

Wearing on Her Nerves: Exploring the Interrelation between the Nervous and Muscular Systems

by

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Part I – Rise and Shine?

Kathy, a 20-year-old woman, awakens one morning to a tingling, numb sensation covering both of her feet. This has happened to her a number of times throughout the year. In the past, when experiencing this sensation, within a couple of days to a week the numbness would subside, and so she is not too concerned. About a week later, she notices that the numbness and tingling not only persists, but has also spread up to her knees. Again, she ignores the abnormal sensation. By the end of a month's time, the numbness spreads to the midline of her body. At this point, she becomes alarmed.

Kathy sees the nurse at her college who tells her that she should see a doctor. Kathy calls her doctor's office to schedule an appointment, but the soonest slot is in two weeks. She makes the appointment and goes about her daily routine.

The next morning, Kathy wakes, but when she attempts to get out of bed, she comes crashing to the floor. Because she is still groggy from sleep, she doesn't really understand what has just happened. As she tries to stand up, the muscles of her left leg engage, but as she also attempts pushing up with her right leg, she again falls to the floor. She sits in bewilderment as she tries to make sense of what has just happened and realizes that she has seriously scraped her knee in her fall. She does not feel the pain from her wound.

Kathy thinks about how odd this year has been. She remembers another medical issue she had earlier in the year when she had lost hearing in her right ear and wonders if there is a connection to her current condition. At that time, Kathy underwent extensive testing, but the ear, nose, and throat specialist remained baffled. He thought that a severe inner ear infection could have destroyed her ability to hear on that side, but there was no conclusive evidence to support this. In an attempt to recover any hearing he could, the doctor prescribed very high dosages of steroids; he told Kathy that she probably wouldn't see a change, but there were rare occurrences where steroids helped. To both Kathy and her doctor's surprise, after about a week of steroids, she completely regained hearing in her right ear. It was a "miracle."

Kathy wonders whether she can count on a new miracle to heal her current medical issues.

Questions

1. What components of the nervous system are involved in physical sensation? How does sensory impulse move throughout the body?
2. What components of the nervous system are involved in skeletal muscle movement? How does motor impulse move throughout the body? What is a "motor unit"?
3. What movements are involved in the action of standing up? What muscles need to contract to perform these actions?

4. What are the different levels of organization of a muscle down to myofilaments? What is a “sarcomere” and how are its proteins organized?
5. Starting from the release of acetylcholine by the motor neuron, what are the steps in muscle contraction? How is contraction ended?
6. Are Kathy’s medical problems related to her sensory neurons, motor neurons, or both? What in Kathy’s medical history supports your answer?

Part II – Diagnosis and Treatment

Kathy realizes that she cannot wait until her appointment to receive medical care; she quickly goes to the emergency room. After a mountain of questions about Kathy's symptoms and medical history, the doctors decide to admit her for further testing. She is transferred to the neurology unit and the doctors request she undergo a series of laboratory tests, including an MRI and a spinal tap. In the meantime, the doctors prescribe high dosages of steroids to help alleviate the symptoms.

Upon reviewing Kathy's medical history and the results of the various laboratory tests, the neurologists diagnose her with Multiple Sclerosis (MS). They explain to Kathy that MS is an autoimmune disease and that her own immune system has been attacking the myelin sheath that surrounds the nerves of her central nervous system. She remains in the hospital for a week until sensation is fully recovered in her lower body and strength is restored in her legs. She is discharged from the hospital and schedules a follow up appointment with the neurologist.

When she returns to the neurologist, they discuss Kathy's different options for treatment. Because there is no cure for the disease, options in medication vary greatly. She decides to try daily injections of Copaxone, a medication that is similar in structure to a protein found in myelin.

Kathy continues to see the neurologist on a regular basis and gives herself an injection every evening. Over the course of seven months of therapy, she only experiences one occurrence of numbness, which subsides after a couple of days. She tries to stay positive and tries to minimize the disease's impact on her life.

Questions

7. What is myelin and how does it affect the transmission of nerve impulses? Identify the cells responsible for the formation of myelin.
8. What are the "scleroses" in Multiple Sclerosis and where do they occur? How does this influence nerve transmission?
9. How do an MRI and spinal tap help confirm the diagnosis of Multiple Sclerosis?
10. Why did steroids help alleviate Kathy's symptoms?
11. How does Copaxone work as treatment for Multiple Sclerosis? How do other types of medications differ?
12. Why did Kathy experience the altered sensation in her lower body? Was there something wrong with her skin? Why couldn't she stand? Was there something wrong with the muscles of her right leg?
13. Did Kathy's hearing loss have anything to do with the Multiple Sclerosis? Why/Why not?



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