NAME ______________________ DATE ____________ CLASS ________

Readings and Case Studies

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Reading 6: Reversing Stroke and Spinal Cord Damage

Directions: Read the following selection, then answer the questions that follow.

Brain injuries, including strokes and severe head trauma, disable tens of thousands of Americans yearly. In addition, spinal cord injuries that result in paralysis occur daily. The disabilities that result can be devastating to the victims. Regenerating brain tissue and repairing spinal cord damage are not yet possible, but strides are being made toward reducing the severity of many disorders and injuries. Eventually, researchers hope to use a combination of methods to repair the damage.

Scientists are on the brink of doing the unthinkable—replenishing the brains of people who have suffered strokes or head injuries to make them whole again. And as if that is not astonishing enough, they think they may be about to reverse paralysis.

The door is at last open to lifting the terrifying sentence these disorders still decree—loss of physical function, cognitive skills, memory, and personality—which costs the nation $65 billion annually.

Until recently there was virtually nothing doctors could do for the 500,000 Americans who have strokes each year, the 500,000 to 750,000 who experience severe head injury, or the 10,000 people who are paralyzed after spinal cord damage.

But that is about to change. Researchers now think it may be possible to replace destroyed brain cells with new ones to give victims of stroke and brain injury a chance to relearn how to control their body, form new thinking processes, and regain emotions.

And after demolishing the long-standing myth that brain cells can't regenerate or proliferate, scientists are developing ways to stimulate cells to do just that.

Although stroke, head injury, and paralysis are three of the most devastating things that can happen to anyone, scientists have recently learned that the damage they cause is not preordained: it takes place over minutes, hours, and days, giving them a precious opportunity to develop treatments to halt much of the damage.

Most of the new remedies are not yet available, but an explosion of research in the last five to ten years has convinced scientists that some of them will work. . . .

Scientists are finding that treatments that work in one type of injury—stroke, head trauma, or spinal damage—are likely to work in the others. All of these disorders share many of the same mechanisms of cell destruction, which come in two phases, primary and secondary injury.

In the primary, or initial, injury, blood flow to a part of the brain is blocked by a clot that plugs an artery or by a physical blow. Brain cells, or neurons, are either damaged or die right away because they are deprived of nourishing blood.

This initial destruction then triggers a chemical attack against tissue that was not damaged in the primary injury. The second phase of injury invokes a process called excitotoxicity and it affects nearby healthy cells, often killing more brain tissue than the initial injury.

Like someone yelling "fire" in a crowded theater, damaged and dying cells scream out a slew of chemicals. These chemicals, which normally help brain cells talk to each other, become dangerously toxic in excessive amounts.

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They literally cause healthy cells to become overexcited to the point of death, when they too spew out their death-throe chemicals.

Interestingly, scientists believe that excitotoxicity is a genetically programmed suicide mechanism devised by nature to kill unneeded or unhealthy cells. Such cell death occurs during fetal development, for instance, to get rid of billions of overproduced brain cells and the webbing between fingers.

It is this same excitotoxic response that is rapidly triggered in stroke, head trauma, or spinal injury to produce the destructive secondary injury. Evidence also indicates that the excitotoxic reaction can occur over a longer period of time, causing a slow form of suicide that may be the final pathway for cellular death in Alzheimer's, Parkinson's, and other degenerative neurological disorders.

The suicide reaction—its scientific name is apoptosis—begins when a damaged or dying neuron releases massive amounts of a neurotransmitter called glutamate. Glutamate is normally one of the most important chemical messengers in the brain.

But when too much glutamate is present, the NMDA receptors ("doors" on cell surfaces) are jammed open. Sodium floods in, causing the cell to swell. Calcium rushes in and smashes at the cell's genetic controls, producing enzymes that eat away the cell's internal support structure and destructive molecules, called free radicals, that chew away its membrane wall.

"It would be like going into the cabin of a 747 jetliner with a sledgehammer and starting to hit left and right," Washington University's Dennis Choi said. "Everything just starts going haywire."

The discovery of the key steps in the suicide cascade of secondary injury is leading to the development of drugs to block them. Experiments in animals show that by blocking the secondary injury, much of the damage that normally occurs from a stroke, head trauma, or spinal injury can be prevented.

—Inside the Brain: Revolutionary Discoveries of How the Mind Works

Understanding the Reading

Directions: Answer the following questions in the space provided.

1. **Identify** What are the common consequences of strokes, head traumas, and spinal cord injuries?

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2. **Identify** What are the two phases of cell destruction common to strokes, head traumas, and spinal cord injuries?

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3. **Explaining** What is the biological purpose of excitotoxicity?

4. **Describing** What happens when too much glutamate is present in the brain?

Thinking Critically

Directions: Answer the following questions in the space provided.

5. **Identifying** What common psychological effects occur in victims of strokes, head traumas, and spinal cord injuries?

6. **Considering Advantages and Disadvantages** Although experiments have been successful in animals, the drugs used are not yet widely available for humans. If someone you cared for experienced a severe head trauma, would you want him or her to participate in a study of these drugs? Why or why not?