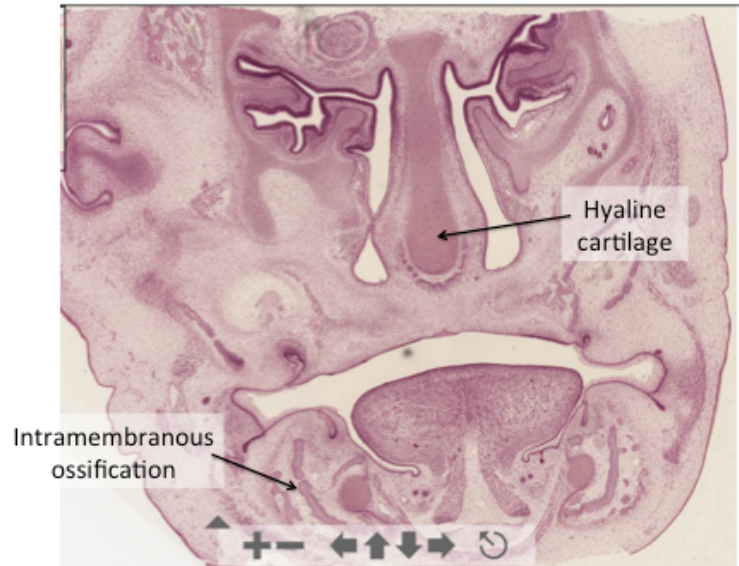


This lab will study bone, cartilage and muscle tissue.

## Cartilage

### Slide 51

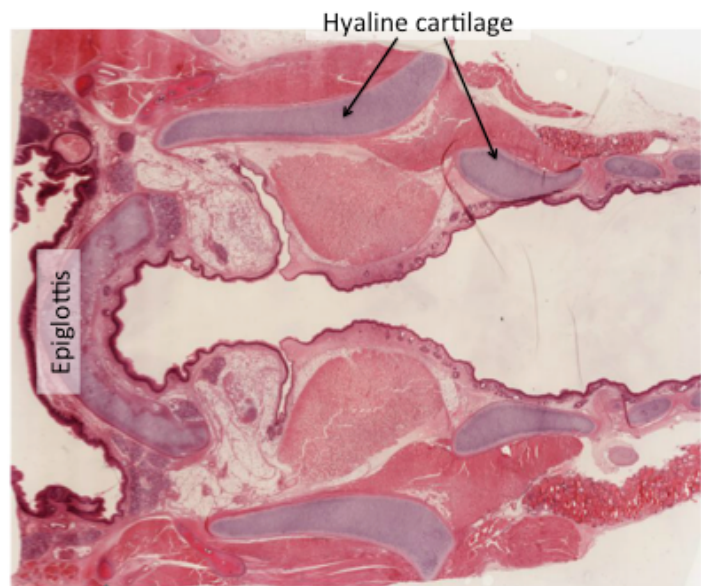
This slide of a fetal pig head shows developing cartilage and bone. The area around the nasal cavity, especially the nasal septum, shows developing hyaline cartilage. Examine the appearance of the cells and the developing matrix, to contrast with adult cartilage which we will be seeing in subsequent slides. Examine the perichondrium that blends into adjacent mesenchyme.



Within the developing jaw, there is bone that is forming by intra-membranous ossification. Notice that the osteocytes do not form isogenous nests. Also examine the cells of the immature periosteum that are involved with the appositional growth of this bone.

### Slide 65

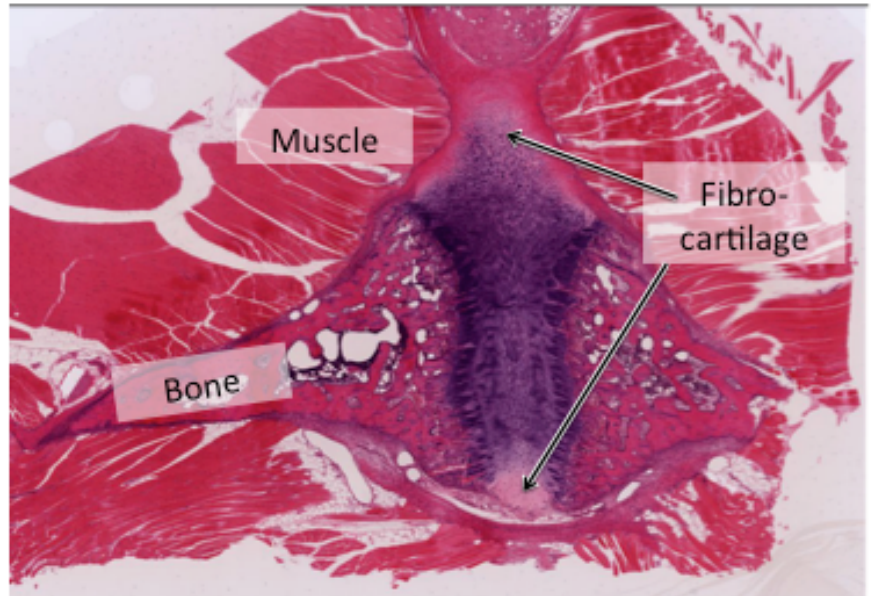
This image of the larynx shows two kinds of cartilage. Most of it is hyaline cartilage. Examine the hyaline cartilage. Look for the classic features, such as the chondrocytes with isogenous nests and the staining of the territorial and inter-territorial matrix. Also inspect the perichondrium and understand how this can contribute to appositional growth. The epiglottis is elastic cartilage. Since this specimen is not stained for elastic fibers, you cannot determine the presence of these fibers simply by inspection. However, you can tell that the



epiglottis is not hyaline cartilage since the matrix appears less homogeneous and somewhat more fibrous.

#### Slide 66

This slide of the symphysis pubis shows both hyaline and fibrocartilage. The fibrocartilage is most evident at the lower and upper aspects of the symphysis. Notice the increased pink fibers within the matrix and the presence of heavy collagen fibers intermixed with some purplish cartilage matrix. Even in these areas you can tell that this is cartilage rather than fibrous connective tissue because there are cells in lacunae and some form isogenous nests.



#### Slide 64

This slide of intervertebral disc is very lightly stained. You should be able to tell that it's very fibrous and also that the cells do not appear to be fibroblasts. The most classic appearance is towards the edges of the specimen near where the disc meets bone. Remember fibroblasts have elongated, dark angular nuclei and very thin cytoplasm, while the cells in this specimen are roundish and appear in lacunae. However, there are only rare isogenous nests because the disc is not growing.

#### Slide 56

This slide shows elastic cartilage in the ear. Note the thin, dark fibers in the cartilage matrix. If this were not stained for elastic fibers, it would have a very similar appearance to hyaline cartilage.

## **Bone**

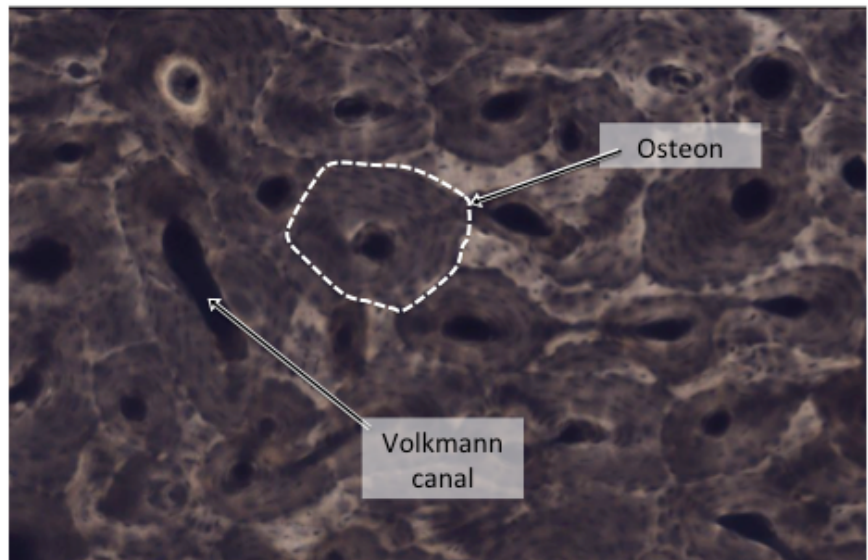
### **Slide 71**

This is a slide of decalcified bone. There is muscle on top of the bone and marrow contents below. Notice that the specimen has folded somewhat at the top, and that there are some areas of incomplete decalcification on the left side that have some blue staining. Nonetheless, you can see that there are single cells in lacunae within the pink de-calcified bone. Most of the periosteum has pulled away from the bone and remains attached to muscle. On the other hand, much of the endosteum still is in contact with the bone (especially on the right side of the specimen). On the left side of the specimen notice that there appear to be some large holes within the bone. These are resorption lacunae.

Particularly on the right side of this specimen, you can see smaller openings that contain blood vessels, surrounded by circular appearing matrix. These represent the osteons or Haversian systems. At high power you may be able to see that these are at the center of some concentric rings within which the osteocyte lacunae reside. Again, particularly on the right side of the specimen, you may notice some layers of bone just beneath the endosteum that appear to be paralleling the edge of the bone. These are circumferential lamellar bone laid down by the endosteum. This is somewhat less obvious on the periosteal side but still can be detected in places.

### **Slide 70**

This is a thinly ground piece of bone which retains the architecture of the calcified tissue. Cells and blood vessels are destroyed in this process. Holes and canals in the tissue fill in with bone dust and appear black. At low power, notice the very dark spots surrounded by lighter gray. These are each individual osteons. The dark spot in the center is the



Haversian canal, where the blood vessel would reside. Notice that there are some longer canals going transversely. These interconnect Haversian systems and are the Volkmann's canals. Next, examine a Haversian system at high

power. Notice the remarkable architecture of these structures. There are dark areas arrayed circumferentially around the Haversian canal. These are the lacunae. On very high power you'll notice that there are many tiny dark lines radiating away from these lacunae. These are the canaliculi that allow the osteocytes that occupy the lacunae to maintain connection with the blood vessel and with neighboring cells. Notice that the circular Haversian systems don't fill all of the space. There are small pieces of bone tissue in between that are called interstitial lamellae. These are the remnants of old Haversian systems. There is often a darker line between adjacent Haversian systems called a cement line.

#### Slide 67

This section of a fetal finger shows the process of endochondral ossification. One can see the remnants of the cartilage model, which are the blue portions of the specimen. At high power you can see that these are hyaline cartilage. At the edge of the cartilage that is near the shaft of the developing bone, you can see a very evident transition from cartilage to bone. Notice the size and orientation of the chondrocytes in this area. There are several layers that are represented in this transition, including zones of proliferation, maturation, hypertrophy, calcification and then ossification as one progresses from the hyaline cartilage to the developing bone. See if you can identify examples from each of these, remembering that the borders are not entirely distinct. Notice that the matrix becomes much darker blue as it calcifies. Then notice the pink forming around the edges of the dark blue. This is the developing bone tissue with osteocytes now surrounded by immature bone matrix that is being deposited on the calcified cartilage. These formations of immature bone around calcified cartilage are called "mixed spicules". If you progress towards the shaft of the bone, the bone appears to be more substantial but is still not organized into clear lamellae. Most of this is still immature, woven bone. You can see how active the periosteum and endosteum are.

#### Slide 68

This is another slide of developing bone. Hyaline cartilage is at the bottom and the transition to bone occurs at the junction between the epiphysis and diaphysis. You can see the layers of transition. If you look the right side of the pink shaft you can see some features of more mature lamellar bone.

#### Slide 69

This specimen shows the end of a long bone with the epiphysis above and diaphysis below. Notice the hyaline cartilage on the articular surface at the very top of the specimen. The epiphysis is full of cancellous bone, and the epiphyseal plate is between the epiphysis and diaphysis. Notice the hypertrophy of

chondrocytes and the maturation of cartilage, with many mixed spicules on the side of the diaphysis. There are a few osteoclasts and many osteoblasts along the sides of these spicules remodeling them into mature bone.

#### Slide 72

This is a cross-section through a developing long bone. Notice that the bone does not have clear lamellar organization. Also notice that there are many large holes surrounding blood vessels. Osteoblasts will line up along these and lay down bone matrix with a narrowing of these holes to form Haversian systems. Also lamellae of bone will be laid down under the periosteum and endosteum. This is the process of “compaction” of immature, woven bone into mature, lamellar bone.

#### Slide 90

This specimen of immature spine shows the maturation of cancellous bone and of the thin margin of cortical bone surrounding the vertebra. There is a very thin rim of lamellar bone surrounding the vertebral body with some developing osteoblasts directly adjacent to it. The majority of the specimen consists of spicules of woven bone that are undergoing a process of maturation into lamellar bone.

### **Muscle**

#### Slide 76

These are teased skeletal muscle fibers. Each represents an individual, multi-nucleated cell called a muscle fiber. The pink cytoplasm is due to the heavy concentration of protein. At very high power notice the peripheral nuclei and light and dark banding patterns (you will have to search for fibers that are in focus in order to see this banding pattern). What makes these light and dark bands? Notice that these fibers tend to remain approximately the same diameter throughout their length (which can be quite long). We will see these muscle fibers cut in many different planes in tissue.

#### Slide 78

This is a slide of a skeletal muscle cut in cross-section. Notice how muscle fibers fit together and the very delicate connective tissue that separates muscle fibers from one another. Also notice the thicker connective tissue that separates the muscle into fascicles.

Slide 66

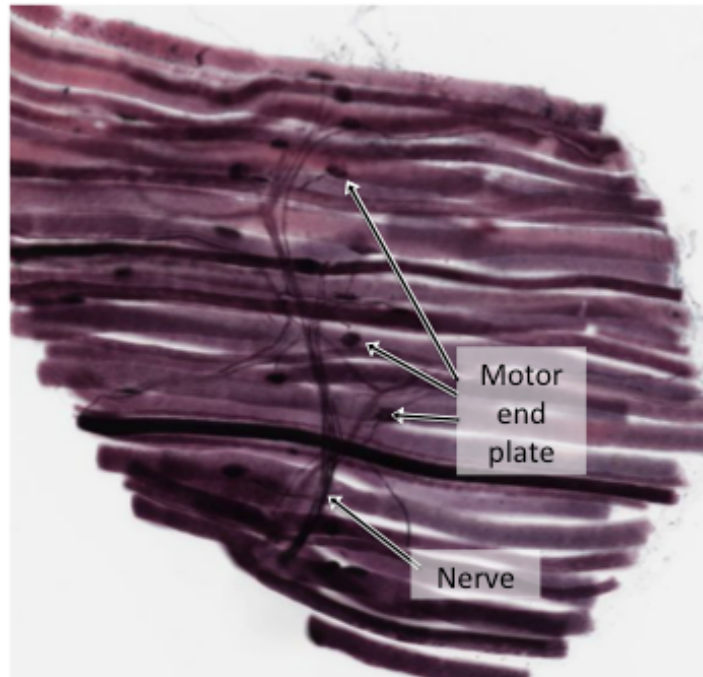
This is the slide of the symphysis pubis again. Notice that there are multiple skeletal muscle fibers attached to the bone in this region. Many of these clearly show the banding pattern of skeletal muscle. Find fibers cut in different planes so that you learn to recognize them when you encounter them in other tissues.

Slide 77

This is a slide of the tongue. The tongue is essentially an epithelium-lined bag of skeletal muscle fibers. Fibers go many different directions and don't have clear layers. Therefore you'll see many different profiles of cut fibers. Focus on some cut in cross section and see how they arrange with other fibers. Notice the variation in sizes and also notice the location of nuclei in relation to the fibers. Next, try to find some cut in longitudinal section.

Slide 96

The nerve is the dark, branching linear structure at the center of this muscle preparation. At higher power noticed the dark, oval structures that are the terminations of the nerve on muscle fibers. These are the neuromuscular junctions. There is one per muscle fiber.

Slide 79

These are teased smooth muscle cells. Notice that they are long and taper to a point at each end with a single nucleus at the center. There are no striations.

Slide 54

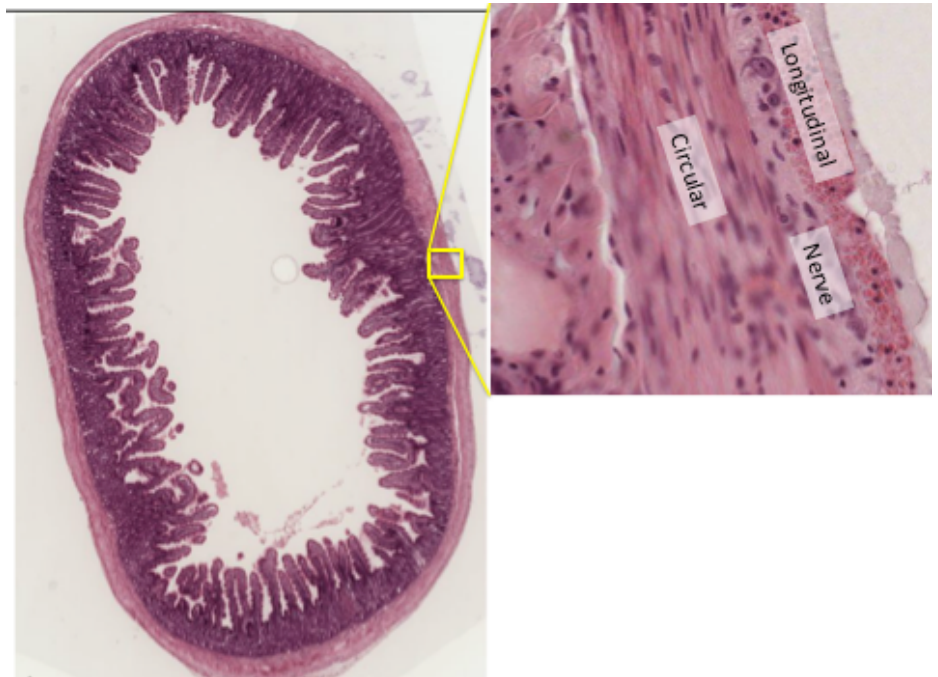
Smooth muscle cells can coexist with several types of other tissues. This is an example from the cervix of the uterus, stained with trichrome stain. Muscle fibers will stain a reddish orange color. Collagen fibers are stained bluish green. At high power you'll notice smooth muscle cells mixed in amongst the heavy collagen. This is a fibromuscular tissue.

Slide 80

In the body of the uterus there is very little connective tissue. Below the epithelium lies the myometrium. This is almost exclusively smooth muscle. Notice that the smooth muscle exists in whorls that interdigitate with other groups of smooth muscle cells. Examine the “cucumber” nuclei and the fact that they're surrounded by pink, muscular cytoplasm. How are these different from fibroblasts?

Slide 28

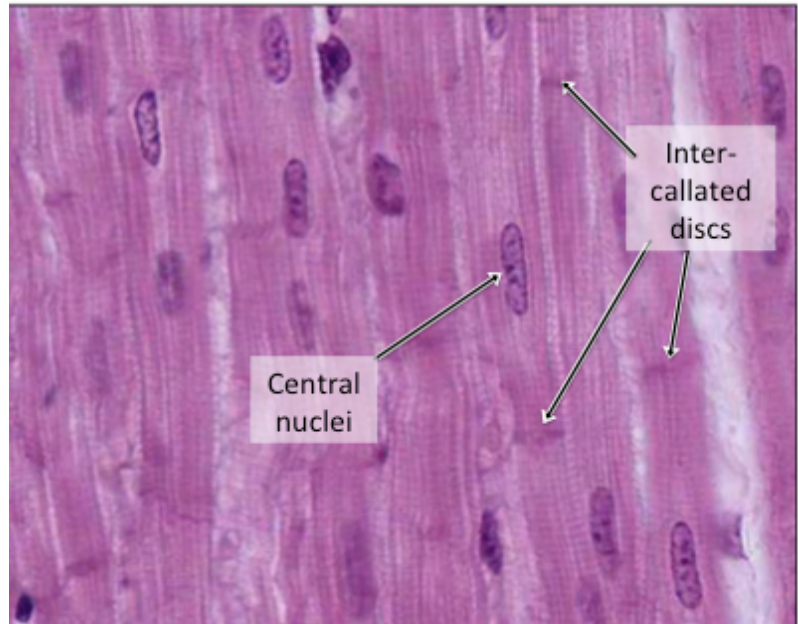
Many hollow organs have layers of smooth muscle. The intestines have an outer layer of longitudinally running smooth muscle and an inner layer of circular muscle. Try to identify these layers in the wall of the jejunum. The outer longitudinal layer is quite thin. In places, you may notice small collections of another cell type separating these layers. These are neurons. Except for these locations, the two muscle layers are directly adjacent. Get used to looking at smooth muscle cells and nuclei because they are present in many tissues.

Slide 81

Study these teased cardiac muscle fibers. Notice the nuclei are in the center of the fibers. If you look carefully you may notice dark lines at intervals crossing the fibers. These are intercalated discs, where one muscle cell meets the next. Furthermore, you will see striations in cells that are orientated longitudinally and you may see that some of these cells branch. This is quite different from skeletal muscle.

Slide 82

Cardiac muscle does not form parallel layers. Therefore, any sections through cardiac muscle will cut some fibers more longitudinally and others more in cross-section. Identify that this is muscle and that it has centrally positioned nuclei that do not look like skeletal muscle nuclei. In fibers that are cut more longitudinally identify intercalated discs and striations. These are particularly evident towards the upper part of the right side of the specimen. One other feature of the specimen is found in the lowest right portion, where there are some extremely large and lighter colored fibers that are cut in cross-section. These are Purkinje fibers, which are modified cardiac muscle cells.



### Slide 113

This trichrome stain of part of the heart also shows cardiac muscle on the lower side of the specimen. Here you can see that cardiac muscle is not organized in parallel layers.

### **Electron microscopy**

Please be sure to look at the Electron Micrographs of muscle on the virtual histology site!!!!