The Brain’s Highway

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Abstract

The peripheral nerves, which are made out of fibers or bundles of axons, include all the nerves beyond the brain and the spinal cord. They start from the edges of the central nerves, or spinal cord, and extend outwards to the periphery of the body. The main function of the peripheral nerves is to carry information from the central nervous system to the muscles and to important organs and then relay the sensory information back to the brain. The three types of nerves in the peripheral nervous system are the sensory nerves, motor nerves, and the autonomic nerves. The sensory nerves, also known as afferent nerves, carry information about the visual environment from the eyes to the brain. The motor nerves, also called the efferent nerves, contain special axons of motor neurons to help control glands and muscles. The third type of peripheral nerve is the autonomic nerves that regulate the internal organs such as heart, intestines, and stomach. These three types of nerves make up the peripheral nervous system and allows communication between the brain and body.

Keywords: [peripheral nerves, neurons, autonomic, afferent, motor nerves]
To truly define the peripheral nerves, the first step is to define nerves and neurons. Nerves are a collection of fibers, or axons, which receive and send messages between the body and the brain. Neurons are composed of three main parts: the cell body, the axon, and the dendrite. The axons are extensions that project to the dendrites, which are parts of the cell body that receive input from other neurons (Harris, n.d). These axons conduct electrical impulses from the brain to the rest of the body; hence the name peripheral nerves (U.S National Library of Medicine, n.d). The main difference that sets peripheral nerves apart from the central nerves is that the peripheral nerves are located in the peripheral of the body, meaning outside of the brain and the spinal cord.

Neurons are very versatile. Some are able to perform the job of a sensory neuron or a motor neuron. Sensory neurons are located in the peripheral nervous system (PNS) and provide information regarding touch, position, pain, and temperature. The cell bodies of these neurons are found in clusters known as ganglia (Mandal, 2014). The cell bodies of the motor neurons are located in the central nervous system (CNS). However, they have long axons that extend from the CNS to the muscles of the body, making them integral to the PNS. These neurons combine together to create the PNS. The physiology of the peripheral nerves is to receive sensory information in the form of signals. These signals are interpreted in the brain and are sent back out in the form of electrical impulses. The motor neurons communicate these signals to the target cells, such as muscles and glands (Khan Academy, n.d). For an example, when a person’s finger comes into contact with a hot pan, the sensory neurons in the area fire off and start to transmit information in the form of electrical impulses. These impulses travel up to the brain which then creates a response. The response in this case would cause the individual to jerk their hand back.
This is an involuntary response known as a reflex (Chawla, 2016).

The peripheral nervous system is divided into two main subsystems: the somatic nervous system and autonomic nervous system. The somatic nervous system includes the peripheral nerve fibers, known as afferent nerves, which send sensory information to the central nervous system and motor nerve fibers that project to the skeletal muscle. Another type of nerve that also plays a major role in the somatic nervous system is the efferent nerves. These are nerves that carry nerve impulses away from the CNS to the periphery towards the muscles and glands. (Biology Online, 2015). The other subsystem of the PNS is the autonomic nervous system. This system regulates internal functions of organs such as the heart, stomach, and intestines (Chudler, n.d). The autonomic nervous system is further divided into three more subsystems: the sympathetic nervous system, parasympathetic nervous system, and the enteric nervous system. The sympathetic nervous system is directly responsible for the “fight or flight” response that occurs in times of distress (Chulder, n.d). The sympathetic nervous system originates from the cell bodies of the first neuron in the central nervous system. Although they may start out in the CNS, their axons extend towards the periphery, making them another crucial part of the peripheral nervous system. The parasympathetic nervous system is one of the other three subsystems of the autonomic nervous system. The parasympathetic nervous system is directly responsible for the “rest and digest” response that occurs when the body is not in distress. The parasympathetic nervous system works to save energy. An example of this is the decrease in blood pressure, slowing of the pulse rate, and digestion (Chulder, n.d). The last subsystem of the autonomic nervous system is the enteric nervous system. This system is the largest and most complex subsystem of the peripheral nervous system. The main elements of the enteric nervous system are the myenteric and the submucosal plexuses. The myenteric plexus is responsible for
regulating the relaxation and contraction of the intestinal wall. The submucosal plexus senses the lumen environment and regulates gastrointestinal blood flow. These three subsystems combine together to allow the peripheral nervous system to work efficiently.

Other essential components in the peripheral nerves are the Schwann cells, a type of glial cells, which wrap around axons to create the myelin sheath. The function of the myelin sheath is to increase the speed with which an action potential travels down the axon. It also helps insulate the electrical impulses so that the impulses can travel faster and more efficiently (Morrell, 1999).

An example of a disorder that can severely affect the peripheral nervous system is Guillain-Barré syndrome (GBS). GBS is an autoimmune disorder in which the body attacks parts of the peripheral nervous system (National Institute of Neurological Disorders and Stroke, 2011). GBS is a disorder that can affect anyone. This syndrome is fairly rare, occurring only about one person in 100,000 (National Institute of Neurological Disorders and Stroke, 2011). Typically, the first symptom of this disorder is a weakness or a tingling sensation in the legs. Eventually, these symptoms can increase in intensity to the point of near paralysis. Chest muscles are affected in twenty percent to thirty percent of people with GBS, making it difficult to breathe at times. In some severe cases, the ability to speak and swallow may be affected, which is considered life-threatening (World Health Organization, 2016).

Infection usually precedes Guillain-Barré syndrome. However, the exact cause remains unknown (Mayo Clinic, 2016).

A type of GBS is called acute inflammatory demyelinating polyradiculopathy (AIDP). This type of GBS is the most common form in the United States of America. The myelin sheath is damaged and prevents the nerves from transmitting signals to the brain. This causes
weakness, numbness, and possibly even paralysis (Mayo Clinic, 2016). AIDP is documented using electromyography. They can depict the impulses that are blocked from activating the muscles. Nerve conduction studies are also used to show the time that it takes a nerve to respond to a signal is slowed. These tools help physicians properly diagnose AIDP in its early stages so that patients can begin therapy. There is no known cure for AIDP or GBS; however, treatment has come in the forms of plasma exchanges or intravenous immunoglobulin infusions (American Association of Neuromuscular & Electrodiagnostic Medicine, n.d).

Another example of a condition that can affect the peripheral nerves is peripheral neuropathy. This condition can result from damage to the peripheral nervous system. Symptoms of peripheral neuropathy include: numbness, tingling sensations, pricking sensations (paresthesia), or muscle weakness. In some cases, sensitivity in parts of the body may increase, and therefore, causing a distortion in sense of touch. Peripheral neuropathy disrupts the messages sent between the central nervous system, the brain and spinal cord, to the peripheral nervous system, the rest of the body (National Institute of Neurological Disorders and Stroke, 2014).

There are over one hundred types of peripheral neuropathies with the most common being diabetic neuropathy (National Institute of Neurological Disorders and Stroke, 2014). High blood sugar can injure nerve fibers throughout the body. In relation to the peripheral nerves, the damage can affect the autonomic nerves, motor nerves, and the sensory nerves. Autonomic nerve damage symptoms vary because the autonomic subsystems control and regulate various organs in the body. Common symptoms may include: heat intolerance, loss of bladder function, and decrease in control of the blood vessels that help regulate blood pressure. Symptoms of motor nerves include: muscle weakness, decreased reflexes, and muscle atrophy. Symptoms of sensory
nerve damage can be a decrease in sensation, a lack of balance, the decreasing ability to feel pain or changes in temperature, or neuropathic pain. About sixty to seventy percent of people in the United States have a mild to severe form of peripheral neuropathy. To diagnose diabetic neuropathy and peripheral neuropathies, physicians often use physical examinations, muscle strength tests, as well as evidence of cramps or fasciculation tests. Various blood tests can also confirm diabetes and may help determine the type of peripheral neuropathy. Regarding treatment for peripheral neuropathy, the first step is to treat any contributing or underlying issues such as infection, vitamin deficiency, autoimmune disorders, or toxin exposure. By doing so, the nerves may be able to recover or regenerate on their own. (National Institute of Neurological Disorders, 2014).

To summarize, the peripheral nerves are a very significant organ in the body. They help regulate many functions as well as contribute to the sense of touch and feel. By understanding how the peripheral nerves function, healthcare providers are able to understand how patients with peripheral nerve disorders or conditions feel. This will allow healthcare providers to deliver a more holistic and quality care to those patients. It allows healthcare workers to take a more holistic approach to give the best care.
References

Primary


Secondary


Appendix A: URSHSS Participation Agreement

Participation Agreement

Date: 2/3/14  
Due: February 3, 2017 @ 11:59 p.m.

Name: Mikayla Roda

Classes participating in the URHSS project include students from the Central Park Campus (CPC) Human Anatomy and Physiology II Classes taught by Professors R. Brown and R. Cravo along with students from the Health Sciences Academy (HSA) classes taught by Professors K. Newby & T. Sanchez.

Human Biological Organ(s) interested in: Peripheral Nerves

Interest in medicine or research:

Nursing

Additional information:

Style of communication/presentation preferred:

Of or powerpoint

Review Rubric criteria and grading or replacement assignment per Individual Professor.

Agreement to participate with assigned partner in the Premier Workshop: Undergraduate Research Health Sciences Symposium. I attest I will meet all requirement of the assignment and present on March 31, 2017.

Signature: Mikayla Roda Printed Name: Mikayla Leigh Roda

Email: MrOdla1@cougarmail.cwlin.edu (This will be shared with partner(s))

You will be matched with a student in another class by your Professors. Your information will be shared for contact purposes. We ask that you correspond via email, texting, or zoom. This will be a project that you can work on and from which you can grow and develop as a scholarly writer and researcher. If you have further questions, please contact your professor(s).
Participation Agreement

Date: 2/4/2017

Due: February 3, 2017 @ 11:59 p.m.

Name: Anna Le

Classes participating in the URMSS project include students from the Central Park Campus (CPC) Human Anatomy and Physiology II Classes taught by Professors R. Brown & R. Cravo along with students from the Health Sciences Academy (HSA) classes taught by Professors K. Newby & T. Sanchez

Human Biological Organ(s) interested in: Peripheral Nerves

Interest in medicine or research: The brain is interesting.

Additional information: HSA student

Style of communication/presentation preferred: Oral presentation / poster / powerpoint

Review Rubric criteria and grading or replacement assignment per individual Professor.

Agreement to participate with assigned partner in the Premier Workshop: Undergraduate Research Health Sciences Symposium. I attest I will meet all requirement of the assignment and present on March 31, 2017.

Signature: [Signature]
Printed Name: Anna Le

Email: ale21@cougarmail.collision.edu [This will be shared with partner(s)]

You will be matched with a student in another class by your Professors. Your information will be shared for contact purposes. We ask that you correspond via email, texting, or zoom. This will be a project that you can work on and from which you can grow and develop as a scholarly writer and researcher. If you have further questions, please contact your professor(s).
Appendix B: Consent Form

URHSS Consent Form

I, Anna Le, give full permission for Mikayla Rolda and Taylor Trupp to use the research collected by this group for the Symposium (URHSS) workshop project for educational purposes only. Each of the three named individuals have permission to utilize this intellectual material insofar as they each provide proper attribution to all parties involved.

Anna Le 2/19/17
Mikayla Leigh Rolda 2/16/17
Taylor Trupp 2/17/17

“We'll get on your nerves!”
Appendix C: Welcome Email to Mentor

Peripheral Nerves Project

10:37 AM (22 hours ago)  
Anne Le ale21@cougarmail.collin.edu  
to trupp1, knewby, mrolia, tcravo, bcc: Ale21

Hello Taylor Trupp,

Thank you for being our mentor for the Symposium (UR/65S) workshop project! We are glad that you will be helping and guiding us. My name is Anna Le and my partner’s name is Mikayla Rolida. We are students in the Health Science Academy at Plano East Senior High School.

Our project will be about the peripheral nerves, its function, and how injury might affect it. We are currently working on a bibliography and our project proposal. Attached below is a consent form that we need you to sign.

Once again, thank you so much for choosing to be a mentor! I will email you later this week to send our bibliography and proposal for approval.

Best Regards,
Anna Le and Mikayla Rolida

Taylor Trupp

10:42 AM (22 hours ago)  
to me

H, Anna,

I am excited to help with this project. I will sign what you need and send it back asap. Im really looking forward to working with both of you. Let me know what you may need and when we can meet or connect to get the details down.

Taylor

On Feb 8, 2017 10:37 AM, “Anna Le” <ale21@cougarmail.collin.edu> wrote:  
Mentor Taylor Trupp
Appendix D: Project Proposal Outline

Mode of Delivery

We will be presenting our project through an oral presentation with visual aids. We will be creating a poster and a PowerPoint to display diagrams and pictures to support our information.

Role Division and Responsibility Delegation

We, Mikayla and Anna, will both be responsible for researching as much as we can in regards to the peripheral nerves. Both of us will collaborate and approve each member's responsibility.

Anna will be responsible for organizing the oral presentation. This includes creating a cohesive presentation (introduction, information, and conclusion) and making sure it is well rehearsed.

Mikayla will be responsible for creating and consolidating the information gathered into a visually appealing PowerPoint and poster. This includes determining what information is necessary and significant to include in the presentation.

Draft Presentation

Introduction

- Introduce name/title
- Give a relatable example to tie into peripheral nerves – anecdote

Main Presentation

- Define peripheral nerves
- Describe structure
- State function
● Explain significance

● Expand on how the peripheral nerves work in conjunction with other organs/systems

Conclusion

● Restate significance

● Summary of presentation
Appendix E: Project Proposal

Mode of Delivery

Mikayla and Anna will be presenting their researched information through an oral presentation with visual aids. These visual aids will include creating a poster and a PowerPoint to display the diagrams and pictures that will support the information of the presentation.

Role Division

Mikayla and Anna will both be responsible for the research of the information regarding the peripheral nerves. Both members will collaborate equally and monitor each member’s responsibilities.

Anna will be responsible for organizing the oral presentation. This includes creating a cohesive presentation, which will include an introduction and conclusion, and making sure it is well rehearsed.

Mikayla will be responsible for creating and consolidating the information gathered into a visually appealing PowerPoint and poster. This includes determining what information is necessary and significant to the presentation.

Taylor, mentor to the members of the project, will supervise and help review the research and documentation for the project.

Draft Presentation

The presentation will be introduced with an example that then advances on to the topic of the peripheral nerves. This may be, but is not limited to, an anecdote or an interesting fact in order to make the topic seem more relatable to the audience. Mikayla and Anna will then formally introduce themselves and their topic.

The main presentation will then continue on with defining the peripheral nerves’
function. Mikayla and Anna will expand on the peripheral nerves’ location and its significance, as well as clarify and explain the structure of the peripheral nerves parts. They will then connect the peripheral nervous system to the rest of the body, such as how it relates to the central nervous system or the musculoskeletal system. This will also help support the information regarding the importance of the peripheral nerves.

Mikayla and Anna will then restate the significances of the peripheral nerves. They will also describe how the peripheral nerves help people and directly affect their daily activities. This includes reporting the consequence of a change to the peripheral nervous system. In the end, Mikayla and Anna will re-summarize, but highlight the important parts of the presentation as the conclusion.

Appendix F: Annotated Bibliography

These certain pages of the article explained how motor function relates to the peripheral nerves. The motor functions are one of the major systems of the body that intertwines with the peripheral nervous system. We can use the information given to explain the significance and functions of the peripheral nervous system.

Fisher, J. P., & Paton, J. F. R. (2012). The sympathetic nervous system and blood pressure in humans: implications for hypertension. *Journal of Human Hypertension*, 26(8), 463-475. The sympathetic nervous system is one of three systems that make up the peripheral nervous system. Having information on how the sympathetic nervous system can connect to the rest of the body can help explain the role the peripheral nervous system plays in the human body. In this particular article the author connects the sympathetic nervous system to blood pressure. Blood pressure is an important comparison because blood pressure related issues are extremely common among humans.

Goedee, H. S., Brekelmans, G. J. F., Asseldonk, J. T. H., Beekman, R., Mess, W. H., & Visser, L. H. (2013). High resolution sonography in the evaluation of the peripheral nervous system in polyneuropathy—a review of the literature. *European Journal of Neurology*, 20(10), 1342-1351. This article contains sonographic images of the peripheral nervous system, which includes the peripheral nerves. This can help explain the structure of the peripheral nerves in relation to other parts of the body, where they are located, and the significance of the peripheral nerves.

This article describes an issue of nerve pain among many Americans and their causes. It also describes a possible solution using gene therapy to reduce issues related to nerve pain. This article will help explain the effects damaged nerves cause the human body and possibly the nerves structure.


This article contains information regarding stress and how it affects the autonomic nervous system. This may help to explain the function of the peripheral nerves. It will also help to explain the effects change has on the peripheral nerves.


Infections such as HIV or rabies can have detrimental effects on the peripheral nerves and the nervous system. These effects will help to explain the significance of the peripheral nerves and their structure.


This article describes an experiment that was performed involving a natural polymer produced by bacteria to create material that would help repair damaged peripheral nerves. This research would help explain the effects damaged peripheral nerves have on the rest of the body as well as give realistic solutions to those effects.

This article discusses the neuron’s generation and compares the neuron’s generation between the central nervous system and peripheral nervous system. The neurons are what essentially differentiate the nervous systems from the rest of the body and the neuron’s “bridge” between the other neurons; this is called the axon. The loss of an axon in the peripheral nervous system can regenerate, while an axon in the central nervous system is not expected to recover. The differences between the central nervous system and peripheral nervous system can help add to the research of the peripheral nervous system and how the two systems can depend on each other in order for the body to function properly.


The aging population and the increasing level of mobility issues have become one of the largest issues during the twenty-first century, and the authors of this article linked the elderly population’s immobility to the central nervous system. As our medicine improves so does longevity, but the elderly’s immobility has become a hurdle to the modern working society and the authors want to explain a way to subdue this hurdle. Although the central nervous system is not the main topic of the article the central nervous system is a major sister-system to the peripheral nervous system, and learning about the central nervous system is important for our research about the peripheral nervous system.


A study was done to look at the relation between the autonomic nervous system and heart rate variability in workers. This topic of study was specifically researched to compare those with heavy mining experience and those who did not have any mining exposure. This can be used to help explain the environmental effects on the peripheral nerves and the relation of the peripheral nerves to other functions of the organs of the body.
Appendix G: Change Log

[Unreleased]
#Changed
  - Grammatical edits in first paragraph
  - Grammatical edits in last paragraph
#Added
  - Added in-text citations according to references

[1.0.0] 2017-01-03
#Changed
  - Sentence structure in first paragraph
  - Sentence structure in last paragraph
  - Grammatical edits in last paragraph

[1.0.1] 2017-13-03
#Changed
  - Font for header
  - Font size for header
  - Formatting for page 6
  - Titles for appendices
#Added
  - Appendix G: Change Log
  - Appendix C: Welcome email to mentor

[1.0.2] 2017-15-03
#Changed
  - Edited the abstract and research paper

[1.0.3] 2017-16-03
#Changed
  - Formatting of annotated bibliography
  - Grammatical issues in main research

[1.1] 2017-30-03
#Added
  - Multiple sclerosis (MS) paragraph
  - More information about peripheral neuropathy