The Soccer Mom:
A Case Study on the Nervous System

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Part I—At the Soccer Game

Thirty-two-year-old Phyllis Jackson was sitting on the bench at the side of the soccer field, sipping a bottle of Gatorade. Her husband, Steven, sat next to her with a concerned expression.

"I'm really worried about you, honey," he said.

"I'm just a little dehydrated; I'll be fine."

"If this were the first incident, then maybe I'd agree with you. But your boss has been on your case about your lack of concentration at work, you forgot to pick up the kids from school last week, and quite frankly, you haven't exactly been yourself with me lately. Now you're having fainting spells during games? Something doesn't seem right."

"I know things haven't been going well for me lately, but I don't know why. I try so hard at work, at home, with the kids, to be a good wife. So maybe all this stress has made me a little unfocused and disoriented. What do you want me to do about it?" Phyllis said, blinking back tears.

"I think you should see a doctor," Steven replied, putting his arm around her and drawing her close. "The kids are getting worried, too."

Phyllis sighed. "Alright, if it will make you feel better. I really just think I need some time to relax, though."

"Well… I could drop the kids off at my sister's tonight; that would give us a little free time…"

"That's really thoughtful of you. I could definitely use a quiet night at home, maybe even go to bed early."

Steven seemed disappointed.

Questions

1. What problems does Phyllis seem to be experiencing?
2. Which of these problems could be caused by dehydration?
3. Which of these problems might make you consider that there's something more going on? Why?
4. Suppose Phyllis does have a more serious problem. Can you think of any neurological problems that could be the cause of these symptoms?

Part II—The Doctor Visit

"So, what seems to be the problem, Mrs. Jackson?" Dr. Warner asked Phyllis.

"My husband wanted me to come in and see you after I fainted during my soccer game Saturday. I've also been having some problems at work, but I think I'm just stressed."

"What kinds of problems have you been having at work?"

"It's been hard to concentrate on tasks. I've also had some problems typing—I've been making more errors than usual, and oftentimes my fingers will go numb."

"I see," said Dr. Warner, taking a few notes on his clipboard. "According to my records you are not on any long term medication. Have you noticed any problems outside of work?"

"Well, my husband has been complaining about our personal life lately. And last week, I completely forgot that I was supposed to pick up our two daughters after school. I've been feeling really tired lately; even my coordination seems off."

"How long has this been going on for?"

"A few weeks, but this isn't the first time. These problems seem to come and go, but it's getting to the point where I can't just ignore them anymore. I don't know, maybe I'm just depressed."

"Why do you say that?"

"My mother suffered from depression throughout my childhood."

"Well, depression certainly could cause some of the symptoms you're experiencing," Dr. Warner said thoughtfully. "Is there a history in your family of any neurological disorders?"

"I don't think so. I have some vague recollection of my grandfather in a wheelchair when I was really young, but I don't know what was wrong with him."

"Okay," said the doctor, nodding. "Well, the few preliminary tests we've run show that you are not pregnant, and that you are not going through menopause. I'd like to send you to see Dr. Thrush, a friend and colleague of mine. She is a neurologist at the local hospital and she will run a few tests to explore your symptoms a little further."

Questions

1. What new signs or symptoms have been revealed?
2. Could any of Phyllis's symptoms be attributed to depression? If so, which?
3. What neurotransmitters are thought to be involved in depression?
4. What neurological disorders could have put her grandfather in a wheelchair?
5. Could any of these neurological disorders explain one or more of Phyllis' symptoms?
6. Could Phyllis have inherited any of these disorders?
7. If you were in Dr. Warner's position, what tests might you suggest to confirm (or not) this diagnosis?

Part III—Diagnostic Tests

Dr. Thrush looked over the results of Phyllis's Magnetic Resonance Imaging (MRI) and evoked potential tests. She was thinking how glad she was that Steven had accompanied Phyllis on this visit as she showed them the MR images of Phyllis' brain.

"The machine took pictures of Phyllis' brain in slices. The dark areas are the brain tissue, Phyllis, and the white areas in the middle and around the outside are the cerebrospinal fluid."

"Is that normal? Am I OK?" Phyllis asked. "And what are those little white dots in the tissue?"

"The white dots are what concerned me," replied the doctor. "So we did another type of MRI, called dark fluid, so that your cerebrospinal fluid would not show up white."

"But I still see the white dots in my brain tissue. What does that mean?"

The doctor looked down, knowing that this was never an easy thing to tell a patient.

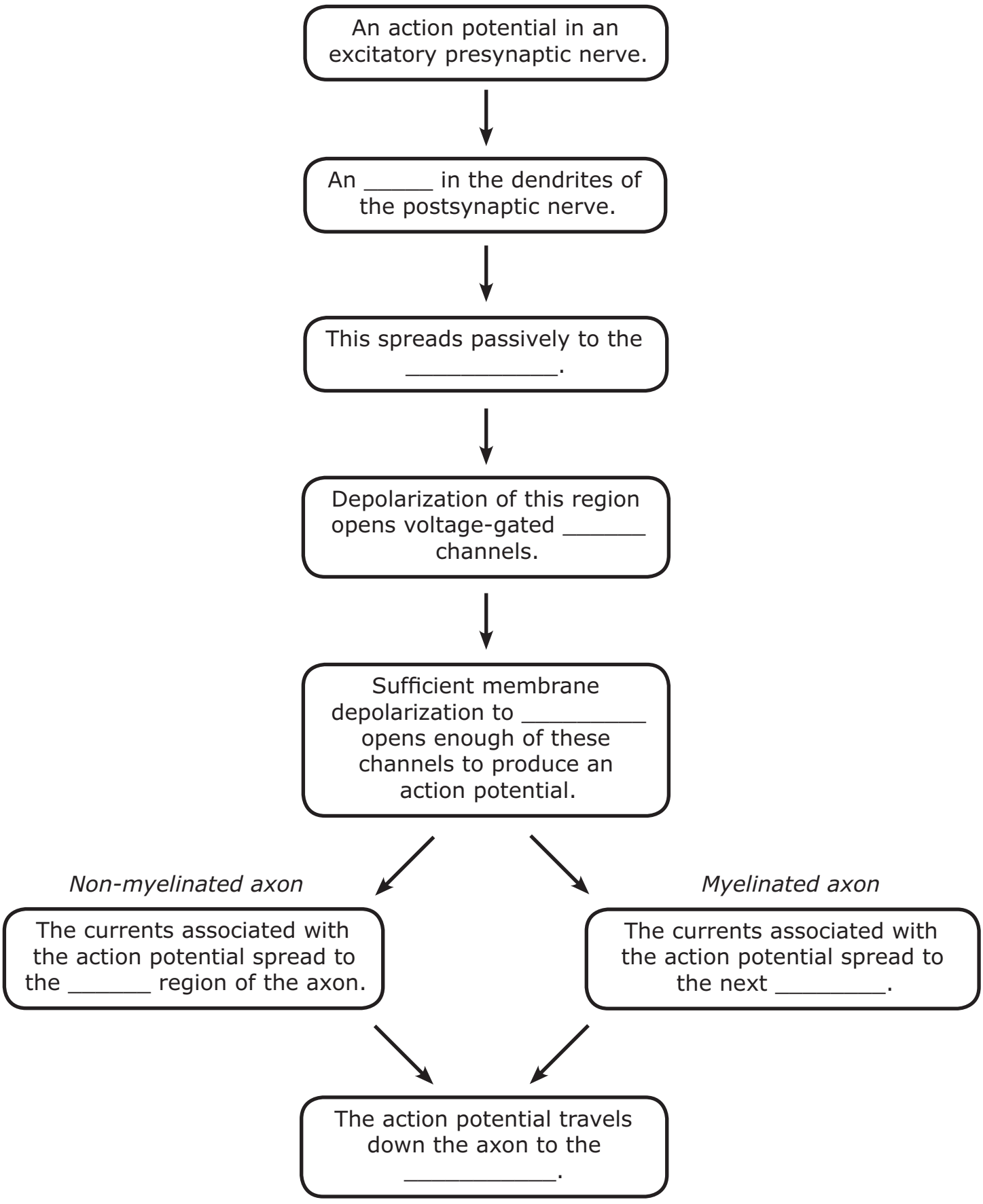
"I am afraid that this indicates that there are plaques or scars in your brain, and that you may have multiple sclerosis."

Tears began to form in her eyes as Phyllis squeezed her husband's hand.

"I am afraid that the evoked potential test and the elevated levels of myelin basic protein in you cerebrospinal fluid indicate the same thing."

Questions

1. Test your knowledge of the function of chemical synapses by filling in the flow diagram on the next page.
2. What type of cell is myelin?
3. What is the function of myelin in nerve cells?
4. In myelinated axons, where are action potentials generated?
5. Where, then, are voltage gated sodium channels concentrated in myelinated axons?
6. What happens to myelin in people who suffer from multiple sclerosis?
7. Why is there an elevated level of myelin basic protein in the cerebrospinal fluid?
8. What would be the effect on action potential conduction at a region of axon where the disease had its effect?
9. What effect would this have on the coordination of movements if this took place in areas involved in motor control of finger movements?


An action potential in an excitatory presynaptic nerve.
An _____ in the dendrites of the postsynaptic nerve.
This spreads passively to the _____.
Depolarization of this region opens voltage-gated _____ channels.
Sufficient membrane depolarization to _____ opens enough of these channels to produce an action potential.
Non-myelinated axon
Myelinated axon
The currents associated with the action potential spread to the _____ region of the axon.
The currents associated with the action potential spread to the next _____.
The action potential travels down the axon to the _____.

Part IV—The Diagnosis

Dr. Thrush informed Phyllis that she was probably suffering from the relapsing-remitting form of multiple sclerosis (MS), in which relapses of symptoms are separated by periods of remission. MS is a disorder in which the myelination of axons is degraded due to unknown factors. The most commonly accepted explanation is that MS is an autoimmune disorder in which myelin in the central nervous system is attacked by the body's own immune system. There is no known cure for multiple sclerosis.

Dr. Thrush ordered physical therapy, weekly injections of interferon beta, and corticosteroids. In addition, she suggested that Phyllis and Steven begin marriage counseling to help them deal with the changes in their lifestyle caused by this disorder.

Questions

1. During remission, axons affected by the disorder regain their function. If voltage-gated sodium channels are concentrated in certain regions of the myelinated axon prior to the disease, what do you think happens to these sodium channels after multiple sclerosis has had its effect?
2. How would these three treatments (physical therapy, weekly injections of interferon beta, and corticosteroids) help to control Phyllis's symptoms?