VS002 Animal Tissues

MAIN IDEA: What are the four types of tissues and how can a displaced abomasum be repaired?

In AgEdNet.com lesson VS001 Animal Cells, you examined the basic unit of life -- the cell. Cells develop specialized structure and function. Collections of similar cells organize for particular functions into tissue. Collections of tissues work together to create a coordinated function in the form of organs. Mammals have four basic tissue types: 1) epithelial, 2) connective, 3) muscle and 4) nerve.

VETERINARIAN'S LOG:

Today was a beautiful day in early June. The farmers were busy making hay and planting the last of their crops. On hectic days like this, the last thing a farmer wants to do is to call the veterinarian. But sometimes, the farmer just does not have a choice. The welfare of their cattle still takes priority despite the pressures of spring planting. I received a call from a farmer who had a cow that was not doing well. Upon examination, I diagnosed a displaced abomasum.

Cows have four stomach chambers. The fourth one is the abomasum. A displaced abomasum (DA) is a common circumstance in dairy cows, often occurring shortly after a calf has been born. This condition is commonly called a twisted stomach. In this disease, the stomach fills with gas and is pulled upwards. Instead of lying in the normal positioning at the bottom of the abdomen, gas pulls the abomasum up toward the side. Cows with this problem do not eat well, and therefore are not very productive.

Several procedures exist to correct a displaced abomasum. The simplest procedure is to roll the cow. In this process, the gas that pulls the stomach upwards is used to pull it back into place by rolling the cow from her right side to her left. This procedure is often effective at correcting the problem, but will not keep the stomach in place. Recurrence of a displaced abomasum (DA) in which the stomach once again is pulled upwards is common after this technique. This works the best in a cow that has other problems that need to be corrected at the same time, such as an infected uterus.

Another technique involves rolling the cow onto her back. Once in this position, the stomach is sutured (stitched) to the body wall inside of the cow. Again the gas in the stomach is used to hold the stomach against the body wall. Either a large needle or a trocar is used to place suture material into the abomasum. A trocar is a metal tube over a sharp metal rod. The success rate for this procedure is higher than for the simple rolling technique, and it is relatively quick to perform. The disadvantage of this procedure is that the exact location of the attachment to the stomach cannot be determined.

Several surgical methods are available to correct a DA as well. The method that I most commonly use requires a surgical approach into the lower part of the abdomen. I make an incision into the cow's abdomen in order to identify all the areas of the abomasum. This is the most time-consuming of the procedures discussed here and is also the most expensive. But in my experience, surgery has the highest success rate. The farmer chose this surgical method for this cow.

With the farmer's help, I rolled the cow onto her back and tied her to a gate. I then used a local anesthetic prior to making an incision into the cow's abdomen. The local anesthetic numbed only the part of the cow's body where I would be operating. The abomasum was then sutured to the body wall and the incision was closed. Once this procedure has been performed, a cow will not have

another DA. The internal sutures in the cow's stomach will keep the stomach fastened securely in place.

Knowledge of tissues affects my everyday life as a veterinarian. In this surgery, I had to know what tissues I would encounter along with their properties and functions. For example, I needed to know about nervous tissue in order to use anesthetic to eliminate any pain for the cow during the operation. Moreover, my surgical incision passed through epithelial, connective and muscle tissues. Each of these tissue layers required special handling procedures.

TYPES OF TISSUES

There are four main kinds of tissue in a mammal's body: epithelial, connective, muscular, and nervous. Each will be described in detail below.

1. Epithelial tissue:

Epithelial tissues are collections of cells packed together in sheets. These sheets line the body's surface and openings. These tissues also cover all of the openings of the intestinal, reproductive and urinary tracts. In addition, they line tubes in the body, such as blood vessels and the heart.

Epithelial tissues perform multiple functions. Skin is an example of an organ mostly comprised of epithelial tissue. Skin protects the body from trauma, the sun's ultraviolet light, extremes of temperature, drying and bacterial invasion. The cells lining the respiratory, intestinal, urinary and reproductive tracts also provide protection.

Along with keeping unwanted substances from entering the body, the epithelial cells also conserve materials within the body. These cells help to prevent excessive loss of fluid and nutrients from an animal's body.

Every epithelial lining has an underlying layer of connective tissue. The skin itself has no direct blood supply. Therefore, the connective tissue not only provides support, but also provides the blood supply that delivers nutrients and removes waste products.

The skin consists of the outside epidermis layer and the underlying dermis layer. The epidermis is made up of many layers of flat cells. The cells originate from the basal or innermost layer and move outward. The outermost cells of the epidermis are dead and continually shed from the surface. These shed cells are replaced by mitosis (cell division) at the innermost basal layer. The dermis is a connective tissue layer that contains blood vessels, nerves and glands. Beneath the epidermis and dermis is another layer of connective tissue, called the hypodermis. The hypodermis supports these two layers which make up the actual skin.

2. Connective tissue:

There are several types of connective tissues. These tissues are made up of specialized cells embedded in large amounts of extracellular material called a matrix. The matrix is different in all of the different kinds of connective tissues. The matrix ranges from the liquid found in blood, to the flexible fibrous material in tendons, to the solid material of bone.

Connective tissues support organs and hold tissues together. For example, connective tissue holds muscles together and attaches the skin to underlying tissues. This type of tissue quite obviously appeared in the DA surgery discussed at the beginning of the lesson. After opening the skin, the

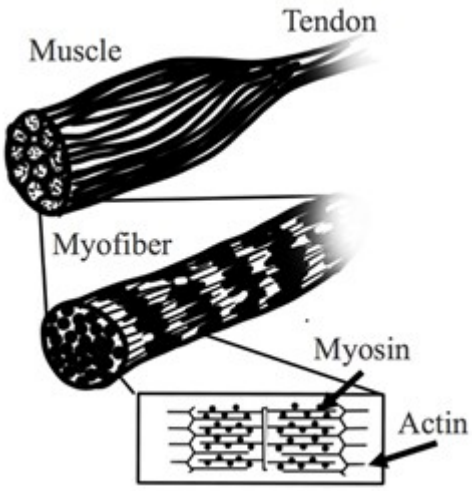
connective tissue layers were encountered next. The connective tissue layers included adipose tissue (fat) deposits. Adipose tissue, another form of connective tissue, consists of cells filled with lipids (fatty acids).

Bone, cartilage, tendons and ligaments are all forms of connective tissue. These are all combined to form the skeleton. By interacting with muscle, motion is possible.

- Bone is the hard, whitish tissue making up the skeleton in vertebrate animals.
- Cartilage is a strong, elastic type of tissue found in the joints and other places such as the nose, throat and ears.
- A tendon is connective tissue attaching muscle to bone.
- A ligament is a connective tissue attaching bone to bone.

Blood is also a specialized form of connective tissue. Blood supplies nutrients to the tissues. During surgery, the veterinarian must be constantly aware of the blood supply and try to minimize any loss of blood.

3. Muscular tissue:



Muscles allow mammals to move. Three muscle types exist in mammals: 1) skeletal, 2) smooth and 3) cardiac. Skeletal muscle attaches to the skeleton and causes motion. Skeletal muscle is voluntary muscle, which an animal can voluntarily choose to contract. Smooth muscle, which is involuntary muscle, is located in many of the hollow organs of the body including the gastrointestinal tract, urinary bladder, and blood vessels. Smooth muscle contracts and relaxes without conscious control from the brain. The third type, the cardiac muscle, is found in the heart. Cardiac muscle is also an involuntary muscle.

A muscle consists of thousands of muscle fibers, or individual muscle cells. An entire muscle cell is called a myofiber. Myofibers have several nuclei and a large number of mitochondria. This is why muscle tissue is often darker than other kinds of tissue. Myofibers are separated by connective tissue that includes blood vessels and nerves.

The ability of a muscle fiber to contract comes from a very complicated system. Each fiber (muscle cell) contains large amounts of two key protein filaments: actin and myosin. During contraction, the actin and myosin protein filaments slide along each other. This shortens the length of each myofiber. This is possible because each myosin protein filament has tiny molecular 'heads' that can move along the actin protein filaments (similar to how your forefinger and middle finger can 'walk' along a tabletop), pulling on them and causing the actin to overlap with the myosin filaments.

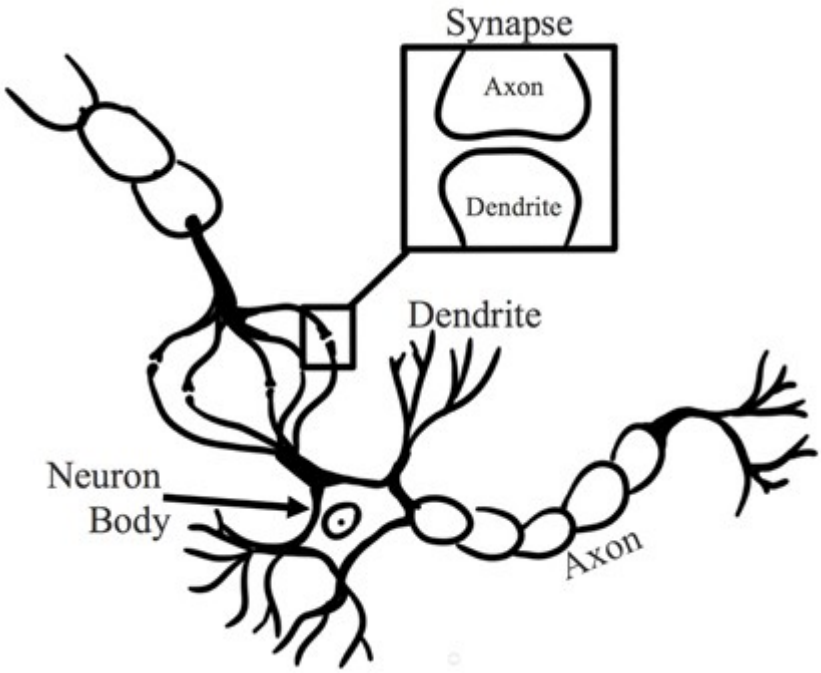
When the muscle relaxes, the myosin molecular heads detach from the actin, causing the actin and myosin proteins to move in the opposite direction away from the myosin. This causes each myofiber to lengthen.

The contraction of a muscle fiber begins outside of the muscle cells with an electrical signal from the brain. This nerve impulse travels to an adjacent nerve cell. The traveling nerve impulse stimulates the release of calcium that is stored inside the muscle cell. This flow of calcium ions enables the

heads to "walk" along the actin filaments, causing these filaments to slide across each other. This shortens the length of each myofiber.

Chemical energy in the form of adenosine triphosphate (ATP) is required for this entire process. The large number of mitochondria is present to supply the needed chemical energy. During relaxation, the cell actively transports calcium back into cellular storage. This process also requires energy.

4. Nervous tissue:



An animal's nerves enable communication between the brain and other areas of the body using electrical signals called impulses. Nervous tissue is primarily found in the brain and spinal cord. Together, the brain and spinal cord are called the central nervous system. In addition, nerves extend from these areas to other locations. The nerves outside of the brain and spinal cord are called the peripheral nervous system.

Nervous tissue contains cells called neurons. Neurons can sometimes be very large cells. Each neuronal cell consists of a body with hair-like extensions creating a squid-like appearance. The body of the neuron houses the nucleus and many other organelles. The axon is a hair-like extension that extends from the cell body. The axon carries the nerve impulse (the electrical signal) to other neurons or to other tissues (like muscles). The axons from many neurons bundle together to form a nerve. The axon can be very long. In a horse, for example, some axons may be over two meters long. The neuron has other extensions called dendrites.

While an axon is an extension that carries an impulse from the neuron, a dendrite is an extension that receives a signal from other cells and carries it towards the neuronal body. An axon often ends on the dendrite of another neuron. There is a tiny gap between where the axon and dendrite meet called a synapse. An axon sends chemical signals across this tiny gap to stimulate the dendrite. When stimulated, the dendrite begins the nerve impulse and the process continues from neuron to neuron until the signal reaches its destination.

There are three types of nerve cells. Motor neurons cause an action, such as a muscle contraction. Interneurons communicate between neurons. Sensory neurons have receptors that detect changes in the animal's environment. Sensory neurons are responsible for detecting pain.

CLINICAL PRACTICE:

The first step in the DA surgery is to administer a local anesthetic to eliminate any pain for the cow. The anesthetic prevents the sensory neurons from communicating with the rest of the nervous

system. The skin is then incised (cut) to expose the underlying connective tissue. This connective layer includes fat as well as very strong sheets of connective tissue that support the abdomen. Cutting through that layer exposes a layer of muscle that also supports the abdomen. Finally another layer of connective tissue is cut to open the abdominal cavity. All four tissue types are involved in the displaced abomasum surgery.

The abomasum is sutured to the innermost layer of connective tissue. This will provide the scar that will hold the stomach in place permanently. The layer of muscle is not sutured. Adding sutures in this layer would not improve the strength of the incision. The next layer of connective tissue is also sutured. This layer is very strong. Finally the skin is sutured to complete the surgery.

VS002 Animal Tissues – Exercise 3

Your assignment: Complete this worksheet to review key concepts from the lesson.

1. The basic unit of life is the _____cell_____ . Collections of similar cells organize into _____tissue_____ . Collections of tissue form _____of organs_____ .

2. A _____displaced_____ _____abomasum_____ (DA) is commonly called a twisted _____stomach_____ .

3. _____Epithelial_____ tissues are collections of cells packed together in sheets. These sheets line the body's _____surface_____ and _____openings_____ . They also cover all of the openings of the _____intestinal_____ , _____reproductive_____ and _____urinary_____ tracts and line the tubes of the body, such as blood _____vessels_____ and the _____heart_____.

4. _____Skin_____ is the epithelial tissue protecting the body from _____trauma_____ , the sun's ultraviolet light, _____temperature_____ extremes, drying and _____bacterial_____ invasion.

5. _____Connective_____ tissues are made up of specialized cells embedded in large amounts of extracellular material called a_____matrix_____ .

6. Connective tissues support _____organs_____ and hold tissues together.

Identify these kinds of connective tissues:

a. Fat cells filled with lipids:

b. Hard, whitish tissue making up the skeleton in vertebrate animals:

c: A strong, elastic type of tissue found in the joints and in the ears:

d. A connective tissue attaching muscle to bone:

e. A connective tissue attaching bone to bone

f. A specialized form of connective tissue supplying nutrients to the tissues:

7. _____Muscular_____ tissues allow mammals to move.

8. _____Skeletal_____ muscle attaches to the skeleton and causes motion. It is a _____voluntary_____ muscle, which an animal can choose to contract.

9. _____Smooth_____ muscle is located in many of the hollow _____organs_____ of the body. It is _____important_____ because it contracts and relaxes without conscious control from the _____brain_____ .

10. _____cardiac_____ muscle is found in the heart and is also an _____involuntary_____ muscle.

11. _____Nervous_____ tissues found in the brain and _____spinal_____ cord are called the _____central_____ nervous system.

12. Nerves found outside of the brain and spinal cord are called the _____peripheral_____ nervous system.

13. Nervous tissue contains cells called _____neurons_____ consisting of a body with hair-like _____extensions creating a squid-like appearance_____ .

14. The _____axon_____ carries nerve impulses to other neurons or other tissues. The _____dendrite_____ is an extension that receives a signal from other cells and carries it toward the neuronal body.

15. Identify three types of nerve cells.

a. Neurons causing an action, such as a muscle contraction:

b. Neurons communicating between neurons:

c. Receptors detecting changes in an animal’s environment:

16. If epithelial cells are continuously shed and lost from the body, why doesn’t an animal’s skin and other epithelial tissue ever become too thin? Where do the replacement epithelial cells come from?