All right, guys, we'll get started. Chapter 22, The Musculoskeletal System. So basically, the skeletal system is a rigid supporting structure for the body. All bones have the same basic structure. They have the cortex, which is the outer layer of compact bone. And then it also has the trabeculae, which is the inner, more spongy texture part of the bone. It has a loose meshed lattice of thin strands that network together. Then the bone marrow is in the spaces between the trabeculae, and it consists of fat and blood forming tissue. So we consider the bones as specialized type of connective tissue. It's in the connective tissue group along with blood, along with adipose.

Question, Stephanie?
STUDENT: (Inaudible)
PROFESSOR: No. What?
STUDENT: Just like marsh mellows.

PROFESSOR: Not that spongy, no. It's firm. It's firm. Have you ever seen -- 4th of July, ribs that have been cut in half or something like that. If you get baby back ribs and they are cut in half, they have an outer cortex. And then the bone on the inside, it's like mesh, that is the trabeculae. So it's still really firm.
STUDENT: (Inaudible)

PROFESSOR: Yeah. No, not really the marrow. The marrow is going to be softer, but of course the trabeculae aren't. So basically bone is considered a specialized type of connective tissue, and it's composed of a connective tissue framework. And the firmness, all right, comes from the calcium salts that are present. Bone is always being remodeled, always being broken down and reformed. Now, types of cells in bone, three types: osteoblasts, osteocytes, osteoclasts. Osteoblasts are the younger bone cells, and they lay down bone, they produce bone. We could say a bony matrix. They produce a bony matrix. That then develop a bony matrix around themselves. They then become mature and are called osteocytes. Osteoclasts are bone cells that break down bone, and they are large cells. They have many nuclei. They are formed from a collection of monocytes. And the way you can remember osteoclasts as breaking down bone is they have high levels of acid and acid phosphatase. So osteoclasts, with a C, have high levels of acid phosphatase to break down bone. And osteoblasts will build up bone. So you can remember that. And so the strength and thickness of the bones depends on the activity. And along with that, with the activity, that's why -- women who are post-menopausal women at risk for osteoporosis, one of the best treatments they can do is
to walk because of that activity on the weightbearing joints. So the bones of the skeleton are connected by joints, several types of joints. There's the fibrous joint, the cartilage joint, and the synovial joint where there is synovial fluid. The synovial fluid suffers as a buffer and reduces the friction between the surfaces of the bones at the joint.

Bone is formed in two ways: intramembranous and endochondral. The endochondral is the one where originally it's the cartilage and then bone takes over the shape of the cartilage model. The intramembranous is more for the formation of bone, more the flat bones, okay. The endochondral is more for the long bones.

Let's see, achondroplasia, that's faulty endochondral bone formation, the achondroplastic dwarf. What that is is basically they have impaired development of their extremities due to the imperfect endochondral bone formation. So they can have an appearance with their body, their head seems bigger. The reason it seems bigger is that the bones of the skull are intramembranous bone that is not interfered with. It's the endochondral bone formation. As a result it's a form of dwarfism. Osteogenesis imperfecta, what that is is thin and delicate bones broken easily. These babies can have multiple fractures, malformations of fingers and toes. They can fused digits. In my practice I delivered one baby in 20 years who had osteogenesis imperfecta.

Other malformations, you can have the clubfoot, a multifactorial genetic inheritance. Treatment can be manipulation. It can be casted. Congenital dislocation of the hip. The hip goes into a socket, the femoral head goes into the socket in the hip. If the hip socket is shallow, you have a greater risk of congenital dislocations. More common in females then males. Once again, treatment is manipulation, casting, and other types of therapy. Sometimes even double diapering or triple diapering helps.

Here is an infant with the osteogenesis imperfecta. They can fused digits. I don't really see any fused digits there. Here is the X-ray. The X-ray points to the fractures in the humorous and the femur.

Clubfoot.

Here's just a diagram of the synovial joint. Synovial fluid reduces the friction.

Rheumatoid arthritis, very interesting. It's a systemic disease, affects the connective tissues throughout the body, especially the joints. It produces a chronic inflammation, thickening of the synovial membranes. We consider it an autoimmune disease. Rheumatoid factor is a blood test you can do to look for the rheumatoid factor, so it confirms the diagnosis of rheumatoid arthritis. And it's an autoantibody that is produced against synovial tissue. It's produce by the B-lymphocytes. Remember, the B-lymphocytes produce antibodies.
The T-lymphocytes are responsible for the cell-mediated immunity. It can occur in men and women. It usually affects the small joints of the hands and feet, okay. And gradually it's progressed. As it progresses, there is dislocation of the joint.

I think we have a picture here. This is not --

Let's see. Yep, this one shows you the joint more of rheumatoid arthritis. The dislocation, the fingers tend to deviation laterally. When you look at them, the fingers deviate to the side.

Let me just see here if I can go back. Here is another one. They get nodules along the tendons. That shows you the nodules.

And basically what this shows is destruction of the articular cartilage. The cartilage is on the right, okay, and extend about 50 percent of the slide over. And then where the arrow is where there is destruction of the cartilage. You have a lot of lymphocytes that are present indicating the inflammation. Once again, the inflammatory reaction, the synovium. All those dark cells are lymphocytes. Those dark spots are lymphocytes.

Osteoarthritis, it's not a systemic disease. Osteoarthritis is an aging disease. It's a disease of weightbearing joints. So the joints that are going to be severely affected for osteoarthritis are going to be hips and knees. Basically, it's degeneration of the articular cartilage seen in older adults. The treatment can be drugs, but more significantly it's joint replacement, joint replacement of the hips and knees.

All right. Let's see. So this is a knee joint, and you see the surface of the femoral condyles. You see a little bit in the center of the -- it looks like an inverted U. In the center of the U, you see the () ligaments. And here notice how it's a roughened area, irritation of the cartilage, and that's advanced osteoarthritis.

Here you have an example of it by X-ray.

Now, this is an example of osteoporosis. Remember I told you osteoporosis affects postmenopausal women, and that the -- where osteoporosis has very significant effects are going to be in the wrists, in the hips, and also the spine. Women who develop osteoporosis can develop a curvature of their spine, accentuation of the cervical curvature. And this is a diagram -- this X-ray shows you that -- why they develop abnormal curvature of the spine because there is compression of that vertebra. The vertebra directly above it is the normal vertebra in that it hasn't decreased in size. The arrow indicates the compressed vertebral body fracture. These are like silent fractures. Patients really are unaware of them. That is part of the reason why postmenopausal women can have a decrease in stature. They actually can decrease in size. Maybe
you've had that with a grandmother, whatever, you've noticed she seems a little smaller when you go to give her a hug or whatever. The reason being is because of the osteoporotic changes in the spine, in the vertebral bodies.

Gout. Gout is a disorder of purine metabolism. Basically what it is is there is accumulation of uric acid in the bloodstream. And then this high concentration of uric acid precipitates as crystals in joints. Typically the joint that gets involved the most is the joint of the big toe. Also, they can form stones in the kidney, the crystals form. We call them tophaceous deposits. And as a result you can develop, as I mentioned, stones in the kidney and it can plug the tubules and cause kidney damage.

Here is an example of gout. Once again, the big toe is swollen here.

Question?

STUDENT: Have you heard of pseudogout with calcium deposits? Is that just a --

PROFESSOR: No, I've never heard of that quite, but I would think if you have hyperparathyroidism, increased functioning of the parathyroid gland that you have higher blood calcium levels, and part of the concern then is deposition of calcium stones either in the kidney or other locations.

STUDENT: But it's not associated with --

PROFESSOR: No, no. They are different enough. It's hard to really compare.

STUDENT: Just like calcium instead of uric acid?

PROFESSOR: That's exactly right. The degree of severity will depend on which has higher levels. The calcium in the blood, the person with the higher calcium in the blood or uric acid, if it's elevated a little bit or a lot, it's going to affect the symptoms.

On the right you have the crystals, okay, as they look under polarized light.

And you here see -- honestly, it's hard for the untrained eye, it's really hard to detect this. It shows you an X-ray of the right hand, and the arrow points to some bone destruction due to gouty arthritis. That's, I think, difficult to see. It's there.

So fractures. You can have a simple fracture, which is basically the bone breaks two pieces. Comminuted fracture is a bone that gets shattered. Compound fracture is that the bone is broken and the overlying skin is broken, so you run the risk of an infection because there is a break in the skin. Pathologic fracture is a fracture through a diseased area in the bone. Some people would say like that osteoporotic X-ray I showed of the spine, that that is a pathologic fracture. It's through a diseased area in the bone, and it occurs and they may be asymptomatic from it. Treatment, closed reduction with plaster cast or open reduction where they actually go in and they () the
two ends of the bone fractures together and they may fix them by putting a pin in.

Osteomyelitis is an infection of the bone, okay, the bone and the adjacent bone marrow cavity. Basically blood gets into the area and organisms gain access to the bone by spread through blood. IV drug users are at increased risk for osteomyelitis. It's difficult to treat. They need IV antibiotics for an extended period of time. Sometimes surgeons actually have to go in, make an incision over the osteomyelitic area, and they scrape off the periosteum. The periosteum is the covering of the bone. They actually scrape it clean to try to reduce the amount of bacteria that's present and promote healing. Typically it occurs more in younger children or certain adults, like I said, who have IV drug use.

So the organisms gain access to the bone by direct implantation of bacteria. It also can occur following trauma or surgery. They get a fever, and they have local pain and tenderness. You get an X-ray, it shows changes in the bone.

Tumors of the bone. Metastatic tumors from the prostate, breast, other organs. I mentioned multi-myoma in the previous lecture. That's a tumor of the B lymphocytes. The B lymphocytes produce antibodies. So these people who have multi-myoma, it's the older age group, they tend to produce high levels. And when you do a blood test, they have high levels of antibody chains. And these antibody chains, they are not healthy normal antibodies. So these chains spill into the urine, and so they have -- when you do a uranalysis on them, they have Bence Jones protein in the urine. We say that Bence Jones protein is pathognomonic for multi-myoma. Pathognomonic, once again, means if you have that it's diagnostic of a specific disease or entity. So multi-myoma tends to occur in people in their 60s and 70s. It occurs usually in the spine, can occur in the skull and also the pelvic bones. All right. It's very noticeable on X-ray of these bones. You also can get benign cysts and tumors occasionally in the bone. You can malignant bone tumors. Chondrosarcoma is a malignant tumor of cartilage. Chondro is going to be cartilage. Osteosarcoma is a malignant tumor of bone.

Osteoporosis, generalized thinning and demineralization of the entire skeletal system. It really results from loss of estrogen. Also can develop in elderly men. It's a relative bone thinning. The thing about the bones of men is that because of testosterone our bone density is lot greater. We can lose bone mass, but we very rarely develop the fragility of the bone that osteoporotic women get or postmenopausal women get. The best treatment is going to be medication, all right. Obviously men can't take estrogen. It's unhealthy for women with the risk of endometrial cancer, affect on the breast. Calcium in the diet really is not that significant. Calcium in the diet is not that significant. There's different preparations for medication
that women can take. Once a month you can take a pill. Once a week. There is an IV preparation that's given every six months. I don't think it's once a year. I think it's every six months. And now there is a shot that can be given, a depro type of shot.

Here we go. There is the X-ray again. It's a good X-ray. Okay. Avascular necrosis, I've never seen this. It is interference in the blood supply to the epiphysis of the bones. The epiphysis is the growth plate of the bones. The epiphysial disks, that's the growth plate of the bones. And what happens is with avascular necrosis, there is a breakdown of the epiphyses. And common sites will be like the head of the femur bone, all right. I'm not really going to ask you anything on this.

Spine. The spine is made up of the vertebral columns. It forms the central axis. You have the vertebral bodies that join and meet. There is disks in between the vertebral bodies. What these disks do is they serve as cushions to absorb shock. And there is four curves of the vertebral column. You have got the cervical, okay, and the lumbar which is the lower, thoracic, and the sacrum. The thoracic and sacral curves are in the opposite direction from the cervical and lumbar.

Oops. Let's see here.

Okay. So here is the side view. You will see the spine being divided into the cervical spine, thoracic spine, the lumbar spine, and the sacral, okay.

And there is a general diagram of the vertebral body. And basically, I want you to notice the intervertebral foramen. That is significant in that that is where the nerve comes out from the spinal cord, okay. It comes out through that opening. Then, of course, you have the disks, all right. And you people have -- can injure their disks, herniated disk. In the diagram you can see the red disks and how if you injure it, it could protrude, okay, and reduce the size of the intervertebral foramen. It could put pressure on the nerve. As a result when people have herniated disks and they have neurologic symptoms it's due to the disk putting pressure on the nerve at that location.

So here we have cross-section through the intervertebral disk. The one on the left shows you the annulus fibrosus, which is a very firm cartilaginous ring. In the center is the nucleolus pulposus, which is a gel. What happens is during exercise, improper exercise, with weights or reaching inappropriately, extending yourself, you put too much strain on the disk, and as a result there is a breakdown in the annulus fibrosus and it allows some of that nucleolus pulposus in the center to bulge out. And when it bulges out, it bulges and puts pressure on the spinal nerve. As a result you get discomfort.

So the intervertebral disk disease, all right, they can undergo progressive wear and tear, degeneration. The nucleolus pulposus extrudes through the annulus fibrosus. As a result you
get back pain and you can get radiation down the leg depending on the location of the herniated disk. You can also have disk injury in the cervical spine and have to have a fusion. The fusion is where they take the disk out and they fuse the vertebral process above and below.

Yes?

STUDENT: (Inaudible)

PROFESSOR: What? It doesn't usually go in on its own. Don't plan on that. You can have physical therapy. And what happens is when it protrudes, it's up to the patient to decide. You know, if they have intractable pain, therapy doesn't help, there is no other alternative, they may want to have surgery. Diagnostically, they may have it, they may have some symptoms that may not be that severe and they may want to live with it. It really depends. It doesn't cause cancer, and you don't die from it.

STUDENT: Pain makes you crazy after a while.

PROFESSOR: I'm not saying it doesn't. Well, any type of chronic pain can do that.

All right. So here they show you a herniated disk through CAT scan, the herniation there.

Scoliosis, abnormal lateral curvature of the spine, so it goes to the side. Lateral is to the side. Occurs in 4 percent of the population. Most cases are idiopathic; we don't know why it happens. It occurs in adolescence more in women than men. As a result it can lead to asymmetry of the trunk, decreased size of thoracic cavity, one shoulder may be higher than the other. The pelvis may be tilted. As a result they may have some back discomfort issues. Large curvatures can pronounce increased compromise for the patient.

Here you have someone with mild curvature on the left, extreme on the right. Left looks pretty bad, but compared to right it's not. But it is.

So skeletal muscle. What happens when the muscles contract is the myofilaments slide together. There is the junction of the nerve with the muscle, the myoneural junction. So the muscle is innervated by the nerve. And the nerve stimulation causes release of acetylcholine, that then crosses the myoneural junction and interacts with receptors on the surface of the muscle fibers and causes the contraction. Basically, you need to have an intact nervous supply. Neurotransmissions and impulses across the myoneural junction, and you need to have normal metabolic processes within the muscle cell.

Myositis is an inflammation of the muscle. It can be from injury or overexertion or sometimes from a systemic disease.

Let's see. So basically with the muscle, there is relatively rare diseases of the muscle, and they tend to be characterized by atrophy and degeneration of the skeletal muscle. These are not that common.

Myasthenia gravis is interesting. It's a chronic disease
characterized by abnormal fatigue ability of your voluntary muscles. It's due to abnormality at the myoneural junction. They can have an autoimmune disease, so they have autoantibodies, and these autoantibodies are against the acetylcholine receptors at the myoneural junction. So remember the acetylcholine, okay, are the chemical transmitters at the myoneural junction. So if you have antibodies against the acetylcholine receptors, we are talking about that at the myoneural junction. Then you block these receptors. And if there is acetylcholine in the myoneural junction, it cannot bind to the acetylcholine receptor. As a result there is no -- you can have decreased muscle contraction because there is no receptors available. So basically, the treatment is drugs that prolong the action of acetylcholine.

STUDENT: When does it usually present?
PROFESSOR: When does it usually present? I'm not really sure of the average age. It's not in the younger age group. It's later on. And there's different degrees of it.
STUDENT: Once you have it, it doesn't go away? It says the same?
PROFESSOR: Right.
(End of class.)

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