Neuroscience Fact Sheet

What is Neuroscience?

- A scientific discipline that studies the structure, function, and development of the nervous system -- including the brain, the spinal cord, and networks of sensory nerve cells, or neurons, throughout the body.
- An interdisciplinary field that integrates biology, chemistry, physics, mathematics and psychology with studies of structure, physiology, and behaviour.
- A means by which neuroscientists seek to find treatments and cures for diseases, disorders and injuries of the brain and nervous system. Examples include: Alzheimer's Disease, Parkinson's Disease, stroke, chronic pain, autism, depression, brain tumours and spinal cord injuries.

Neuroscience Research

- Major themes in research include: brain development, sensation and perception, learning and memory, attention and emotion, sleep, aging, neurological and psychiatric disorders, stress.
- Levels of Research:
    1. Behavioral: study of the neural basis of behavior (i.e. what causes people and animals to do the things they do.)
    2. Systems: study of the various parts of the nervous system like the visual or auditory system. This could also include investigations of what parts of the brain are connected to other parts.
    3. Local Circuit: study the function of groups of neurons (nerve cells.)
    4. Single Neuron: study how individual neurons respond to various stimulations.
    5. Synapse: study the function of the synapse (the interconnection between neurons) when it transfers electric activity (information) from one cell to another.
    6. Membrane: study what happens to ion channels (pore-forming proteins) on a neuronal membrane.
    7. Genetic: study the genetic basis of neuronal function.

Facts about Neurological and Psychiatric Diseases, Disorders and Injuries

- There are more than 1,000 brain and nervous system diseases, disorders, and injuries and they affect 10 million (one in three) Canadians of all ages.
- Common root causes across these diseases, disorders and injuries include cell loss, loss of cell function and chemical imbalances.
- 50% of all Canadians – about 15 million people – have had a brain disorder impact their family.
- Health Canada has conservatively evaluated the economic burden of these disorders at $22.7 billion; however, curent estimates of the economic cost fail to take into consideration suffering and disability that do not result in death and hospitalization. Lost productivity and psychological costs to patients and caregivers are also not taken into account. When disability is included, the burden reaches $35 billion and higher, according to the World Health Organization.
- Brain disorders are among the leading causes of death in Canada and are the leading cause of disability.

Recent Discoveries/ Advances in Neuroscience

- Alcoholism - A product of neuroscience research, Naltrexone is the first new medication in 45 years approved for the treatment of alcoholism.
- Alzheimer's - Based on a study involving primates, scientists may soon be able to employ genetic engineering to treat such devastating human diseases as Alzheimer's disease and Parkinson's. Studies reveal that a substance called human nerve growth factor, a naturally occurring protein, has beneficial effects on brain cells. When genetically engineered growth factor-producing cells were injected into the brains of monkeys, deterioration was reversed in up to 92 percent of diseased brain cells.

- Depression - Scientists are discovering potentially powerful strategies for entirely new classes of antidepressants. One of the most promising of the new strategies is to target the body's hormone system for regulating stress. Indeed, studies have shown that this system is overactive in some depressed people, keeping stress chemicals in the bloodstream and harming the brain. Scientists are trying to identify new drugs that can rebalance the stress system and protect or repair the brain.
- Multiple sclerosis - Two forms of the immunosuppressant drug beta interferon have now been approved for the treatment of relapsing/remitting multiple sclerosis. Beta interferon may actually slow the progression to physical disability and reduce the number of exacerbations. When attacks do occur, they tend to be less severe and shorter in duration. MRI scans, used to chart the course of the disease, indicate that beta interferon lessens the destruction of myelin, the fatty substance surrounding nerves that is damaged in multiple sclerosis.
- Parkinson's - Studies of a procedure called pallidotomy, which destroys overactive neurons in a brain region called the globus pallidus, show that many patients improve significantly following treatment. One new study shows a marked reduction in rigidity and paralysis, improved motor responses to Parkinson's drugs, and disappearance of uncontrolled movements following pallidotomy.
- Post-Traumatic Stress Disorder (PTSD) – Recent studies have found that selective serotonin reuptake inhibitors ease the symptoms of depression and anxiety. These drugs are the only agents currently approved for treating the symptoms of PTSD.
- Schizophrenia - Using a brain imaging technique called positron emission tomography, or PET, scientists have shown that patients with schizophrenia use as much of their brain to perform a very simple sound discrimination task as normal people do when performing a demanding task. The abnormal mental strategies could result from factors such as abnormal brain wiring. Understanding why they occur will lead to an improved understanding of the disease.
- Stroke - Researchers have identified several genes that protect nerve cells against death when they are exposed to stress caused by factors such as stroke. Scientists hope to find ways to manipulate these genes to improve nerve cell survival in stroke and degenerative neurological diseases.

Challenges for the Future

The scientific study of the nervous systems – especially in molecular biology, neural networks and computational neuroscience – has exploded in the second half of the twentieth century, principally due to technological advances such as the patch clamp to listen to ion channels; the electron microscope to see inside neurons; single unit techniques to record electrical activity from inside and outside of individual neurons; positron emission tomography to study brain function; magnetic resonance imaging to see inside the living brain. Yet there is still much to learn about the brain and the rest of the nervous system. Some of the yet unsolved problems of neuroscience include: What are the neural causes of mental diseases like psychotic disorders (e.g. mania, schizophrenia), Parkinson's disease, Alzheimer's disease or addiction? How can we help nerves regenerate? Can we cure spinal cord injuries? Can we transplant or replace parts of the brain?

Sources: Society for Neuroscience; University of Washington