Saving Lives Through Medical Research

Recent reports of medical breakthroughs have increased awareness of the value of science as an investment. Just as most investments take time to develop and mature, investments in science really are investments in the future – whether it be future health, future safety or future capability. The following synopses highlight some significant medical developments, developments which had their genesis in Naval Science & Technology projects that no one at the time could predict where they would lead.

Almost 4,000 Americans died in 1996 as they waited for an organ transplant.

- Naval S&T developed a novel medical therapy that re-educates the immune system so that even completely mismatched organs are accepted as one's own.

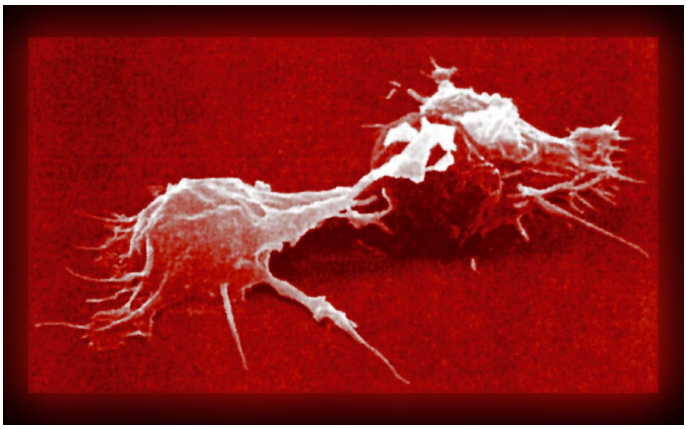
Trauma patients are highly susceptible to infections and toxins in the bloodstream.

- Researchers have found that DHEA may directly counter the immunosuppressive effects of stress and increase a patient's natural resistance.

Therapeutically effective blood and blood substitutes has long been a priority for treating patients.

- Naval S&T has overcome a variety of blood limitations to provide a means of ensuring a safe, readily available blood supply.

AVOIDING REJECTION



Imagine waiting weeks, months, even years for an organ transplant as your health and your quality of life diminishes; wondering if an organ that matches your body chemistry will be found in time to save your life. Fortunately, this may not be the scenario for future generations. Through the Navy's Science and Technology program, scientists recently developed a novel medical therapy that re-educates the immune system so that it recognizes transplanted organs—even ones that are completely mismatched—as being the individual's own.

Stemming from earlier work that suggested that some immune responses could be turned off or on at will, researchers focused on the T lymphocytes, or T cells, which control this on or off response. T cells aid the immune systems by fending off infectious agents, but they can also attack "invading" transplanted organs, which ultimately leads to organ rejection.

The research team observed that T cells are controlled by two chemicals known as co-stimulators and receptors. This therapy controls the T cell co-stimulators and receptors to keep the immune response turned off against invaders. The result is that the T cells won't attack transplanted organs, no matter how mismatched.

Unlike current anti-rejection therapy, which destines the recipient to lifelong anti-rejection medication, this new therapy suggests that the immune system is re-educated to leave the transplanted organ alone, thus precluding the use of expensive daily medication and avoiding unpleasant side effects, such as an increased susceptibility to infections and tumors.

As research continues, we may see more applications for other immune system illnesses ranging from the relatively innocuous, such as hay fever, to severe and life-threatening, such as multiple sclerosis and lupus.

IMMUNE SYSTEM DISCOVERIES

As baby boomers grey, renewed interest in products that promise new-found youth capture the attention of the popular press. Most recent among these is a naturally produced hormone called dehydroepiandrosterone, known commonly as DHEA. Produced by the adrenal glands, DHEA is at its highest level in the blood stream at age 25, and then steadily declines throughout an individuals lifetime. While DHEA may or may not be the fountain of youth, Navy researchers have been studying its effect on the immune system in medical trauma situations.

Despite being stabilized, trauma patients are highly susceptible to infections and toxins in the bloodstream. This is thought to be the result of immune system compromise by trauma-associated stress. Recent studies suggest that DHEA may directly counter the immunosuppressive effects of stress and increase a patient's natural resistance to pathogens present in their wounds or escaping from their intestines.

Administered under the skin within one hour of trauma, DHEA was shown to preserve the normal functioning of the immune system and to increase resistance to bacterial challenge in animals. Taken orally, a derivative of DHEA known as DHEAS was shown to promote the immune response in aged mice.

As more studies are conducted into human immunology, the significance of this discovery may lead to greater application and increased immunity for military casualties, as well as for those typically most vulnerable to immune system compromise—children and the elderly.

STARTING WITH BLOOD

Research in the development of safe and therapeutically effective blood and blood substitutes has long been a priority for treating casualties in combat, as well as victims of accidents and disasters. In order to acheive the goal of a safe and plentiful blood supply, many challenges first needed to be overcome.

Blood has a limited shelf-life. In the 1930s, a unit of blood could be stored for about three weeks. Attempts to prolong the shelf-life of blood in the 1960s included freezing. Currently, researchers are working on new storage solutions that may be able to extend the shelf storage of liquid blood up to 15 weeks. Another avenue that is being pursued is freeze-drying blood so that refrigeration would not be necessary, only an infusion of water.

A second challenge faced by researchers is that *blood must be matched* to the immunological characteristics of the recipient. In 1986, the Universal Donor Blood Program allowed scientists to enzymatically convert Type A and Type B cells to the universal donor Type O blood cells. Positive results from the Navy's research and clinical trials will not only provide a method to develop a continuous supply of Type O red blood cells but also will make greater use of existing supplies of blood Types A and B, which are sometimes unused and discarded.

More recently, through the Naval Science & Technology program, scientists have developed an artificial blood known as Liposome-Encapsulated Hemoglobin (LEH). LEH provides the medical field with a synthetic blood that is free from contamination by viruses and that can be stored for an extended period of time. The LEH program is designed to supplement the supply of fresh red blood cells of the universal donor Type O class. Methods are currently underway to adopt the process to make LEH on the commercial level.