pdb.org/pdb/explore/explore.do?structureId=2mlt>.

Klocek, Gabriela. *Melittin Interaction with Sulfated Sugars and Cell Membranes*. N.p.: Biozentrum, 2008. *University Library of Basel*. Web. 15 Apr. 2013. <http://edoc.unibas.ch/715/1/DissB_8208.pdf>.

Strait, Julia Evangelou. "Nanoparticles Loaded with Bee Venom Kill HIV." *Newsroom*. Washington University in St. Louis, 7 Mar. 2013. Web. 15 Apr. 2013. <http://news.wustl.edu/news/Pages/25061.aspx>.

Terwillige, Thomas C., and David Eisenberg. *The Structure of Melittin*. Rept. no. 11. N.p.: n.p., 1982. *The Journal of Biological Chemistry*. Web. 15 Apr. 2013. <http://www.jbc.org/content/257/11/6016.full.pdf>.