Skeletal (Script)

Slide 2

The skeletal system functions in:

1. Support of the body. It keeps us upright.

2. Protection of vital organs.

3. Movement. Muscles act on the bones which allow us to move about.

4. Blood Formation in the Bone Marrow.

5. Electrolyte Balance. Bone stores and releases calcium and potassium ions.

6. Acid-base balance. Bone buffers blood, or maintains a neutral pH, by absorbing or releasing phosphate or carbonate salts.

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BONE TISSUE/OSSEOUS TISSUE

Like other connective tissues, bone is composed of cells and matrix.

The matrix is 1/3 organic and 2/3 inorganic. The organic portion is made of collagen which allows bone to be flexible and absorbs pressure. The inorganic part is made of hydroxyapatite, a crystallized salt made of calcium and phosphate, that provides strength to the tissue. This is one of the ways that our body stores calcium. Bone needs both the organic and inorganic components. If it did not have the organic portion, it would be very brittle and fragile and the hydroxyapatite crystals would fracture easily. But, if hydroxyapatite was not present, our bones would be all rubbery and have no strength.

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Bone tissue has a number of types of cells

1. Osteogenic Cells are stem cells that give rise to most other bone cells. They are found in the endosteum and inner layer of the periosteum. They continuously multiply.

2. Osteoblasts are one form of cells that are derived from osteogenic cells. They are nonmitotic, meaning that they do not undergo mitosis and cannot reproduce themselves. The only way to get new osteoblasts is from osteogenic cells. Osteoblasts are bone forming. They produce the organic component of bone tissue. By removing calcium from the bloodstream to build bone matrix, their activity lowers blood calcium levels.

3. Osteocytes are mature osteoblasts. As bone is formed and the matrix is secreted, the osteocytes become trapped in the matrix. Once there, their function is to maintain homeostasis of bone material.

4. Osteoclasts arise from a different line of cells through the fusion of ~4 stem cells in the bone marrow. They are very large in size and are bone dissolving cells. They release hydrochloric acid to dissolve the matrix and put calcium and phosphate back in the blood, thereby increasing blood calcium levels. They work in concert with the osteoblasts to ensure a proper balance of bone tissue. They are found on the

bone surface and have ruffled borders. The ruffled borders increase the surface area which allows for the osteoclasts to more efficiently re-absorb bone matrix.

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Bone tissue comes in two forms, compact and spongy bone. We will talk about the specifics of each momentarily.

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In this slide, we can see the formation of the various types of bone cells. The top portion shows the development of an osteoblast from an osteogenic cell and then as it matures into an osteocyte.

Osteoclasts develop from the merging of about 4, in this case 5, stem cells. These are not osteogenic stem cells; these stems cells are the same stem cells that will form blood cells.

Slide 7

As previously mentioned, bone is made of two types of tissue. The first type is called compact bone. It is strong for weight-bearing and formed by combining osteons.

An Osteon is 1 central canal and its concentric rings. The osteons are what give bone tissue that tree ring appearance.

Central and perforating canals contain blood vessels and nerves. The central canal is at the center of the osteon. Perforating canals are smaller canals that run perpendicular and feed into the central canal. The rings of matrix around the central canal are called lamellae. On the edges of the lamellae you will find lacunae.

Lacunae are tiny cavities that contain the osteocytes. Off the lacunae are canaliculi, or slender channels, that branch off and allow osteocytes to communicate with one another via dendrites or extensions of the cell body.

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Here is another depiction of the osteon. Notice the central and perforating canals with the blood vessels and nerves. Also, can you distinguish between the lacunae, canaliculi, and lamellae

Slide 9

The second type of bone is called Spongy bone. It is a lattice of rods, spines, and projections of bone and looks like a sponge, hence the name.

The spikes and projections that stick out into the cavity more are called Spicules. Trabeculae are similar, but the projections form more of a thin, plate like structure. The trabeculae also have lamellae, but no central canal, as is seen in the osteons of compact bone. The spaces between trabeculae are filled with marrow. Since spongy bone is closer to the bone marrow, it is closer to more of the nutrients and doesn't need the central canal to transport those nutrients. Spongy bone develops along lines of stress and serves to disperse stress and pressure which allows for strength without weight.

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Both types of bone tissue are found in all bones, compact is the covering, spongy is the middle. In flat bones, I think of the two types of bone tissue as similar to an oreo cookie. The compact bone would be the chocolate cookie part and the spongy bone would be the filling inside. Whereas, in long bones, the spongy bone is found in the epiphyses and the compact bone forms the outer layer of entire bone.

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There are also numerous types or shapes of bones.

1. Long Bones are longer than they are wide and work as levers. They are primarily used in movement, blood production, and storage. Examples would be the arms and legs, phalanges (fingers and toes), metacarpals and metatarsals.

2. Short Bones are equal in length and width and have limited motion. They glide across one another which allows for bending in multiple directions. These types of bones can be found in the carpals and tarsals, or wrists and ankles.

3. Flat Bones, as the name implies, are flat. Their purpose is to enclose and protect and provide broad surfaces for muscle attachments. These are the cranial bones, ribs, sternum, and scapula.

4. Irregular Bones have elaborate shapes and multiple functions. The vertebra of the spinal column and the sphenoid in the cranium are examples.

We will focus on the anatomy of the long bone for the majority of our skeletal discussion.

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LONG BONE ANATOMY

1. Epiphysis: These are the ends of the bones and where they will articulate, or form joints, with other bones.

2. Diaphysis: This is the shaft, or middle of the bone. It is hollow and forms the walls of the medullary cavity.

3. Medullary Cavity, also called the marrow cavity, is where we find bone marrow. There are two types of marrow, red and yellow.

Red produces Red Blood Cells. In juveniles, all their marrow is red. As adults, a larger portion of our red marrow is converted to yellow which is more fatty and used for storage.

4. Periosteum: is a layer of tough fibrous tissue that covers and attaches to the bone surface. It has two layers within it. The outer layer is made of thin collagen fibers and the inner contains bone tissue forming cells. It functions to provide strength and acts as an anchor for attaching muscles and tendons. It is also important for growth and healing.

5. Endosteum: Is a thin layer of reticular connective tissue that lines the medullary cavity.

6. Metaphysis or epiphyseal plate: This is the connection between the epiphysis and diaphysis and is only found in juveniles and often referred to as the growth plate. It is made of hyaline cartilage and as we become adults it is replaced with bone and fuses the epiphysis to the diaphysis.

7. Articular Cartilage: Is also made of hyaline cartilage and covers the surfaces of the epiphysis to reduce friction and allow for smooth movement.

Slide 13

Bone growth is called ossification and occurs in two forms.

1. Intramembraneous ossification produces flat bones. They develop within a fibrous sheet that is similar to the dermis. This growth is "within a membrane" of mesenchyme and how it got its name.

2. Endochondrial ossification produces long bones, ribs, vertebra, and most bones of the body. Bone develops from a pre-existing cartilage model. Slowly the cartilage is converted to osseous tissue.

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You do not need to know the specific steps of either form of ossification, but you need to be able to describe the difference between the two. This diagram shows intramemebraneous ossification. You can see how the trabecula are starting to form.

Slide 15

This diagram works through the steps of endochondral ossification. Again, you do not need to know the specific steps, but notice how the cartilage is being converted over to bone.