Coalition of
Academic
Supercomputing
Centers

C A S C

THE IMPACT OF HIGH PERFORMANCE COMPUTING ON BIOLOGY, MEDICINE AND BIOMEDICAL RESEARCH

High performance computing has enabled medical science to make dramatic breakthroughs in understanding the complexities of the human body and other living structures and to develop more effective treatments for such devastating illnesses as heart disease, cancer, Alzheimer's and asthma. Here are some examples:

THE HEART -- Using computation and visualization techniques only possible on advanced high performance computers, researchers can now program realistic mathematical models of organ dynamics such as the human heart. The complexity of a heart model is so great that a single beat requires a 150 hour run on one of the fastest supercomputers available.

Renowned university researchers have used this technology to develop a fully functioning, three-dimensional computational model of a heart, its valves and nearby major vessels. Such modeling has made possible the study of normal and diseased heart functions that are difficult or impossible to address through animal and clinical studies.

BLOOD -- Using high performance computers for molecular modeling has enabled scientists to gain detailed insights into how metal ions bind to proteins -- a critical step in the coagulation of blood, providing hope for hemophiliacs and people with other clotting disorders. In related work, bio-engineered modifications of hemoglobin are being developed to enable blood to deliver oxygen more efficiently. Beneficiaries include people with breathing disorders, cystic fibrosis patients and patients with certain heart and lung disorders.

ASTHMA -- With the number of asthma cases in the United States tripling over the last 20 years, researchers are continually seeking better methods to inhibit the inflammatory agents that cause this chronic and debilitating lung condition. As a corporate partner with the National Center for Supercomputing Applications (NCSA), Eli Lilly and Company has benefitted from the center's powerful computers and staff know-how in advanced molecular dynamics modeling to synthesize new drugs. Some of these drugs have already been tested on asthma sufferers and found to be more effective than earlier treatments.

ALZHEIMER'S DISEASE -- At the Cornell Theory Center, researchers have collaborated with an international team to understand how acetylcholinesterase, or AChE works in its role as nature's vacuum cleaner. This enzyme breaks down acetycholine after that neurotransmitter has done its job of transmitting nerve impulses across the gaps between nerve cells and muscles. Better understanding of how AChE works could help to treat or cure diseases, such as Alzheimer's Disease, that are characterized by malfunctions in the neurotransmitter system. Chemicals that block AChE are already being used to treat myasthenia gravis.

Virtual reality simulations are being used to understand this interaction better and to design new pharmaceuticals that fight the disease by inhibiting AChE.

CANCER -- North Carolina Supercomputing Center researchers are using supercomputers to target cancerous tumors more accurately and for more precise dosage planning in radiation treatment. In traditional 2-dimensional treatment planning, targeting errors occur as often as 20 percent of the time. Today's more accurate 3-D computer planning systems have not only increased patient survival rates but also significantly reduced the destruction of healthy tissue.

Such breakthroughs have been made possible by federal support for high performance computing and by the federal role in funding leading-edge applied research in medical technology through the National Institutes of Health.