A Level Biology B

H422/02 Scientific literacy in biology

Question Set 8

1. This question is based on the **Advance Notice Article** SPINAL CORD INJURIES: HOW COULD STEM CELLS HELP?

(a) **(i)** The spinal cord contains both motor and sensory neurones.

State one similarity and one difference between the structure of motor and sensory neurones. **[2]**

(ii) Explain why a spinal cord injury (SCI) causes both paralysis **and** loss of feeling below the site of the injury. **[2]**

(iii) Describe the role of the myelin sheath in the propagation of nerve impulses. **[2]**

(iv) The Advance Notice Article discusses oligodendrocytes, which are cells found only in the central nervous system (CNS).

State the name of the cells that perform a function equivalent to oligodendrocytes in the peripheral nervous system. **[1]**

(b) **(i)** Treatment of injuries to the spinal cord, including with stem cell therapy, requires surgeons to determine the exact location and extent of the injury.

State the name of an imaging technique that could be used for this purpose. **[1]**

(ii) Describe how the technique you have given in **(i)** can be used to help surgeons to assess the location and extent of injury. **[3]**

(c) The Advance Notice Article describes several types of stem cell.

Stem cells can be classified as totipotent, pluripotent, and multipotent.

Suggest which of these types of stem cell have been used in the clinical trials described in the Advance Notice. Give reasons for your choice. **[3]**

(d)* Using information from the Advance Notice Article, evaluate the risks, benefits and ethical issues related to the use of stem cells in the treatment of spinal cord injury (SCI).

In your answer, you should demonstrate an understanding of the current and future potential of stem cell therapy.

[6]

Total Marks for Question Set 8: 20

Advance Notice Article

SPINAL CORD INJURIES: HOW COULD STEM CELLS HELP?

The spinal cord transmits information between the brain and the rest of the body. Injury to the spinal cord, which currently affects 333,000 Europeans, can cause paralysis, and there is currently no effective treatment. Could stem cells help?

Introducing the spinal cord

The spinal cord is the delicate tissue encased in and protected by the hard vertebrae of the spinal column. Together, the brain and spinal cord form the body's central nervous system.

The spinal cord is made up of millions of nerve cells that carry signals to and from the brain and out into other parts of the body.

Neurones in the spinal cord also need the support of other cell types. Oligodendrocytes, for example, produce myelin.

What happens when the spinal cord is injured?

A spinal cord injury (SCI) affects both neurones and myelin sheath. At a cellular level, axons are crushed and torn, and oligodendrocytes begin to die.

The body cannot replace cells lost when the spinal cord is injured, and its function becomes impaired permanently. Patients may end up with severe movement and sensation disabilities. They will generally be paralysed and without sensation from the level of the injury downwards. Injuries high in the neck, such as those suffered by Superman actor Christopher Reeve, paralyse the whole body including the arms and shoulders. A common level of injury is just below the ribs, resulting in normal arm function but paralysed legs. Depending on the location and the extent of the injury, patients may suffer complete or incomplete paralysis, and loss of feeling, sexual function and bowel control.

How could stem cells contribute to spinal cord repair?

A spinal cord injury is complex, involving various forms of damage to different types of cell. The environment of the spinal cord changes drastically during the first few weeks after injury (immune cells flow in, toxic substances are released, and a scar is formed). A combination of therapies is needed, acting at the appropriate time-point and on the correct targets.

Studies in animals have shown that a transplantation of stem cells or stem-cell-derived cells may contribute to spinal cord repair by:

- replacing the nerve cells that have died as a result of the injury
- generating new supporting cells that will re-form myelin and act as a bridge across the injury to stimulate re-growth of damaged axons
- protecting the cells at the injury site from further damage by releasing protective substances such as growth factors, and soaking up toxins such as free radicals, when introduced into the spinal cord shortly after injury
- suppressing the damaging inflammation that can occur after injury.

Different cell types, including stem cells, have been tested in these studies. None of these cells has produced more than a partial recovery of function, but it is an active area of research, and several different types of stem cell are being tested and modified.

Stem cell treatments are beginning to be tested in clinical trials

Clinical trials using neural stem cells

In December 2010 a Phase I/II clinical trial on chronic spinal cord injury began at the Balgrist UniversityHospital in Zurich (Switzerland). The trial uses a type of stem cell derived from human brain tissue, which can make any of the three major kinds of neural cell found in the central nervous system. Analysis of clinical data to May 2014 has shown that the significant post-transplant gains in sensory function first reported in two patients have now been observed in two additional patients.

Neuralstem began a Phase I safety trial of its NSI-566 neural stem cells for chronic spinal cord injury (cSCI) at the University of California, San Diego School of Medicine. The four cSCI patients have no motor or sensory function in the relevant segments at or below the injury, and are considered to be completely paralysed.

All patients in the trial will receive six injections in, or around, the injury site. They will also receive immunosuppressive therapy for three months.

Clinical trials using mesenchymal stem cells (MSCs)

Mesenchymal/stromal stem cells are being investigated as possible treatments for spinal cord injuries.These include studies that investigate the safety and efficacy of MSCs derived from the patient's own bone marrow, adipose tissue (fat) or cord blood.

Clinical trials using embryonic stem cells

The company Asterias Biotherapeutics has developed a programme that focuses on the developmentof a kind of nerve cell, oligodendrocyte progenitor cells (OPCs), for spinal cord injury. These cells, known as AST-OPC1, are produced from human embryonic stem (hES) cells.

In a Phase 1 clinical trial, five patients with thoracic spinal cord injury were administered two million hES-derived OPCs at the spinal cord injury site. The subjects received low-level immunosuppression for the next 60 days. Delivery of OPCs was successful in all five subjects, with no serious adverse events associated with the administration of the cells or the immunosuppressive regimen. In four of thefive subjects, scans suggested a reduction of the volume of injury in the spinal cord. The hope is that OPCs may re-myelinate and restore lost functions when transplanted into the injured spinal cord.

Can stem cells be used to treat spinal cord injuries now?

No. Although stem cells are already very useful in SCI research and are beginning to be tested in clinical trials, there are currently no proven and approved stem cell treatments available for spinal cordinjuries. Several different approaches and types of stem cell are being investigated for their potential use in future treatments. The aims of the various strategies are to enable axons to regenerate, to replace lost myelin, and to protect the cord from spreading damage after the injury. It is likely that we will see further clinical trials based on these strategies.

Taken from: http://www.eurostemcell.org/factsheet/spinal-cord-injuries-how-could-stem-cells-help