Anatomy Lecture Notes Section 1: Tissue Membranes and Fasciae in the Body

Tissue Membranes

Within the body there are many structures called **membranes**. In general, the different membranes cover surfaces in the body. In terms of naming the various membranes, it is necessary to recognize the specific tissues involved, the function of it as a structure, and the location of the membrane in the body. The focus in these notes at this point is the **epithelial tissue membranes**.

In general, tissue membranes are usually made up of thin layers of cellular tissue that cover exposed body surfaces, line internal body cavities, or cover organs within organ cavities. Tissue membranes can be categorized into **epithelial** and **connective** tissue membranes.

Epithelial Membranes

Epithelial membranes consist of **epithelial tissue** (on the top or at the exposed or apical end), and **connective tissue** below, to which it is attached by way of the basement membrane. There are two "wet" types of epithelial membranes, called mucous membranes and serous membranes. There is also a "dry" epithelial membrane called the cutaneous membrane (skin). They all follow this basic pattern:

$$\text{Membranes in Anatomy} = \frac{\text{Epithelial Tissue}}{\text{Connective Tissue}}$$

The 3 types of Epithelial Membranes:

1. Mucous membranes – These membranes line the body passageways or tracts that are exposed to the outside environment. They are "wet" membranes, having a mucus secretion for protection and hydration.

2. Serous membranes – These line internal body cavities that are **not** open to the external environment. They are also a "wet" membrane, having a serous (watery) secretion for the main purpose of reducing friction between two surfaces that are constantly moving across each other.

3. Cutaneous membranes – This is the only "dry" membrane in the body and it covers the entire outermost surface of the body, familiar to most of us as the skin. It plays an important role in the prevention of water loss from the body and also acts as a physical barrier and protective to deeper tissues.

All of the epithelial membranes listed above will have some type of epithelial tissue on the top (like the formula above), and supporting connective tissue immediately deep to it. Now let's look at the specific details for each of the three types of epithelial membranes.

1. Mucous Membranes

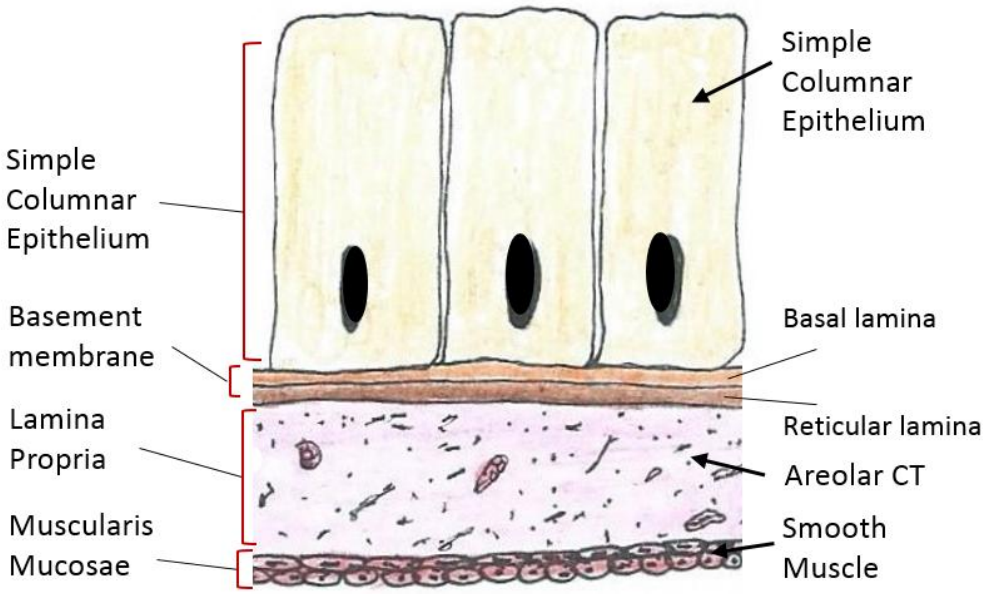
Mucous membranes are epithelial membranes that consist of epithelial tissue that is attached to an underlying loose connective tissue. There is often a third layer to the mucous membrane it is made out of smooth muscle is called the 'Muscularis Mucosae'.

These membranes, sometimes called *mucosae*, line the body cavities that technically are directly open to the outside. This includes the entire **digestive (gastrointestinal) tract** - it is all lined with mucous membranes. Other examples of where mucous membranes are found in the body include the **respiratory tract**, the **urinary tract**, and the male and female **reproductive tracts**.

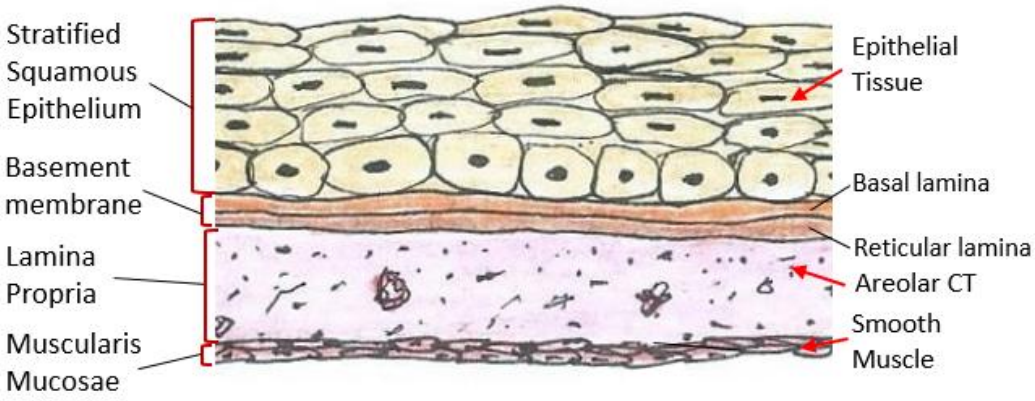
The function of the mucous membrane can vary, but its roles include:

- **Protection** – of the deeper tissues and the entire body. *Usually has *stratified* epithelium.
- **Absorption** – of substances across the membrane. *Usually has *simple* epithelium.
- **Secretion** – of substances for various purposes in the body.

Examples of Mucous Membranes



The above drawing shows a classic type of mucous membrane found in many regions of the body. The epithelial portion of the membrane is **simple** (only one cell layer thick) columnar (it's taller than it is wide). If the epithelial portion is simple, it usually means that a primary role of this membrane is absorption, as one cell layer is much easier to get across than multiple cell layers. The **columnar** cells give more protection and is found in the stomach, small and large intestines for example. Absorption is a role, but so is protection. Other mucous membranes with shorter cells like a **cuboidal** or **squamous** cells are for fast absorption and can be found in the respiratory tract where rapid gas exchange becomes vital.



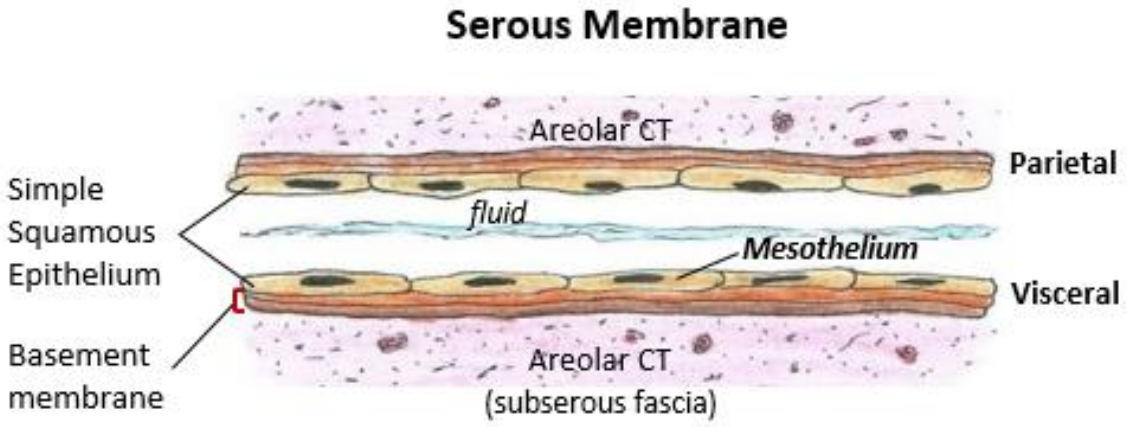
Here is another example of a mucous membrane, now epithelial portion of the membrane is stratified (many cell layers thick) squamous (very flat at the apical end). Thus, its main function is **protection**. This type of mucous membrane is found in the **oral cavity** (mouth), **esophagus**, anal canal and the **vaginal canal**. Mucus, produced by the epithelial exocrine glands, covers the epithelial layer. The underlying connective tissue, called the **lamina propria**, (meaning layer of my own) helps support and nourish the

avascular epithelial tissue. The deepest portion of this membrane is called the **muscularis mucosae**, which is composed of two very thin layers of smooth muscle orientated perpendicular to each other. This structure helps to provide limited local movement of the tissue in specific regional areas.

2. Serous Membranes

Serous membranes line body cavities that do not open directly to the outside environment. These membranes **line internal body cavities** and they also **cover the organs located in those cavities**. Serous membranes are wet or moist membranes and are always covered on their surface by a thin layer of thin **serous fluid** which is watery and slippery, that is secreted by the epithelium of the membrane.

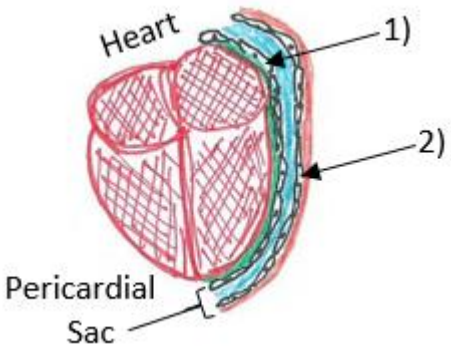
All serous membranes secrete serous fluid, and this thin watery fluid **lubricates** the membrane surface and **reduces friction** and **abrasions** when the organs (**viscera**) that are covered by them move across the surface of the walls (**parietal**) that are directly surrounding them.



The serous membrane in the drawing above is composed of epithelium which is *always* **simple squamous** epithelium attached to a thin layer of connective tissue, which is *always* **areolar connective tissue**. Any serous membrane will always have two components: One component covers the outermost surface of the organ and is called the **visceral layer**. The other component covers the inner lining of the bag or the cavity, and it is called the **parietal layer**.

Serous membranes have special names given to them according to their location, meaning which cavity they are in, and also for which of the two surfaces they are covering – the organ = visceral and the wall around the organ = parietal.

For example, within the thoracic cavity there are other cavities, such as the **pericardial cavity** (meaning around 'peri', the heart 'cardium'). The pericardial cavity contains the heart. As seen in the drawing below, the outermost surface of the heart (which is an organ!) has a serous membrane, labeled **1)** that is the **visceral pericardium**. The pericardial sac is the bag (or wall) around the heart also has a serous membrane on its inner surface labeled **2)** that is the **parietal pericardium**.



Here are the other examples of serous membranes:
There are the two pleural cavities which each contain one lung. The outermost surface of the lung is called **visceral pleura**, and the inner surface of the bag around it is called the **parietal pleural**.

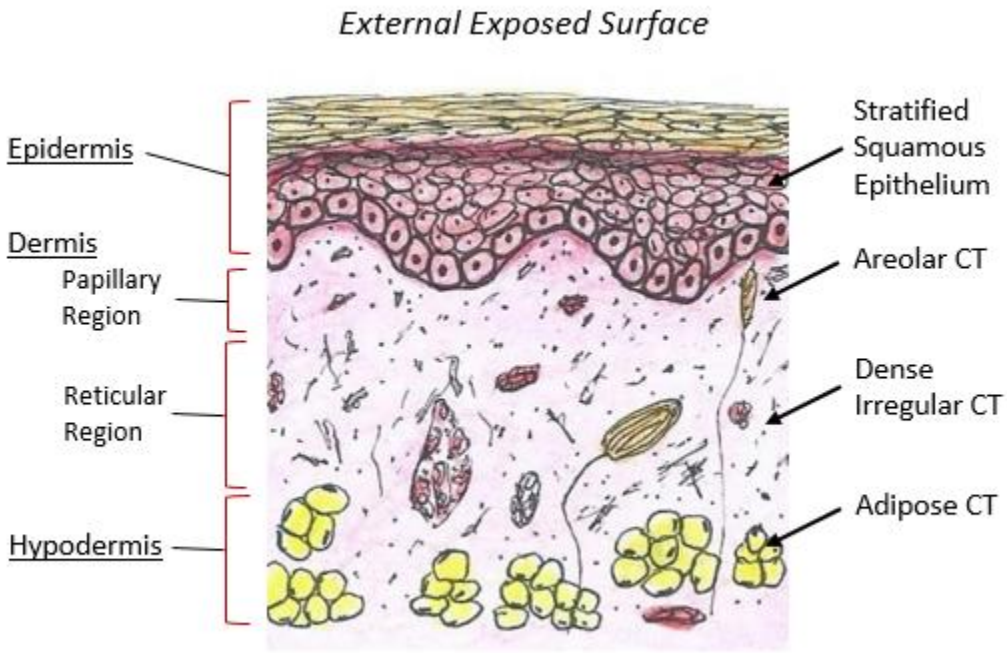
In the abdominopelvic cavity, all of the organs there move against each other in the peritoneal cavity. The outermost surface of those organs is called the **visceral peritoneum** and the 'wall' of that cavity is called the **parietal peritoneum**. A serous membrane is an epithelial membrane composed of mesodermally-derived epithelium called the **mesothelium** that is supported by connective tissue. These membranes line the coelomic cavities of the body, which means that they cover the organs located within the cavities **that do not open to the outside**.

Serous fluid secreted by the cells of the thin squamous mesothelium lubricates the membrane and reduces abrasion and friction between organs. Three serous membranes line the thoracic cavity; the two pleura that cover the lungs, and the pericardium that covers the heart. A fourth, the peritoneum, is the serous membrane in the abdominal cavity that covers abdominal organs and forms double sheets of mesenteries that suspend many of the digestive organs.

3. Cutaneous Membranes

The skin, also called the cutaneous membrane, is an epithelial membrane. The skin is composed of a stratified squamous epithelial membrane resting on top of connective tissue. The apical surface of this membrane is exposed to the external environment and it's outermost layers are created by dead, keratinized cells that help protect the body from desiccation and pathogens. These dead cells are held together by the typical cell attachments of epithelial tissue, such as tight junctions and desmosomes.

The layers of the skin that constitute the cutaneous membrane are the **epidermis**, which is the outer layer composed of the epithelial tissues, and the **dermis**, which is the inner layer composed of a combination of two connective tissues. One of the primary roles of this membrane is to help protect the rest of the body's tissues and organs from physical damage such as abrasions.



As seen in the drawing above, the cutaneous membrane is composed of a **stratified squamous epithelial tissue** (that is keratinized or dry) sitting upon first **areolar connective tissue** (the superficial connective tissue layer) and then **dense irregular connective tissue** (the deeper connective tissue). In the cutaneous membrane, the epithelial tissue is called the **epidermis**, and the entire connective tissue is called the **dermis**.

Deep to the dermis is the **hypodermis** layer, and this is not technically considered a part of the cutaneous membrane. The hypodermis, which consists mostly of adipose (fat) tissue, is also a type of fascia, it is called **superficial fascia**, which gives support to the cutaneous membrane above it.

Cutaneous is from the Latin 'cutis' which means 'of the skin'. This membrane, also called the **skin**, has an important role in protection of the body against trauma and also prevents excessive water loss. It has many other functions which will be covered in depth in the lecture notes for the **Integumentary System** that it is a central part of. Briefly the skin provides effective insulation, temperature regulation, provides sensory input (sensations), and the epidermis of the cutaneous membrane initiates the synthesis of vitamin D.

Connective Tissue Membranes

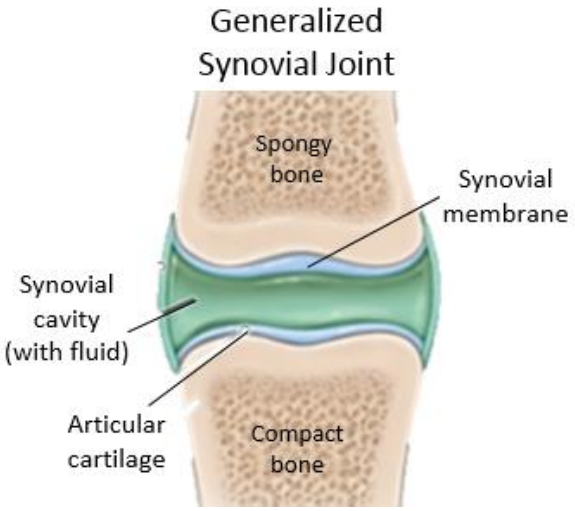
Connective tissue membranes contain only connective tissue, **synovial membranes** and **meninges** belong to this category. Synovial membranes will be examined in more detail in the articulations section. The meninges (cranial and spinal) will be discussed further in the nervous system section of this course.

The connective tissue membranes are formed solely from connective tissue. These membranes encapsulate organs, such as the kidneys, and line our movable joints.

Synovial Membranes

Synovial membranes are connective tissue membranes that line the cavities of the freely movable joints such as the shoulder, elbow, and knee. In the articulation (joint) system, we will more closely examine synovial membranes.

Within the membrane are found fibroblast-like cells called 'synoviocytes' that sit on the inner layer of the synovial membrane. They release hyaluronan, also called **hyaluronic acid**, into the joint cavity. The hyaluronic acid effectively traps available water within the joint capsule to form this slippery viscous substance called **synovial fluid**, a natural lubricant that enables the bones of a joint to move freely against one another without much friction.



Synovial fluid is an important body fluid as it readily exchanges water, nutrients and gases between the cartilage and the blood. It also acts as a lubricant at the movable articulation, as well as a hydraulic cushion.

Like serous membranes, synovial membranes line cavities that ***do not open to the outside environment***. However, unlike serous membranes, they do not have a layer of epithelium, instead they have a layer of connective tissue cells that perform similar functions. As mentioned above, synovial membranes secrete synovial fluid into the joint cavity, and this nourishes, protects and lubricates the articular cartilage on the ends of the articulating bones so that they can function properly and provide ease of movement.

The Meninges

Another type of connective tissue membrane that acts as a covering of delicate nervous tissue are called the meninges. The protective covering of the brain is called the **cranial meninges**, and the protective covering of the spinal cord is called the **spinal meninges**.

Both of these meninges are located within the cranial and spinal cavities respectively, which are located within the larger dorsal cavity. The primary role of the meninges is to provide protection of the brain and spinal cord, as these are vital and relative delicate structures.

Three layers of membranes known as meninges act to protect the brain and spinal cord (shown on next page). The three layers from outermost (superficial) to innermost (deep) are as follows:

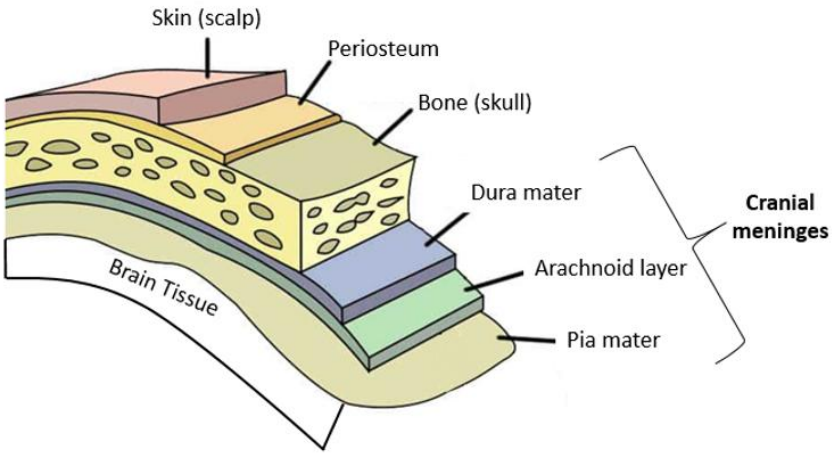
1) the **dura mater** is the thick, tough fibrous outer layer of the meninges (dura means tough and mater means mother);

2) the **arachnoid** is the middle layer of the meninges and is a web-like structure, that has a space below that is filled with cerebrospinal fluid (CSF) that cushions the brain;

3) the **pia mater** is the most delicate and thinnest tissue, and the innermost layer that covers the nervous tissue and follows its contours.

The meninges function to protect the central nervous system (CNS) from trauma or injury to the brain or spinal cord, such as a blow to the head, or taking a tumble, by acting as a shock absorber. They also anchor the CNS, like a seat belt is clipped in to restrict movement, the meninges keep the brain and spinal cord from moving around within the skull or spinal column.

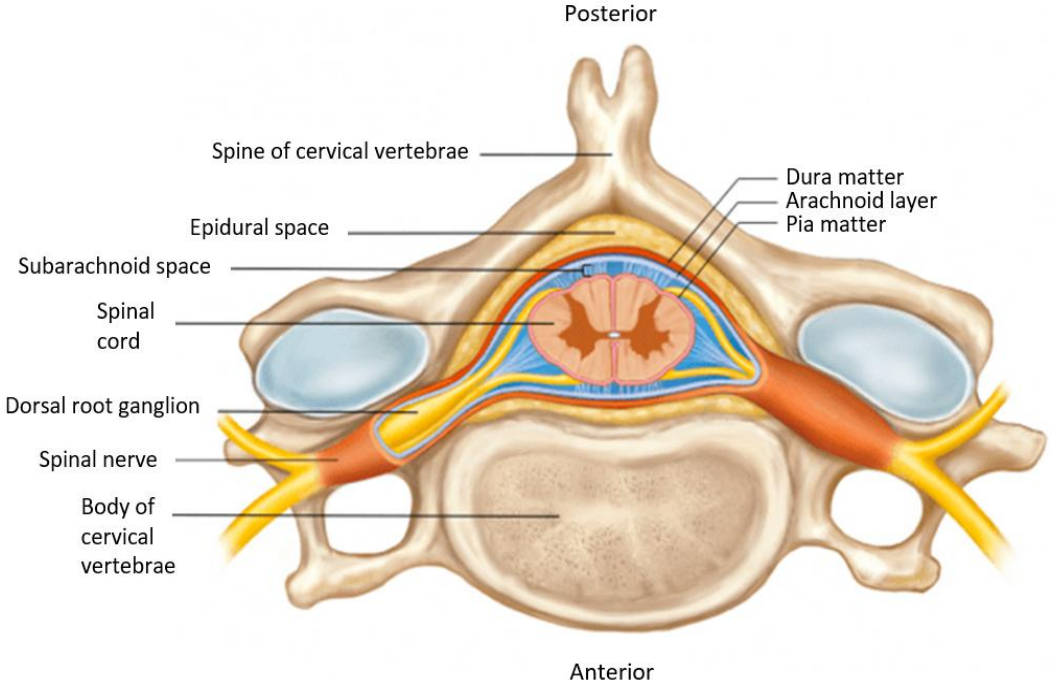
The Cranial Meninges



The illustration on the previous page shows the meninges (singular **meninx**), the specific example displayed depicts the **cranial meninges**. The illustration below shows the spinal meninges, and as we will see in the nervous system section as we analyze the anatomy more thoroughly, the cranial and spinal meninges have slightly different arrangements, creating very important differences.

Note the three-layered membranous envelope that are all deep to the bone (the skull or the vertebrae) for both the cranial and spinal meninges. The meninges are always composed of the outer dura mater, the middle arachnoid layer, and the inner pia mater. This membrane completely surrounds the brain and spinal cord. Contained within the membrane, specifically within the space between the pia mater and the arachnoid (called the **subarachnoid space**) is cerebrospinal fluid (CSF), it is circulated throughout the CNS. In addition, the CSF also fills the **ventricles** of the brain and the **central canal** of the spinal cord.

The Spinal Meninges

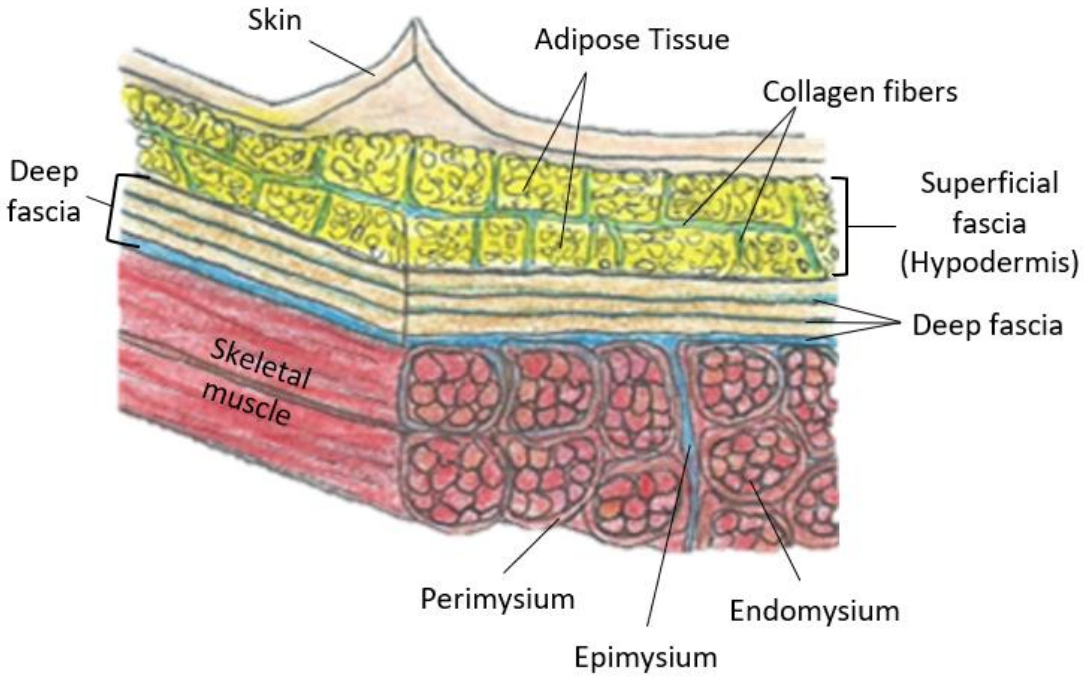


Fasciae of the Body

In the body, **fasciae** (plural) is a **fibrous connective tissue network** that wraps, supports, connects and separates various structures, like muscles, organs, bones, nerves, lymph and blood vessels. It is a very dynamic tissue that has many important roles in the body.

Fascia acts as a three dimensional (3D) structural framework for the entire body, providing structural integrity to internal elements, but it also acts to reduce friction by wrapping and protecting various structures. Importantly, fascia also transmits force through its collagen fibers and allows for the smooth actions of movement to occur throughout the body.

In anatomy, **fascia** (singular) refers to a single band or sheet of fibrous connective tissue in the body that acts to bind tissues together. The term **fasciae** (plural) is grammatically correct for describing multiple fascial layers, and therefore it is commonly used in anatomical and medical contexts, at the same time, most people simply use the term *fascia* for both singular and plural instances.



The drawing above shows the arrangement and relationship between superficial and deep fasciae.

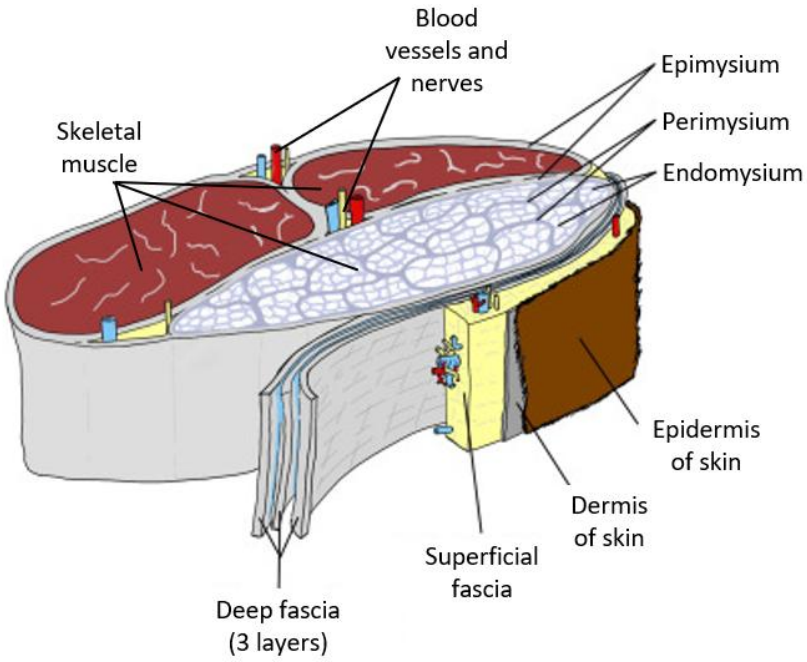
Superficial Fascia

The **superficial fascia** is found directly under the skin and is also called the **hypodermis** and the **subcutaneous** layer. All three names can be used to describe this structure. Superficial fascia is composed primarily of adipose tissue and dense irregular connective tissue that both contain collagen fibers.

Superficial fascia has many roles but one of the most obvious is for **insulation**, the padding of the adipose tissue **provides protection** against both heat loss and physical trauma. Characteristic of fascia in general, superficial fascia is dynamic and ranges from thin to thick layers under various regions of the skin. Importantly, it **tethers** the deeper structures below it to the skin above (superficial) to it, and at the same time also allows a certain degree of movement of these regions. There is a network of collagen fibers running through the abundant adipose tissue of this fascia.

Deep Fascia

In contrast to superficial fascia, **deep fascia** is made of tough, **dense fibrous connective tissue** that is rich in collagen fibers. As seen in the image below, a primary role of deep facia is to wrap around and separate individual skeletal muscles. It forms a **strong**, **fibrous**, **internal framework**. It is bound to various joint capsules, ligaments, tendons, and other connective tissues, creating a robust internal network for the entire body. The deep fascia creates compartments that provide structural support for these muscles, and it provides access pathways for blood vessels, lymphatics and nerves.



The deep facia surrounding and separating skeletal muscles is usually composed of three (3) layers of collagen (see image at left) which are typically organized in perpendicular orientation to each other. This type of arrangement provides great strength and resilience for forces applied from multiple directions.

Deep facia also forms tendons, aponeuroses (which are broad flat tendons like the iliotibial tract and epicranial aponeuroses, and sheaths (like the carotid sheath). This tissue plays a crucial roles in body movement, venous drainage, and proprioception, which means the perception or awareness of body movement or position.

The term '**myofascial**' combines muscle (myo) and the surrounding connective tissue (fascia) and is viewed as a larger, more comprehensive structural feature of the body. It supports and connects the two elements of skeletal muscle and fascia, forming the body's structural framework from head to toe. A great deal of tension and energy can be stored and transferred via the myofascial framework.

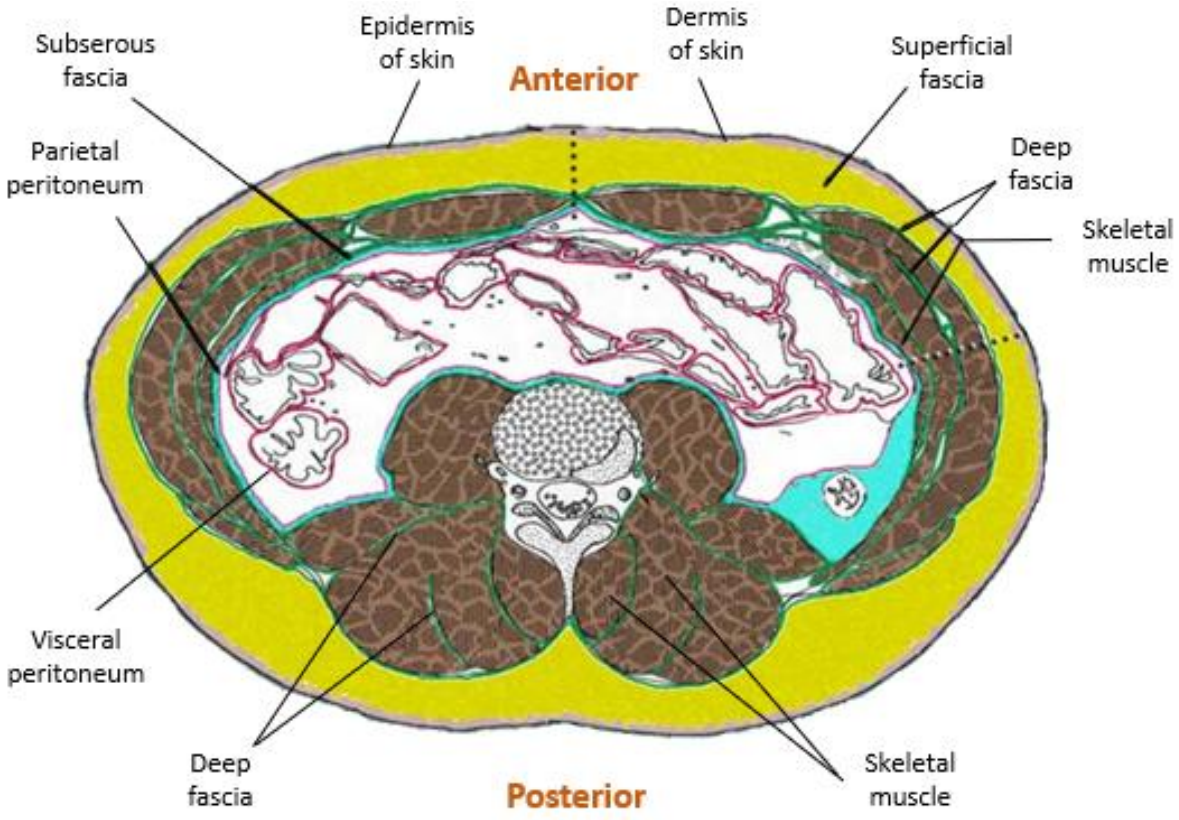
Fascial tissues, especially structures like tendons or aponeuroses, are able to store and release elastic potential energy within them. Biomechanical studies emphasize the role of fascial networks in in the body as distributing forces across multiple joints stretching great distances in the body. This highlights the concept that that fascia participates dynamically in coordinated movement and postural stability.

The link between fascia, muscle, and bone health/function is reinforced by recent studies that show the important role fascia has in helping muscles of the body work in relation to the orientation of the bones. Fascia has a role in assisting the contraction of muscle cells to generate a balance of forces that affect muscle tone and actions during contractions.

Subserous Fascia

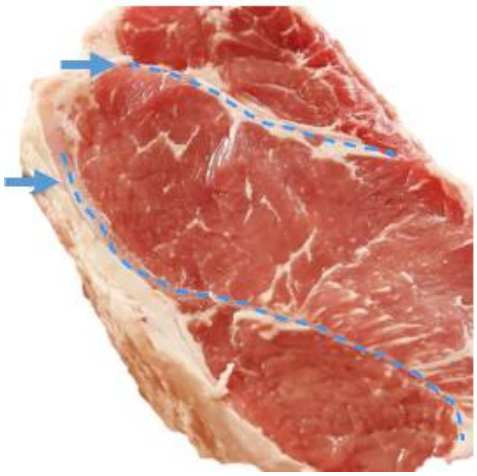
The innermost type of facia is called **subserous fascia**, which is also known as **visceral fascia**. It is composed of a layer of **areolar connective tissue** that acts to suspend organs within body cavities.

This fascia is found beneath (deep) to the simple squamous epithelium of the serous membrane of the peritoneum in internal peritoneal cavity, called the parietal peritoneum. It can also be found as the connective tissue of the pleura body cavities. It acts to hold organs in place while allowing movement, like a supportive hammock made of connective tissue with collagen fibers which is crucial for organ function and preventing prolapse of various structures. The image below presents a nice summary of the 3 different types of fascia and their relationship to each other.



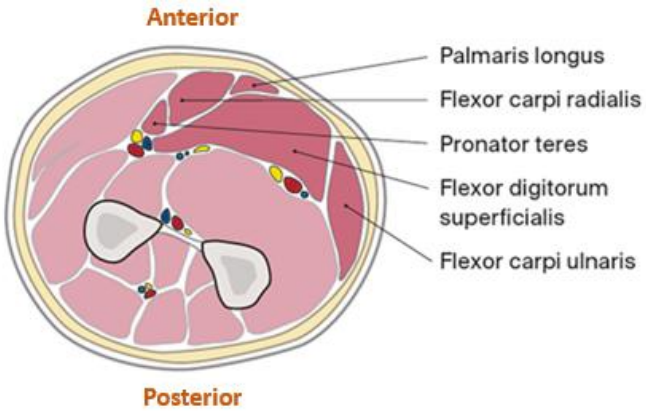
Above is an illustration of a horizontal (cross or transverse) section of an abdomen. The most superficial (outermost)surface of the body is the epidermis of the skin. Immediately deep to the epidermis is the dermis of the skin, and deep to that is the thick **yellow** colored layer of the superficial fascia. Continuing to look deeper into the transverse section, the various layers of the skeletal muscle can be seen. These are sub divided by the deep fascia, seen as a **green** color in the drawing. Deepest of all the fascia is the subserous fascia, which can be seen as a **light blue** color in the image above. The innermost lining of the peritoneal cavity (contained within the abdominal cavity) is the parietal peritoneum, which is a serous membrane that can be seen as a **dark pink** color in the drawing. The internal organs within the peritoneal cavity are covered with another serous membrane which is also called the visceral peritoneum, also seen as a **dark pink** color in the drawing.

In anatomical models it is not really possible see the deep fascia, however, if you look at a raw steak (at right) you can get a sense of how fascia is arranged around and separating muscle groups in the body. There are blue arrows at the top left of the image that shows the connective tissue fascia as white streaks on the surface, they are highlighted with blue dashed lines over them. This fascia effectively divides the one muscle group from another.



Anatomical Fascial Compartments

A fascial compartment is a section within the body that contains muscles and nerves that is surrounded by deep fascia. When looking at skeletal muscle and associated tissues, including bone, we can view muscle groups as 'compartments', mostly due to the deep fascia that creates the divisions.



In the image to the left it shows how the forearm of the upper limb is divided into its sectional fascial compartments, which contain an anterior and posterior compartment. Each whole skeletal muscle is wrapped in deep fascia to make them separate but connected structures. These different layers are important in enabling muscles that sit next to, or on top of, each other to move freely without affecting each other's functions.

Regional and sectional anatomy routinely study the **anatomical compartments** of various body regions because it reveals underlying relationships of various muscles, and therefore allows us to understand different functions of individual muscles, and muscle groups.