MODULE 2: HISTOLOGY II

Muscle and Nervous Tissue

Muscle Tissue

General Characteristics of Muscle

- Elongated cells in direction of contraction
- Appearance depends on direction of cut (longitudinal or cross section)

General Functions of Muscle

- Contracts in response to a stimulus to generate movement
  - Movement of one part with respect to another
  - Movement of materials through the body
  - Movement of the body through space (locomotion)

Skeletal Muscle

A. Skeletal muscle makes up the majority of the tissue that we think of when we think of muscles. It is under voluntary control and is located throughout the body. Skeletal muscle is generally attached to bones by tendons and uses these bones as levers to accomplish work. However, not all skeletal muscle is anchored to bones. Some, like those in the face, are attached to fibrous connective tissue. Skeletal muscle occurs in bundles. Each skeletal muscle cell or fiber is elongated and has multiple nuclei that are located on the periphery of the cell. The cells are very large and can be several centimeters long, often running the entire length of the muscle (*note: when referring to muscles we use the terms cell and fiber interchangeably. This is not to be confused with the fibers found in the matrix of connective tissue*). Skeletal muscle is also striated with alternating light and dark bands running the entire length of the cell. These striations are caused by the regular overlapping arrangement of the muscle proteins, actin and myosin. The dark band is called the "**A Band**" and the light band is the "**I Band.**" If you look carefully, you will be able to identify a very thin, dark line running down the middle of the "I Band." This represents the backbone of the actin molecule and is called the "**Z-disk**".

When we look at skeletal muscle in cross section, we see that individual skeletal muscle fibers are surrounded by a thin layer of loose fibrous (areolar) connective tissue, the **endomysium**. Furthermore, we see that the muscle fibers are not uniformly distributed throughout the muscle; rather, they are grouped into bundles called **fasciculi** with each **fasciculus** likewise surrounded by "heavier" connective tissue, the **perimysium**. Finally,

the entire muscle is surrounded by a sheath of dense fibrous connective tissue, the **epimysium**. The large collagen fibers in the epimysium are continuous with those of the tendon that attaches the muscle to bone. Your biceps, for example, is composed of many fasciculi bundled together with each fasciculus being composed of many muscle fibers.

Smooth Muscle

A. Smooth muscle is an involuntary, non-striated muscle that is found in the walls of hollow organs like arteries, veins, the stomach, the small and large intestines, the uterus, uterine tubes, the urinary and the gall bladders just to name few. Smooth muscle cells are fusiform in shape (football shaped). Each muscle cell contains one centrally located, cigar-shaped nucleus. The cells are arranged side by side in sheet-like layers. The muscle cells are much smaller than skeletal muscle fibers and are woven together to form the sheet-like layers. Most of the digestive tract—with the exception of the stomach—has smooth muscle arranged in two layers: an **inner circular** and an **outer longitudinal** layer. The stomach has *three* layers of smooth muscle in its walls.

Cardiac Muscle

A. Cardiac muscle is found only in the heart. Like smooth muscle, cardiac muscle is involuntary; however, unlike smooth-muscle, cardiac muscle is striated. The muscle fibers resemble skeletal muscle, with the following exceptions: the cells are branched, they have a single, oval, centrally located nucleus and the striations are not as pronounced. Additionally, the muscle fibers are shorter and thus are connected end-to-end. At the points of connection there are specializations called **intercalated discs** that both hold the cells together with desmosomes and allow communication between the cells via gap junctions. Under the microscope, the intercalated discs look like very pronounced striations.

List of Terms

Spend as much time as you need reviewing Muscle Tissues and structures. The most important thing will be for you to practice identifying all of the structures listed in the table below. Use your online resources, open lab, and any other tool that you have to become confident in your identification skills. Your exam will ask you to identify and then write in (Fill in the Blank) the correct term for your identification. The table below is a comprehensive list of all the terms from this section that we would consider asking about on an exam.

List of Terms for Muscle Tissue

Skeletal Muscle - Longitudinal Section

Skeletal Muscle - Cross Section

- **Striations**
- **Sarcomere**
  - **A-band**
  - **I-band**
  - **Z disc**
- **Endomysium**
- **Perimysium**
  - **Fasciculi (F*asciculus*, singular)**
- **Epimysium**

Smooth Muscle - Longitudinal Section

Smooth Muscle - Cross Section

Cardiac Muscle - Longitudinal Section

- **Intercalated Discs**
- **Striations**

Cardiac Muscle - Cross Section

Nervous Tissue

General Characteristics and Functions of Nervous Tissue

- Composed of neurons and neuroglial cells
- Main function is to transmit and process information
- Divided into two major components
  - Central Nervous System: composed of the brain and spinal cord
  - Peripheral Nervous System: composed of nerves and ganglia

Overview of the Nervous System

The nervous system is uniquely designed for gathering, transmitting, processing and storing information. It controls voluntary as well as most involuntary functions. The nervous system is divided into two major components. The Central Nervous System (CNS) includes the brain and spinal cord and the Peripheral Nervous System (PNS) contains those structures outside of the brain and spinal cord, namely nerves and ganglia. Two classes of cells are found in the nervous system: neurons, which transmit the nerve impulses; and neuroglial cells, which carry out support functions in the nervous system. Most neurons have three parts: the soma, the axon and the dendrites. The soma (or neuron cell body) houses the nucleus of the cell and most of the other organelles**.** In the CNS, soma are usually found in gray matter, whereas in the PNS, they are located in discrete clusters called ganglia. In addition to the soma, neurons possess two types of processes: axons and dendrites. Dendrites are short, branched processes designed to transmit information toward the soma (incoming signals). Typical neurons have many dendrites which are found in the same locations as the soma. Axons are processes that carry information away from the soma (outgoing signals). A neuron typically has a single axon that, in some cases, can be as long as a meter. Axons in the CNS are located in the white matter; axons in the PNS are the principle component of nerves. Specialized neuroglial cells in the CNS (oligodendrocytes) and PNS (Schwann cells) wrap themselves around the axon producing a coating called the myelin sheath that can run the entire length of the axon. Each Schwann cell can produce a segment of myelin sheath that will cover about 1

millimeter of the axon. Between each segment of the myelin sheath is a small un-myelinated gap called a node of Ranvier.

Spinal Cord

A. In the spinal cord smear, we can see neuron cell bodies. In these slides, gray matter from the spinal cord is literally smeared across the microscope slide disrupting the normal histology of the gray matter. This process, however, allows us to see the large, multi-shaped **neuron cell bodies** or **soma**. **Axons** and **dendrites** can be observed attached to the cell body, but there is really no reliable way to determine which is an axon and which is a dendrite. In the background, you will see many small, dark nuclei. These are the nuclei of the various **neuroglial cells**.

B. Under low magnification the entire cross section of the spinal cord can be observed. It looks like a large circle with an "H" or butterfly shaped structure in its center**.** The "H" is the **gray matter** and, therefore, contains neuron cell bodies. The lighter colored tissue around the gray matter is the **white matter**, containing axons that run up and down the spinal cord. Two grooves divide the spinal cord into right and left sides. These are the **anterior median fissure** and the **posterior median sulcus**. In the very center of the spinal cord is a small, fluid filled open space called the **central canal**. The gray matter around the central canal is the **gray commissure** which connects the right and left sides. The rest of the gray matter is subdivided into three horns: the right and left **ventral, dorsal** and **lateral horns**. The white matter is subdivided into columns, the right and left **ventral, dorsal** and **lateral columns**. If you have a good preparation, you will be able to see a **dorsal root ganglion** which is actually a cluster of **soma** in the PNS**.** It can be seen just lateral to the spinal cord.

Higher magnification of the ventral horn of the gray matter will reveal the large neuron cell bodies of the motor neurons that originate in this tissue. White matter under high magnification reveals tissue composed of small, clear circles with dark dots in the center (kind of like a doughnut). The dark dots are **axons** and the clear area around the axon is the **myelin sheath**.

Peripheral Nerve

A. In longitudinal sections, a peripheral nerve has a unique appearance. At first it may look very nondescript, but on closer observation you will be able to see a **node of Ranvier**. It will look something like a "+" sign. The horizontal line is an axon and the vertical line is a node of Ranvier. Once you have located a node, you should be able to make out the myelin sheath on either side of the node. A nerve is composed entirely of axons surrounded by layers of connective tissue.

In cross section, nerves look somewhat like white matter of the spinal cord—that is, dark dots with light circles around them. Again, the dots are axons and the lighter circles are the myelin sheath. If we observe this tissue under low magnification, we see that nerves are arranged somewhat like skeletal muscle; that is, groups of axons are bundled into **fasciculi** and each nerve is composed of many fasciculi**.** Also, like skeletal muscle, these structures are surrounded by connective tissue layers. Individual axons are surrounded by the **endoneurium**, fasciculi are surrounded by **perineurium** and the entire nerve is surrounded by **epineurium**.

List of Terms

Spend as much time as you need reviewing Nerve Tissues and structures. The most important thing will be for you to practice identifying all of the structures listed in the table below. Use your online resources, open lab, and any other tool that you have to become confident in your identification skills. Your exam will ask you to identify and then write in (Fill in the Blank) the correct term for your identification. The table below is a comprehensive list of all the terms from this section that we would consider asking about on an exam.

List of Terms for Nerve Tissue

Neuron

- **Soma (Cell Body)**
- **Axon**
- **Dendrite**

Spinal Cord

- **Gray Matter**
- **White Matter**
- **Central Canal**
- **Ventral Horn**
- **Dorsal Horn**
- **Lateral Horn**
- **Gray Commissure**
- **Ventral Column**
- **Dorsal Column**
- **Lateral Column**
- **Anterior Median Fissure**
- **Posterior Median Sulcus**
- **Dorsal Root Ganglion**

Identify a Spinal Cord smear and each of the structures below in this smear:

- **Soma**
- **Neuroglial Cell Nuclei**
- **Axons And Dendrites**

Peripheral Nerve - Longitudinal Section

- **Node of Ranvier**
- **Axon**
- **Myelin Sheath**

Peripheral Nerve - Cross Section

- **Endoneurium**
- **Perineurium**
- **Epineurium**