

## Part I—Meet Annie

Annie felt despondent. Her teammates were being kind to her, but she knew that she was the reason that her team lost the swim meet against the neighboring college. How many people could lose with a four-second lead against someone they had beaten so easily last year? As she walked out of the locker room she noticed that the blurred vision and eye strain had returned, even though she was wearing glasses instead of her usual contacts. Her eye strain had become worse over the past month. Over the last week she had had mid-term exams and papers to write and recently typing made her hands and fingers ache and they felt weak. Even swim practice, which helped relieve her stress in the past, had become taxing. Her coach noticed that her times were getting worse, even though he could see that she was working hard in practice.

As Annie walked out of the locker room she looked up and she saw her boyfriend, Matt, waiting for her. As they walked back to her dorm, Annie thought how nice it was to have Matt to support her during such a tough time. Annie was gasping for air and felt weaker than ever after they had walked up the two flights of stairs to her floor. She told herself that she must set some time aside next week to do something about this constant fatigue.

Annie had already packed her bags for the trip home and Matt was able to carry all of her stuff to his car in one trip. When he returned to the room he found Annie reclining on the bed with her eyes closed. He asked her if she was ready to go. “Sure, just can’t keep my eyes open these days. I am sure I’ll be better when we’re home.”

Matt knew that Annie liked to drive, so when they got to the car he handed her the keys. She tried to take them, but her fingers didn’t seem to work and she dropped his keys on the ground. Matt grabbed the keys and opened the passenger door for Annie. As they set off for home, Matt asked, “Are you feeling okay? You’re not usually so exhausted after a swim meet, and you seem to be having trouble catching your breath. I am worried about you.” Matt thought that this was probably the best time to suggest that she see a doctor.

For each underlined word, write a short definition in the box.

1. Summarize the setting (background) for this case.
2. What symptoms does Annie exhibit? **Prioritize** these symptoms in order of what you think is the most concerning and the least concerning.
3. What is the one common feature of all of her symptoms?
4. When did Matt notice that Annie was having trouble breathing?
5. List any diseases, disorders, or health problems that you can think of that might cause these symptoms. (Brainstorm)

## Part II—The Doctor’s Office

On Monday afternoon, Matt drove Annie to her family doctor. She seemed to have slept for most of the weekend, and Matt thought that she looked much better than last Friday after the meet. In fact, she told him that she felt so much better that she really didn’t need to go to the doctor.



“Seriously, this is stupid. I’ve been feeling much better in the past few days. It’s amazing what some rest can do. That’s all I need; I really don’t need a doctor as long as I take a nap periodically. Let’s not waste his time; let’s just go home.” Matt looked at her with his eyebrows raised, “Let’s just hear what he has to say; better safe than sorry.”

Matt sat in the waiting room and Annie went with the nurse. After a few minutes Dr. Jones entered the cubicle, “Well, Annie, what seems to be the problem?”

“It’s nothing, really. I have just been tired lately. You know I’m going to college on a swimming scholarship, but my times have been getting worse this season, and I’ve been short of breath more than usual after my workouts. I think it’s just because I was stressed out over school; I have been feeling much better since I came home last Friday. “I see,” said the doctor. “Have you had any other problems?”



“Well, yes. My hands and fingers seem to get tired when I type, and a few days ago, after a swim meet, my fingers felt too weak to grab my boyfriend’s car keys when he offered them to me; but I was tired after a really hectic week.”

Dr. Jones looked pensive and asked, “Have you had any trouble with your eyes? Like have they been drooping?”

Annie looked confused. “I have had a lot of eye strain and double vision recently. It gets blurry when I stare at the computer screen too long; I seem to get a zillion papers every week. I also think the chlorine level in the pool is too high. Everyone on the team complains about it because, if your goggles come off, your eyes sting like mad.

The doctor smiled, “I swam before those goggles were even invented, so I know what you mean about stinging eyes. But, I think what you’re telling me goes beyond simple fatigue. I’m going to refer you to a neurologist at the hospital.”

5. What specific question does the doctor ask Annie?

6. What excuse does Annie give about her eye strain?

7. What is a neurologist? (you may need to look this one up)

8. Based on how the doctor responded, do you think he believes that Annie’s problems are caused by not getting enough sleep?

### Part III—The Neurologist

Annie returned to the neurologist's office with her mother. That morning Annie had been subjected to several different tests and she had been asked to return after lunch when the results would be in. The nurse told her that they were rushing this through because they knew that Annie was only home for a week. Annie and her mother sat in the waiting room for what seemed to be hours. At last the nurse came for them.



"Some of the results are here, and the rest are on their way," she explained. "So the doctor will see you now." Annie and her mother went into the doctor's office and sat down.

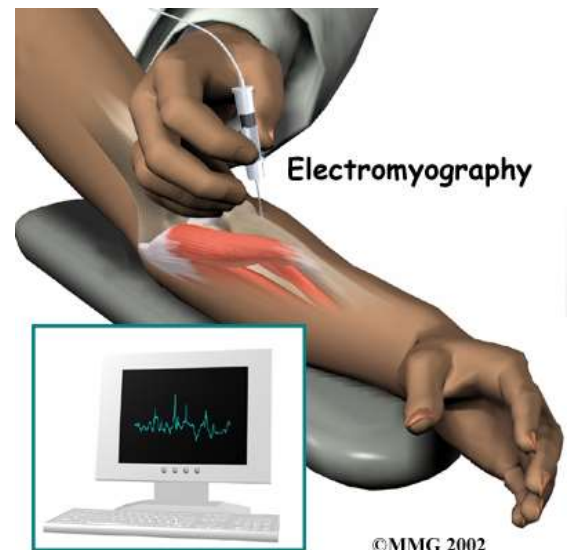
"Well, Annie, I have read your family doctor's notes, and we put you through a battery of tests this morning." the neurologist skimmed through the chart, "Hmm, blurred vision, weak fingers, and decline in swimming performance. OK, let's see what we found out today. First, the nerve conduction and the electromyography (emg) tests; these are the only results we have right now. This was the test when they put sticky electrodes on your skin, remember?" Annie nodded.



"Well, for the nerve conduction tests one set of electrodes stimulated the nerve and another recorded its response a little way down the nerve. The nerve conduction results are normal. There is no nerve fatigue and the conduction velocity is fine; nothing wrong with your nerves."

Annie and her mother looked at each other and smiled with relief.

"Now, the electromyography test involves recording from a muscle; it was done in two stages. The first stimulated the muscle directly, and there isn't too much out of the ordinary there. The second stage is when the nerves were stimulated and the muscle response was recorded. These results concern me because the muscle response decreased quickly during repeated nerve stimulation, indicating that your muscle response fatigued over time."



9. Summarize the results of the nerve conduction test?

10. What is the EMG test? What did this test reveal about Annie's muscles?

11. Based on these two tests, does Annie have a nerve problem or a muscle problem?

## Part IV—The Neurologist Makes a Diagnosis

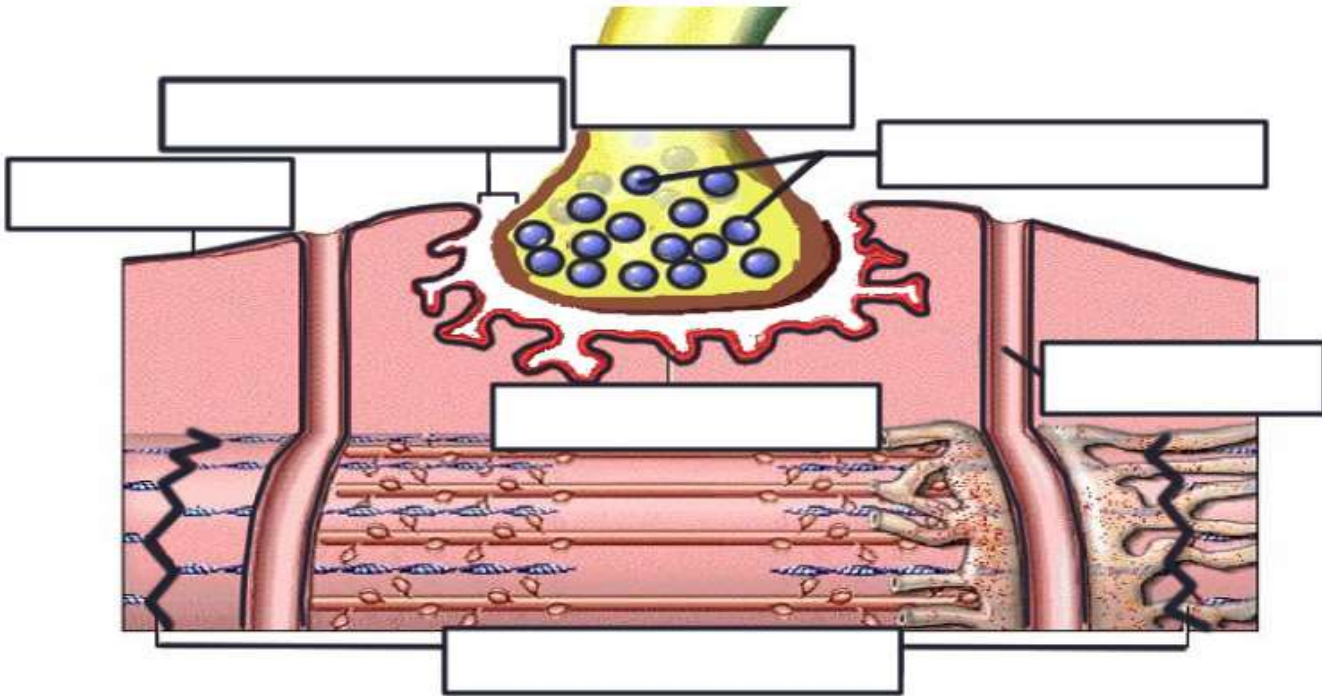
They heard a knock at the door and turned to see the nurse enter; she was holding a folder with the hospital's stamp. The doctor looked over the lab results and then continued.

"I'm afraid I don't have very good news. Do you remember when the nurse injected that solution into your arm and you said that suddenly you felt much stronger?" Annie nodded.

"That was the **edrophonium** test. It temporarily relieves symptoms of people who suffer from myasthenia gravis. I am afraid that the diagnosis is confirmed by these lab results, which show the disease.

The nurse handed Annie and her mother a pamphlet about myasthenia gravis while the doctor explained. "Myasthenia gravis causes your immune system to attack the acetylcholine receptors on your muscles. As these receptors stop working, the muscles fatigue easily. Often the first symptom is weakness of the eye muscle." The doctor held a chart up showing the neuromuscular junction.

12. **Label the image** below that shows the neuromuscular junction: Sarcomere | Sarcolemma | Synapse | Motor End Plate | Nerve | Vesicles | Sarcoplasmic Reticulum | T- Tubules |



13. Add to the drawing by **placing stars** where the acetylcholine receptors would be located. ★

14. **Edrophonium** is a drug that blocks cholinesterase from breaking down acetylcholine in the muscles. Why does this improve Annie's muscle function?

15. Why is myasthenia gravis called an **AUTOIMMUNE DISEASE**? (you may need to look up the definition)