This fifth article in our series explores major age-related anatomical and physiological changes in the nervous system.

The nervous system, along with the endocrine system, controls and integrates the activities of major organs and tissues. It receives and processes sensory input from organs such as the eyes, ears and skin, and responds through a variety of effector organs.

The brain is extremely complex, with around 100 billion interconnected neurons. Despite decades of intensive research, most aspects of its function remain poorly understood.

There is a progressive loss of neural tissue with age (Montague, 2005), usually reflected by a gradual decline in cognitive function.

**ANATOMICAL CHANGES IN THE BRAIN**

The ageing brain gradually loses neurons and some of the supporting neuroglial cells – it has been estimated that brain mass drops by around 10% between the ages of 20 and 90 years. From the age of 20–60 years, neural losses are only around 0.1% per year but the process speeds up thereafter (Esiri, 2007).

In addition, the remaining tissues display an increased concentration of potentially harmful materials such as iron, aluminium and free radicals.

Aged neural tissue shows increasing pigmentation, largely due to the deposition of a brown pigment called lipofuscin and a black pigment called melanin.

Lipofuscin is linked to the formation of neurofibrillary tangles (abnormal areas of tangled neural tissue present at high densities in Alzheimer’s disease), which are often present at low densities in aged brain tissue, even in the absence of underlying disease.

Loss of neurons is most apparent within the cerebral cortex. The grooves (sulci) that mark the surface convolutions (gyri) of the cerebral cortex are visibly deeper in brains taken from older people (Fig 1). A significant amount of neural tissue is lost from the hippocampus (Burke and Barns, 2006), an area of the limbic system with an important role in memory and the acquisition of skills.

There is a gradual increase in the size of the fluid-filled chambers (ventricles) within the brain (Fig 1) because of a progressive loss of the cells lining the ventricles. These expand and fill with more cerebrospinal fluid. It has been estimated that individuals in their 90s may have ventricles up to three times bigger than those of 20-year-olds.

The medulla oblongata and other areas of the brain stem show minimal neural losses compared with other regions of the brain. This may reflect the essential role of the brain stem in life support, controlling critical processes such as breathing, peristalsis, heart rate and blood pressure.

There appears to be no direct correlation between normal age-related loss of neural tissue and decrease in intellectual function – indeed, many people with severe dementia have normal brain mass.

Research indicates that, as neurons are lost, those remaining show increased plasticity, with lengthening axons and the sprouting of new dendrites (Joynt, 2000). This allows new connections (synapses)
between adjacent nerve cells to be established and may partially compensate for age-related loss of neurons.

**PERIPHERAL NERVE CHANGES**

With age, the peripheral nerve cells often show a progressive degeneration of the myelin sheath (insulative layer around the axon). This slows the conduction of nerve impulses by around 5–10% (Joynt, 2007). In health, this reduction in conductivity causes few problems but, in older people with diabetes, it may contribute to and exacerbate any pre-existing diabetic neuropathy.

Damage to peripheral nerves is not repaired efficiently in older people and some damaged nerves will remain unrepaired. This can contribute to reduced sensation and motor control.

**FUNCTIONAL CHANGES**

In the absence of underlying disease, intellectual ability is usually retained until at least age 80 (Joynt, 2000). The gradual loss of neurons, slowing of nerve conduction and depletion of neurotransmitters often slows the processing of information and, as a result, some tasks may take longer to complete in older age.

Some functional changes are commonly experienced by older people, including:

- Loss of short-term memory: this is probably the earliest indication of age-related changes within the brain. Unlike dementia, it tends not to affect life skills, such as the ability to cook, but typically manifests itself in trivial inconveniences such as forgetting an item from a shopping list or misplacing keys.
- Loss of verbal skills: individuals over the age of 70 may increasingly have problems in choosing appropriate words (for example, struggling to find the correct word to finish a sentence) and learning new languages becomes increasingly difficult.
- Reduced reaction times: the progressive loss of neurons, a reduction in impulse velocity and changes within the spinal cord typically lead to a slowing in reaction times (Spirduso, 1995). This can create problems on encountering painful or harmful stimuli.
- Depression: Clinical depression is more common in older people and may be related to reduced levels of neurotransmitters such as serotonin. Depression can often produce worrying symptoms that mimic dementia (pseudodementia), frequently leading to great anxiety.
- Increased activity of neuroactive drugs: because neural mass is reduced, drugs that affect mental function may be more potent in older people. As such, normal doses of common antidepressants and neuroleptics may induce confusion or delirium.

**SPINAL CORD CHANGES**

There is a gradual age-related loss of neural tissue from the spinal cord. Up to 46% of neurons may be lost in humans over the age of 50 (Esiri, 2007).

Although this appears to have little effect on spinal-cord function, changes in the composition and shape of the cartilaginous intervertebral discs (see part 10, the musculoskeletal system) may increase the chances of injury due to poor coordination, balance and fine motor control.

**REFERENCES**


**REDUCING THE EFFECTS OF AGEING**

There is strong evidence that keeping mentally active can reduce some of the age-associated problems described in this article (Mahncke et al, 2006).

Older people should be encouraged to engage in stimulating activities such as socialising, reading and participating in games, which are thought to improve cognitive function and memory as well as reducing the risk of depression.

It is a common misconception that ageing naturally leads to conditions such as confusion, dementia and delirium. The human brain has so many neurons that it has a natural built-in redundancy that allows it to adequately cope with the physical changes that are associated with ageing. Indeed, in the absence of disease, it is possible for adequate mental function to be retained throughout life.