Peripheral Nerve Histology

SUMMARY

NERVE VS NERVE FIBERS (AXONS)

• A peripheral nerve encompasses bundles of nerve fibers (axons) and has various connective tissue coverings (superficial epineurium, perineurium, and endoneurium).

NERVE COVERINGS

Outside to Inside:

Superficial epineurium

• Superficial epineurium is the outer covering of the nerve.

• It is a supporting coat: a cylindrical, dense connective tissue sheath.

Perineurium

• Perineurium encases separate nerve fascicles.

• It is a mechanically strong sheath that is dense and forms a protective barrier around the nerve fascicle: a blood-nerve barrier.

• Perineurium comprises a flattened form of epithelial cells that are joined by special junctions, which helps it withstand tremendous pressure.

Endoneurium

• Endoneurium is a loose connective tissue; it comprises collagenous fibers.

Additional, less often addressed terminology:

Deep epineurium

• Deep epineurium accounts for the connective tissue sandwiched between the nerve fascicles.

• We find vasculature in this region.

Perineurial septa

• Perineurial septa pass through the nerve fascicles and carry vasculature to the nerve fibers.

NERVE FIBERS (AXONS)

• The nerve fiber is the nerve cell axon.

• Myelin sheath surrounds myelinated axons.

• Schwann cells: each myelinates at most one axon internode.

MYELIN

Unmyelinated cell

In an unmyelinated cell, we see:

• The Schwann cell nucleus intermixed with axons within Schwann cell cytoplasm.

• The mesaxon is the zone of apposition for the Schwann cell membrane and the axon.

• Multiple axons can pass through a Schwann cell, when the nerve fiber is unmyelinated.

Myelinated cell

In a myelinated cell, we see:

• The Schwann cell nucleus lies off to the side of the axon, which is enveloped in concentric circles of myelin: a myelinated sheath.

Schwann cells vs oligodendrocytes

• Unlike oligodendrocytes, which can myelinate up to 50 individual axons, a Schwann cell only myelinates one axon, as shown here (specifically only one peripheral nervous system internode).

DORSAL ROOT GANGLION

We highlight the following:

• Ganglion cell

• Cell nucleus

• Surrounding satellite cells (which support the ganglionic neurons).

- Satellite cells are derived from neural crest cells in the same way that Schwann cells are.

PERIPHERAL NERVE IN LONGITUDINAL VIEW

We highlight the following:

• Schwann cells

• Myelin sheath

- The myelin sheath is vacuolated because its high lipid content creates this artifact upon paraffin embedding.

• Deep stained nerve fibers (axons).

Clinical Correlation

• Neuropathy

Related Tutorials

• Polyneuropathies: Histopathology & Common Etiologies

• Polyneuropathies: Charcot-Marie-Tooth & Diagnostic Testing

FULL-LENGTH TEXT

NERVE COVERINGS

Overview

• Here, we'll learn the histology of the peripheral nerves.

• To begin, let's draw a cross-section of a peripheral nerve.

Superficial Epineurium

• First, draw the outer covering of the nerve: the superficial epineurium.

Perineurium

• Within the nerve cross-section, draw two separate nerve fascicles, which are are encased in perineurium, which is a

mechanically strong sheath that is dense and forms a protective barrier around the nerve fascicle: a blood-nerve barrier.

Endoneurium

• Then, immediately internal to it, draw the endoneurium, which is a loose connective tissue; intermixed in the endoneurium, draw various groups of nerve fibers.

Nerve fiber (axon)

• Indicate the nerve fiber axon.

Myelin

• Then draw the myelin sheath that surrounds myelinated axons.

Schwann cell

• Then, include a Schwann cell, each of which myelinates at most one axon internode.

Additional Terminology

Deep epineurium

• First, specify the deep epineurium, which accounts for the connective tissue sandwiched between the nerve fascicles.

• Add a representative artery and vein to this region.

Perineurial septa

• Then, draw perineurial septa, which pass through the nerve fascicles and carry vasculature to the nerve fibers.

HISTOLOGY

Now, let's look at these histological features in actual slides.

• In one slide, stained with H&E, we see two nerve fascicles.

• On the other, a darkly stained section (stained with osmium tetroxide), one see one major nerve fascicle.

• On the H&E slide, label the perineurium of one of them; we see that it comprises a flattened form of epithelial cells.

- They are joined by special junctions, which helps it withstand tremendous pressure.

• And label its endoneurium, which mainly comprises collagenous fibers.

• Then, label the superficial epineurium, which is a supporting coat: a cylindrical, dense connective tissue sheath.

• And the deep epineurium that lies between the fascicles.

• Label its perineurium.

• Then, the endoneurium.

• Next, the peineurial septa, which pass through the nerve fascicle.

• Next, label the surrounding superficial epineurium.

• Then, the deep epineurium.

MYELINATION

Now, let's address Schwann cells and show how they myelinate cells.

Unmyelinated cell

• Draw the Schwann cell nucleus.

• Then, draw a few axons.

• Now, surround the nucleus and axons in the Schwann cell cytoplasm.

• Indicate mesaxon for the zone of apposition for the Schwann cell membrane and the axon.

• Importantly, we show that multiple axons can pass through a Schwann cell, when the nerve fiber is unmyelinated.

Myelinated cell

• Next, draw the cytoplasm of another Schwann cell.

• Then, draw an axon.

• Show that it's enveloped in concentric circles of myelin – a myelinated sheath.

• Draw its nucleus off to the side.

Schwann cells vs oligodendrocytes

• Unlike oligodendrocytes, which can myelinate up to 50 individual axons, a Schwann cell only myelinates one axon, as shown here (specifically only one peripheral nervous system internode).

MYELIN HISTOLOGY

Let's look at a higher magnification section of our osmium tetroxide stained slide.

• Point out a typical, black staining myelin sheath.

DORSAL ROOT GANGLION

Now, let's look at a dorsal root ganglion.

• Identify a ganglion cell.

• Then, the nucleus.

• Then, the surrounding satellite cells, which support the ganglionic neurons.

- We show them, now, because they are derived from neural crest cells in the same way that Schwann cells are.

LONGITUDINAL VIEW OF A PERIPHERAL NERVE

Finally, let's examine two slides of a peripheral nerve in longitudinal view.

• Label a Schwann cell in each slide, then show myelin sheath, which is vacuolated because its high lipid content creates this artifact upon paraffin embedding.

• Then, label deep stained nerve fibers.

SENSORY RECEPTORS

This information is not within the present tutorial but is available, here:

- Sensory Receptors

OVERVIEW

Major Sensory Receptor Types
*There are six major forms of sensory receptors (*from superficial to deep*):

- Free nerve endings

- Merkel cells

- Meissner corpuscles

- Ruffini corpuscles & Krause end bulbs

- Pacinian corpuscles

Major Classes of Sensory Receptors

• There are three major classes of sensory receptors:

- Mechanoreceptors detect mechanical deformation

- Nociceptors detect pain

- Thermoreceptors detect temperature

SENSORY RECEPTORS BY LOCATION WITHIN THE SKIN

EPIDERMIS

Free nerve endings

• Unmyelinated nerve endings.

• Detect pain and temperature.

BASAL EPIDERMIS

Merkel cells

• Discs at the ends of unencapsulated nerve fibers.

• Detect tactile sensation: light touch/hair movement.

SUPERFICIAL DERMIS

Meissner corpuscles (aka tactile corpuscles)

• Elliptical shaped.

• Lie perpendicular to the epidermis, within the dermal papillae.

• Detect light touch; hence, "tactile corpuscle".

DERMIS

Ruffini corpuscles

• Detect pressure.

Krause end bulbs

• Detect pressure and low-frequency vibration.

DEEP DERMIS & HYPODERMIS

Pacinian corpuscles (aka lamellated corpuscles)

• Pacinian corpuscles are large and oval-shaped with a very characteristic concentric, lamellated histological appearance.

• They are encapsulated mechanoreceptors that detect touch, pressure, vibration.

- Capsule distortion works to amplify the signal of a mechanical stimulus.

HISTOLOGICAL IMAGES

Histological images modified with permission from:

• http://medsci.indiana.edu/a215/virtualscope/docs/chap6_3.htm

• http://medsci.indiana.edu/c602web/602/c602web/toc.htm

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DRAWING HIGHLIGHT

Assess your knowledge with this Peripheral Nerve Anatomy drawing highlight.