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BIOLF111X

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STEAM project

Multiple Sclerosis

Course Objective: Unit 6: Explain how neurons carry an electrical charge.

For my STEAM project I am focusing on how multiple sclerosis also knows as MS, disrupts the ability of neurons to carry electrical charges, directly connecting to the Unit 6 course objective. Normally, healthy neurons generate action potentials by allowing ions to move across the membrane. An action potential is an electrical signal that a neuron uses to send information to the brain to the body. Myelin helps these electrical charges to travel quickly along the axon. Myelin is a protective fatty-like insulation that wraps around the axons in the nervous system. In MS, the immune system destroys this myelin because it thinks myelin is a threat to the body. This leads to the blockage or slowing down of electrical signaling and leading to the neurological symptoms the autoimmune disease causes. My project demonstrates this using an artistic model that visually explains how demyelination interferes with neural communication and signaling.

In healthy neurons, the myelin sheath allows action potentials to move rapidly by saltatory conduction, "jumping" from one node to the next, creating the normal signal and communication. This insulation keeps the electrical charge inside the axon and ensures the signal travels quickly and efficiently. A clinical research group led by Filippi (2020) describes this as a core requirement for normal sensory, motor, and cognitive function, because even small disruptions in the speed of conduction can significantly change neurological processing.

In MS since it is an autoimmune disease, inflammatory cells mistakenly attack and break down the healthy myelin sheath. When myelin is lost, the fiber then becomes exposed, and the neuron can no longer keep its electrical insulation. Conduction becomes slower and more energetically demanding. Some signals fail to work altogether. The review by Greenfield and Hauser (2020) says that demyelination forces the axon to rely on continuous conduction, which is less efficient than saltatory conduction. This breakdown in electrical signaling explains symptoms people with MS have such as muscle weakness, numbness, visual disturbances, and trouble balancing. The progression of lesions across the central nervous system also accounts for the many other symptoms among MS patients (Gholamzad 2024).

My STEAM project uses a visual model to help viewers understand this process. A healthy neuron is built from pipe cleaners, clay, and beads to represent a thick, intact myelin sheath. The demyelinated neuron shows broken, thinned, or missing myelin segments caused by the disease. By placing the two neurons side-by-side, the viewers can see how electrical signals easily travel

along the insulated axon and then become blocked or weakened along the damaged myelin ones. Seeing the healthy versus damaged neurons side by side makes it a little easier to understand how electrical signals travel normally, and how damaged myelin affects the signals. It shows a real disease that many people have lived with that has been studied by many scientists.

This project model is accurately made with each detail chosen to represent each piece. The colors were chosen to help viewers understand this disease just by looking. It not only shows how neurons send electrical signals but also shows an understanding on why losing healthy myelin (demyelination) causes serious problems.

References

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Gholamzad, M., Ebtekar, M., Ardestani, M. S., Azimi, M., & Mahmodi, Z. (2024). A comprehensive review of multiple sclerosis epidemiology and risk factors. Journal of Neurology,. https://journals.lww.com/md-journal/fulltext/2024/02230/review_of_multiple_sclerosis_epidemiology.15.aspx