>> Prof. Steve Langjahr: February 22, 2017. This is our fifth lecturer in anatomy. It's our second system, and one that we'll spend a ton of time on in lecture, handling the bones of the skeleton. So in lecture, we're not really going to describe individual bones much. But rather, give you an overview, the big picture. Some of the organizational issues, functional attributes of the skeleton. As we look to the skeleton, we see it's made of a number of bones. And I venture to guess that many of you know the exact number. What is the number of bones in the human skeleton?

>> [In Unison] Two-hundred and six.

>> Prof. Steve Langjahr: Yeah. I remember my son came home and one day in the fifth grade. And he said, "Dad, we studied the skeleton." I said, "Great, Derek, how many bones in the skeleton?" He said, "206." I said, "Yeah, high five. And I said,"Derek, how many bones in the skull?" And he looked at me sort of stunned, and he said, "Well, one."

[Laughter]

Well, no, actually. But anyway, we'll get to that. Yes, there are 206. Are you born with more or less than that number? Way more, 50% more. And that's a paradox. How do you have less now than you did when you were born? Obviously, bones that were many, fused into one. And so that's the nature of growth, and certainly a fact. So let's begin to organize, arbitrarily, this system. And science basically divides the skeleton into two parts. The vertical, or so-called axial skeleton, and everything that hangs on that, which is the appendicular skeleton. So let's go down the axial skeleton. The most superior component of, is naturally, the skull. And the skull is not one bone, but rather, incredibly twenty what?

>> [In Unison] Twenty-two.

>> Prof. Steve Langjahr: Two. And these are interlocked, joined by so-called sutures, at least in adulthood. These sutures can be seen in the specimens that we have. And it's possible to separate these sutures, at least in the laboratory, so that we can tear apart the skull into its individual parts. Eight of these 22 form the cranial cavity, and so naturally, they're called cranial bones. Many of these are paired, such as the parietal and temporal. Many of them are singular. But obviously, the cranial bones enclose the brain, provide physical protection for the brain and other structures therein. The rest of the bones are part of the face, and naturally called facial bones. These form what you might know as the cheek areas, nose bridges, the pallet, which you can stroke with your tongue, inside your mouth. The eye sockets, which are more properly called orbits. And the jaw, which from now on, we'll call the mandible. So these are the basic components, then, of the skull. Inside the skull and somewhat obscure, are the six tiniest bones of your body. They're called ear ossicles, a word which means little bone. Interestingly, these bones are the only bones of your body that never grow. They're the same size now as they were in your birth. They're inside the temporal bone, and maybe you know already their names. They're

the malleus, incus, and stapes. These make possible hearing, and so they have a function quite special and unique. Speaking of unique, there is this bone, which is actually considered part of the skull, even though it doesn't attach there. In fact, it doesn't attach anywhere. The name of the bone is the hyoid bone. That refers to a letter in the Greek alphabet, which is an upsilon, basically a U-shaped letter. And so the bone is U-shaped. It doesn't articulate with any other bone. It's suspended just above the larynx. And you can find it, even bang it back and forth. And naturally, it's a curiosity, and it begs for the question, what's it do if it doesn't attach to anything? Actually, muscles attached to it. Every time you swallow, you can feel the hyoid move. And so it helps in the movement of the larynx, which is necessary for swallowing, in order to divert food into the esophagus. The hyoid has some forensic significance, if you watch CSI. If somebody is found dead and their hyoid is broken, that suggests what? Strangulation by one means or another. It's difficult to break, but certainly commonly broken in that kind of trauma. So moving away from the skull, the rest of the axial skeleton forms the trunk. Which is a catchall phrase for the vertebral column and the ribs, which attach, at least in part, to some of those vertebrae. So perhaps you call it the spinal column. You can also call it the vertebral column. And you know, naturally, that it's basically the stacking of individual bones. And those individual bones are called vertebrae. Notice when you have an E on the word, that's plural. What's a single bone? Vertebra. Vertebrae is plural. There are 26 vertebrae in the adult spinal column. And they all have a basic design or similar four plan, or floor plan, so to speak. But let's at least enumerate them from proximal to distal. The first are call what? Cervical. The word cervix means neck, and there are seven of these. Interesting, of course, how many bones in a giraffe's neck? Seven. Interesting. So seven cervical vertebrae, followed by 12 so-called thoracic. These are those that are associated with the thoracic cavity. And you would guess, associated with what other bones, then? What bones form this cage around the thoracic cavity? Ribs. So, by definition, thoracic vertebrae are those which attach to ribs, or have ribs attached to them. Distal to the thoracic are five rather stocky and sturdy vertebrae. These are called lumbar. The word lumbar literally means back. And we know that word refers to lower back in most conversations today. And then below that, distal to that, is a single bone, at least in adults. But it started out as five individual bones. The name of the entire bone is called the sacrum. Now, the word sacrum, interestingly, means sacred. I'm not sure how sacred it really is. But that's the name. And distal to that are seven very tiny bones, collectively called the coccygeal vertebrae. And also, in most adults, those four are fused into one. One structure which is called simply the coccyx. Many people refer to that by the colloquial description. They call it what?

>> The tailbone.

>> Prof. Steve Langjahr: Their tailbone. Humans don't have tails normally. But nevertheless, these are remnants of those vertebrae in other animals, which constitute the tail. Yep, just seven cervical vertebrae in a giraffe, just like you and I. The basic design of a vertebra is shown from above in this sketch. And

I've got one enlarged there on the board. So although you'll spend more time in lab on this, we should at least describe the various parts. Because it is familiar to you that the vertebrae, as they pile up, create a space which surrounds and creates the spinal cavity. And what goes through, or otherwise is protected by the spinal cavity, is the spinal cord. So here is the design of a typical vertebra. And this is, let's call it posterior, or dorsal. And this is anterior, or ventral. We could also think of this as a clock. So that would be 12 o'clock, 3 o'clock, 6 o'clock, 9 o'clock, in back. This structure which sticks out the back, and is very palpable, is called the spinous process, because it is very spiny or slender. Those two processes, which extend laterally, in fact, bilaterally, run obviously transversely. So what is the expected name for those? Transverse processes. The weight-bearing part of each vertebra is indeed very heavy and stout, and has the simple name body or centrum. But how, then, does the body communicate with the transverse process? There's this bridge of bone that joins the body to the transverse process. And that's called the pedicle. The word pedicle means foot or pedestal. What joins the transverse process to the spinous process, this bridge of bone here, is called the lamina. And, of course, there are two lamina. So as we go from 12 o'clock all the way around, what is at the 12 o'clock position? Spinous process. Then lamina. Then transverse process. Then pedicle. Then body. Then back to pedicle. Back to transverse process. Back to lamina. Clearly, what's created in the center is a hole, a pathway, for the spinal cord. And incidentally, if these bones do not form, if the lamina do not fuse, then the spinal cavity is exposed. And we mentioned the herniation of the spinal cord. You might recall spina bifida. So the development of each vertebra, naturally important. I was on a beach, actually, up in Monterey, and there was a dead whale there. So I couldn't resist going through the carcass. And so what does this look like? That's a whale vertebra. And this is a cervical vertebra from a whale. So I wanted to sneak that into my car, but I didn't think that would fly. But nevertheless, vertebrae are impressive in all mammals, especially in whales. The vertebral column doesn't always develop well. It doesn't always stay straight. And many of you recognize this as a adolescent condition that worsens with time. It's called what?

>> Scoliosis.

>> Prof. Steve Langjahr: Scoliosis. All of you were screened in junior high, unless you missed that day. But let's move on. The spinal column is, indeed, just that. But what attaches to some of these vertebrae are ribs. And they, in turn, attach to the sternum, at least some of them do. What about the sternum? Most people call the sternum the breastbone. But we don't, we call it what? And the sternum is actually not one bone at all. It has three parts: proximal, middle, and distal. The distal part, you can feel right now. And it might be rather rubbery because, at least in youth, it's partly cartilage. The distal end is called the xiphoid, which means to resemble a sword. S, W, O, R, D. And it is very pointy. The middle piece is simply called the body. And the proximal piece is shaped a bit like, well, a triangle. Its name is manubrium. So, to repeat, manubrium, body, xiphoid or xiphoid process. Do all ribs attach

here? No. In fact, technically, no ribs attach there. Those that do, do through cartilage. In other words, it's not a bone-to-bone connection, and thankfully so. Why? Why do we want cartilage connecting the ribs to the sternum, and not bone? Well, it would disallow expansion of the chest and certainly makes CPR a crushing, traumatic event. So the cartilage allows for expansion. Every time we inhale and exhale, there's flexibility, and indeed, a resilience and degree of shock absorption there. So the cartilage that connects some of the ribs to parts of the sternum are called costal cartilage. The word costal means rib. But specifically, what kind of cartilage? Does anybody know? It's hyaline cartilage, hyaline cartilage in this location. There are 12 pairs of ribs, which means, obviously, 24. And incidentally, this is true in either sex. Some people think men have less. That's some sort of Biblical reference, but no. What? They all have what?

>> Twelve.

>> Prof. Steve Langjahr: Twelve. Males, females, 12. Twelve pairs. Those that actually make connection to the sternum are called true ribs. Those that connect to other ribs, and therefore indirectly join up with the sternum, those are called false. And those that don't connect at all, are usually the last two. And for that reason, they're called floating. The number varies. That is, it's not actually always this perfect or exact. In fact, there are people on this planet that have ribs in their neck, actually. There in this picture, this is normally rib one, two, three, and so forth. These occur in some people, and they're called cervical ribs, because they're connected, obviously, to the cervical vertebra, number seven. It's pretty rare, and if you have this, you probably know about it. Because it probably occurred to you, that doesn't seem right.

[Inaudible Comment]

This doesn't cause any real impairment or disability. It's just a curiosity. And there are lots of curiosities in anatomy, of people born with one kidney or three kidneys. You know what I mean. So it's not alarming to find some weird things like this.

[Inaudible Question]

Not usually visible at a distance, but certainly palpable, that's for sure. And photographable, naturally, with an x-ray. So let's move on. We said that the axial skeleton, then, includes the skull and the trunk. And the trunk is made up of the vertebral column and the rib cage, which includes the sternum as well. So what about the rest? The rest of the skeleton basically connects to, hangs on, and is part of the axial skeleton. And for that reason, is called the appendicular skeleton. And the components here are pretty obviously the upper extremities and the lower extremities. The upper extremities, you'll get into great detail in lab. But basically, both of the extremities are connected at what are called girdles, or points of affiliation. The upper girdle might be known to you as the shoulder or shoulder girdle. But its anatomical name is pectoral girdle, which refers to chest. The pectoral girdle includes two bones that you may know, only one of which actually attaches to the axial skeleton. These are those two bones. The bone that we affectionately call the collarbone is better known as what?

>> Clavicle.

>> Prof. Steve Langjahr: Clavicle. The one behind us, scapula, often referred to as the shoulder blade. These then form what girdle? Pectoral girdle. Which of these actually connects to the axial skeleton, and where exactly does it connect? Does the scapula connect to the axial skeleton at all? No. Does the clavicle? Yes, and it does so right here at the sternum, specifically the M word, manubrium. And this allows for quite a bit of flexibility. In fact, the clavicle is almost like a joystick there. And naturally allows for much greater vertical reach, as you reach above your head. That said, when we fall and we reach out to break our fall, the energy of that impact goes up our arm, and passes right through the clavicle. Therefore, with that knowledge, what do you think is the most commonly broken bone in the human body?

>> Clavicle.

>> Prof. Steve Langjahr: Clavicle. For exactly that reason. Kind of interestingly though, the least commonly broken bone in the body is the scapula. And that's also understandable, because it's not connected. That is, it's not a pathway for energy as we break our fall, and so it's not likely to encounter a great deal of trauma. Now, what attaches to the pectoral girdle are obviously the bones of the arm. And maybe you know already, they are the humerus, radius, ulna. And then the bones of the wrist and the rest of the hand. We'll get to their names, but essentially, there are 27 bones in the hand alone. So they're quite complex, enabling all the wonderful things we can do with our hands. Creating pretty much everything around us. Everything that we see is built by human hands, more or less. So quite a testimony to the capability of the human hand. The lower extremities also number 60, but they're anchored to a girdle. A little bit beefier, a little stronger. And the name of this girdle is commonly called the hip girdle. But we're going to call it, instead, the pelvic girdle. It's actually made of six bones, three on each side. Although, those three fuse in adulthood. But, at least in youth, these three bones, which are not really distinct there, are the ileum, ischium, and pubis. Once again, when you're born, how many bones are here? Three. How many are there now? One. So the ilium, ischium, and pubis will fuse into one, and create at least one side of this so-called pelvic girdle. Attached to that, naturally, the bones of the legs, including the femur, tibia, fibula, and then the 26 bones of the foot. We know that the pelvic girdle is different in different genders, right? And we'll get to this in a moment, but which gender has a wider, more spacious pelvic girdle?

>> Females.

>> Prof. Steve Langjahr: Females. And this accommodates the passage of a fetus. Looking at these, at first, you might see little difference. But just visually appreciate this dimension, and notice it's much narrower here. So this pelvis must be the male, and this is the female. And you'll learn and be expected

to recognize this in lab. So here, then, is a brief description, at least of the organization. And we'll study the skeleton, essentially, in these two parts. Now we have to sort of unravel, that is reveal, some terminology here, that refer to skeletal morphology. Morphology is the study of shape. Everything that we see and handle has some morphology. Does a chair have morphology? Does an automobile have certain morphological features? Yes. So morphology is simply the design, which, of course, correlates heavily with the function. So what are some surface features of bone? Knowing up front that none of these features are accidental, and none are therefore aesthetics. All of them have a definitive function and we'll allude to those. But let's first describe categories. The first of these morphological categories are those that are projections or elevations. And very often, these can be palpable. What's that mean, palpable? You can feel them through the skin. Because they are surface features which often poke or protrude. The first one, which is a very common description, is a process. A process, for us, means any roughened protrusion or bump. Now, right behind the ear, you may know, there's one that's very palpable. And, in fact, it's number 24 in this illustration. You may know it's called the mastoid process. Its function is for muscle attachment, specifically tendons of skeletal muscles. Therefore, it provides an anchoring point, so that motion can be created. I mean, after all, what is skeletal muscle? That is, why is it called skeletal muscle? Attaches to the – and therefore moves, or at least supports the skeleton. And a process is one of many that allow that kind of connection. A spine. We think of the spine as a generic reference to the vertebral column, but it's much broader. A spine is any pointy or slender process. So indeed, as you reach over your shoulder, you'll feel what bone back there? We've already named it. Scapula. And you can feel, running horizontally, a long, slender spine. It's called the scapular spine. And its function also marked with an asterisk. What does the asterisk refer to? Looking down the page, a reference to what? An attachment for a ligament or a tendon. In other words, the attachment of connective tissue. In case that wasn't something you caught previously, tendons connect what to what?

>> Muscle to bone.

>> Prof. Steve Langjahr: Muscle to bone. Ligaments connect bone to bone. But many of them attach to a spine or a process, in order to get a good grip on the bone. A crest. A crest refers to something that's semicircular, and therefore curved and ridge-like. Often roughened, and roughened implies, again, for ligament or tendon, attachment. Usually tendon, therefore a reference to skeletal muscle. Then we have something called a condyle. Here's a look at, obviously, the hand. Twenty-seven bones here. And we see in the knuckles, as an example, smooth, rounded surfaces. Smooth, of course, implies for motion. And so condyles are indeed designed and used as a joint, a movable joint. Usually located around a condyle are bumps which have nothing to do with the movement of the joint directly. But they do support and maintain the proximity of the bones. Those are not called condyles, they're called epicondyles. The word epi means upon or above. And so we describe them as a prominence, a bump near a condyle, typically for ligament attachment. Therefore helping to keep the bone

indeed connected with the other bone. So with that said, if ligaments break, then the joint is going to separate, something called dislocation. Epicondyles, then, tend to provide attachment points for ligaments more often than not. Then we have something called a tubercle, which is a word not totally unfamiliar. Perhaps you've heard the word tuber, especially in biology. But the word tuber simply means bump. And so it is a small, rounded nodule. Here's the first rib, seen from above. And here is this so-called articular tubercle. Again, there's an asterisk. What's an asterisk mean? Point of attachment for ligaments or tendons. In some locations, we have larger tubercles, which are called tuberosities. And that doesn't have to be scary, because if you think about it, tuberosity reminds you of monstrosity. Or at least, it suggests something bigger. And so what is the only difference between five and six? Size. Tuberosity, bigger than a tubercle. And bigger still, is something called a trochanter, which is limited to and found only in the femur, the proximal end. And in lab, you'll discover number three is called the greater trochanter. Number five is called the lesser trochanter. Why are these marked with an asterisk? Asterisk means ligament or tendon attachment. And they're roughened in order to make sure that the connection is strong and durable. So these are some projections and elevations. Most of them provide for connective tissue attachment. Some of them are important in forming slippery or smooth surfaces for a joint. But let's go to the next category. These are depressions. Depressions are just that, not convex, but concave. And a number of words are applicable and fit this description. Fossa, also called fossa, a shallow, blind pocket, often forming a what? Joint. Now, blind doesn't mean it doesn't see. Blind simply means it is dead-end. You could pour water in it and it would fill. In other words, there's no outlet. And so here, we're looking at the skull, specifically the cranium from above. And back here at 30, there are two shallow fossa. And maybe already, you know that these are called the posterior cranial fossa. These, in fact, don't form a joint. You know from your lab work, perhaps, that a part of the brain sits there, specifically the cerebellum. But at least some fossa are important in this way. Next on the list, fovea. Not to be confused with phobia, which means to be scared of something. Fovea simply means a small pit. And most commonly, or at least the best example, is the one at the end of the femur. Specifically, in the head of the femur. You can't see it in this view. And that location is called the fovea capitis, but you'll get to that. You'll see all that in lab. A fovea, though, is an anchoring point for a ligament. And to say again, ligaments connect what? Bone to bone. And in this context, then, prevents dislocation of the hip. Number three, a sulcus. That's not a – well, wait a minute, is that singular or plural? Hmm. Actually, it's singular. Plural would be so sulci or sulcuses [phonetic]. But in Latin, the word sulcus means a groove. And it's often a very deep, bony groove, which tends to support. That means surround and keep in place, blood vessels. Back here, we already identified the posterior cranial fossa. And number 26 runs transversely across the back of the cranium at that location. If you've had lab, you may already have been introduced to the fact that that's called the transverse sulcus. Its function is to cradle, to hold in place, a very large vein in that location. Then number four, facet. Or some people pronounce it facet. Some people mispronounce it, faucet. But I assure you, it's not a faucet. It's a facet, a flat or slightly shallow pad, very often smooth. And whenever you say smooth as opposed to rough, you think, you naturally think about something forming a J, O, I, N, T, right? And so facets often do form an articulation or a joint. Especially prominent along the vertebral column, and in conjunction with the ribs. Let's move now to openings, holes or chambers. The generic word for a hole, at least in anatomy, is foramen, which is actually singular. So when you say foramen, you say hole. Are there a number of holes exiting and entering the cranial cavity? In fact, the biggest one is obviously 31 there. And many of you know already, its name. It's called the foramen magnum, because it's the biggest. And the function of a foramen is to allow passage of soft tissue. What soft tissue goes through number 31? Spinal cord. So as we discuss and as you study these terms, don't just remember their description, but rather, connect to a function. So what is a foramen? It's a hole. What's its function? To allow passage of soft tissue, including vessels and maybe nerves. So again, these holes aren't there for fun. They're allowing the passage of veins, arteries, very often nerves. Beyond that, we have narrow cracks, very often gaps. Gaps between bones, and these are called fissures. Fissure is actually a term borrowed from geology. If you see a crack in a rock, what is that crack in the rock? It's a fissure. When we have the big one here, we're going to have a big fissure all up and down the state. But anyway, the word fissure just means a crack, a narrow slit. And again, not by accident and not without purpose, here, we see the eye socket. And is there a gap running vertically up and down in this particular space? Yeah. And maybe you know already, this is called the superior orbital fissure. And the one that runs downward is called the inferior orbital fissure. Speaking of orbit, that has nothing to do with space or even atomic chemistry. Orbit means, for us, a deep, circular pocket or socket. And without other description, the orbit always refers to these, of which you have how many? Two. The orbits are, in fact, made of many bones, to accommodate the eyes and other structures in the orbit. Number four, a meatus. The word meatus is singular, so meati would be plural. As a word, it simply means a circular entrance into a long, tubular space. And so if I stick my finger in my ear, is that a meatus? It is. It's in the temporal bone, as you know. And many of you know that that's the external auditory meatus. And there's also an internal auditory meatus, which is seen inside the cranial cavity. So a meatus is essentially an entrance or an exit from a tubular space. And therefore, is accommodating the entry or the exit of some soft tissue. Or, in the case of the ear canal, sound. Dorothy.

[Inaudible Question]

Well, they could be, but that's not bone. In other words, that's soft tissue. So all of these structures that we're describing are visibly found in bone. And therefore, they would be seen in skeletons that are laying in the Antelope Valley, or whatever. Next, but not always visible, and certainly by definition, concealed, are sinuses. Everybody's heard the term sinus. You might be taking medicine for sinusitis. And there are four sinuses that surround your nasal cavity. They're called paranasal sinuses. And you'll know and you'll describe and you'll be able to identify them in lab, especially with x-ray photography. But, by definition, they're invisible. So what's the C word here? Concealed. The only way to see a sinus is with technology. Or in this case, with just high-powered light. This is a skull lit from behind. And what do we see that otherwise would be invisible? These spaces. And because they're in this bone, what are the exact name for those sinuses? Frontal sinuses. We also have the maxillary sinus, ethmoid sinus, and you know, perhaps also, the sphenoid sinus. Hollow cavity for – leaving that blank. Anybody have any ideas? You might say, well, I don't know. Sinuses don't seem to have much function. They just give me a pain. They do contain air, but that isn't their function. So let's leave that on the table, we'll leave it hanging, we'll come back. It's actually quite an interesting function that certainly is not obvious. But let's move on. As we leave these terms, many of which you'll use over and over again, we want to now turn our attention to the functional aspects of the skeleton. Does the morphology of the skeleton relate to its functions? Yes. And we mentioned that there is very few, there are very few features of the skeleton that have no function. So what are some of the obvious functions? Knowing that the architecture of bone, that is bone morphology, directly relates to function. It determines and limits that function. So right off the bat, you would assume that the skeleton protects, right? Protects what? Protects how? What are we protecting against? House dust? Mosquitoes? No, we're protecting against what?

>> Trauma.

>> Prof. Steve Langjahr: Trauma, most often. So physical protection against trauma. And what's an example? Have some examples in mind. What part of the skeleton is famous for its protection of what?

>> The skull.

>> Prof. Steve Langjahr: The skull is designed to protect your –

>> Brain.

>> Prof. Steve Langjahr: – Brain. Are vertebrae protecting anything? Are ribs protecting anything? Is the pelvis protecting anything? So a number of examples. Number two, the skeleton permits movement and provides mechanical advantage or leverage. Now, this is important to stress: the skeleton doesn't cause movement. What causes movement? Muscle. But does the skeleton permit muscle to cause movement? Yes. And, of course, we refer to joints. It's joints that really allow the skeleton to have this function of movement. Number three, support. Even if you're not moving, is the skeleton supporting your body against gravity? Yes. And there are a number of examples, most notably these bones that stack up to form your vertebral column. Do they support? Sometimes not so well. Think of scoliosis. But still, support is inherent there. And other examples include, obviously, the femur. What happens if you break your femur? Well, you're not going to have any support there. In other words, you're not going to be walking. Allows passage of soft tissue. What part, that

is, what attribute of bone allows for this function? What does soft tissue go through? Holes, and what do we call those holes? F word, foramen, or another F word, fissure. Or an M word, meatus. So are these holes there by accident, or do they accommodate the passage of soft tissue? Soft tissue means nerves, arteries, veins, sometimes ligaments or even tendons. Number five, mineral reserve. We don't think of our skeleton as a bank, B, A, N, K. But it is banking something. It's storing – storing what minerals, to be exact? Calcium and –

>> Phosphorus.

>> Prof. Steve Langjahr: – Phosphorus. Now, when you hear the word storage, you think, well, storage for what? A rainy day? No. Are there people who become pregnant? Yes. And what does that have to do with anything? When a skeleton, when a new human being is developing in a woman, is a skeleton being formed there?

>> Yes.

>> Prof. Steve Langjahr: And where are the resources coming from to build that skeleton? Mom's skeleton. Is mom's skeleton sacrificing for the sake of this new skeleton? Yes. And can mom's skeleton suffer because of that? Yes. So anyway, mineral reserves, specifically calcium and phosphorus. Now, there are some curiosities in the skeleton that don't seem to fit either of these five functions. For instance, why is the female pelvis wider? Is it for better protection? Not really. Does it provide better support? Not really. Oh, allows passage of soft tissue. Sort of.

[Laughter]

Because obviously, an infant, not entirely soft, but is going to be passed. So, once again, we return to these images, this time from above. Which of these pelvises is a female? Left or right?

>> Left.

>> Prof. Steve Langjahr: Left. Very hard to get a fetus through that. Indeed, it would be hard to create a fetus in that. This is male, this is female. In general, male skeletons are heavier. So what? Is that for better protection? Is that for better support? It's kind of a stretch, but we know that men are, well, more muscular, aren't they, than females, as a rule? I know you can find a more muscular female than me.

[Laughter]

But, in general, what does that have to do with anything? Muscles create force, energy, right? And? So what? Does that require that the bones be stronger? Yes. Indeed, as you become muscular, by any means, what happens to your skeleton in response to that increased muscle mass? Does your skeleton become stronger and heavier as a result? Sure. And vice a versa, if you never exercise, what happens to your skeleton? All right. So heavier skeleton in males is just a reflection of their muscle mass. Which demands a stronger frame. Foot arches.

You know that the bones of your feet, 27 of them, are not all in contact with the ground. Or even the inside of your shoe. That is, there's this vertical sort of arcing or arch. Why is that? Well, you've heard the term balance and certainly equilibrium. But basically, this provides for better shock absorption, better energy absorption, when you do what? When you – when you run, when you walk. So that function is not listed here. You don't see it in 1, 2, 3, 4, or 5. Foot arches provide energy absorption. That is, cushioning from the hard knocks of running. The patella is a curious bone. We all know that that's the kneecap. And it's tempting to say, oh, well, that's protection. It's out there, it's protecting something. It's like a shield. But not really. The function of the patella is actually listed there, but not an obvious function. And that is it provides functional advantage, something called leverage. Here's a meter stick, and this is just a support there. If I push down here, does that improve my ability to lift something? This is a standard lever. And so the patella is a point of leverage which allows these muscles in the thigh, you know as the quadriceps, to have better action on the tibia. So we can kick soccer balls better and get paid for it. So the patella, not for – not for protection, but for better mechanical advantage, better movement. The ear ossicles are instantly distinct. They don't provide protection. They are designed to transmit movement picked up by that membrane skin covered drum called the tympanic membrane. Ear ossicles, important for hearing. And now we're back to sinuses, which we left mysterious. They are, by definition, hollow spaces. But what good do they do? Are they for protection? Support? Mineral reserve? Passage of soft tissue? No, no, no, no, no

[Inaudible Comment]

They do sometimes become pesky or painful because of air pressure changes. And can they become infected? Yeah. But none of that's the function. Actually, air doesn't move through the sinuses, although it moves in. So here it is, the sinuses are to lighten the skull. Some people have a hard time holding their skull up as it is.

[Laughter]

So we find, actually, if you think about it, a sinus is the absence of bone, isn't it? So think about the maxillary sinus, what if it was solid bone? Would that serve any advantage? No. Would it be a disadvantaged? Yes. Why? Because it would be heavier. So sinuses lighten the bone and that is an important function. Why the fused sacrum? We said the sacrum is five bones. But in you and I, it's actually one. Does that provide for better mineral reserve, or passage of soft tissue? No. What do you think?

[Inaudible Comment]

Well, maybe so. But basically, one solid piece is stronger than five individual pieces. So yes, it's strength, but also provides better support. Especially at that location, because doesn't every – doesn't the weight of your entire body pass up through your legs through your sacrum? So it is, obviously, a key point, which deserves that kind of strength and rigidity. Let's finish here real quick. Bone, we shouldn't think of as just cement, but rather, living tissue. And as living tissue, can it be healthy and unhealthy? Are there bone disorders? Yes. One is called rickets. You don't hear about rickets much. At least not in this country. But it's due to faulty calcium deposition. Either because of lack of calcium in the diet, or because of lack of this vitamin which prevents the absorption and deposition of that calcium. So here we see some x-rays of legs that are bowed, right? Why does this disease affect the lower extremities more than the upper extremities? These are the ones that are weight-bearing. So this is the result of lack of vitamin D and/or sunshine. Here's another case of rickets. And you can see it causes these black bars on the face and nose.

[Laughter]

Terrible thing. Only joking. Now, in women, there's a kind of rickets, which is not rickets. Remember, we said, women that become pregnant are going to give up their calcium for the sake of the new skeleton. Will that cause reduced calcification of their own skeleton? Will that cause softening of their own bones? Yes. And please be clear, it softens the bones. It doesn't make them brittle. And so the term is osteomalacia, which literally means softening of the bones. Can you fix this? Can you treat this? Yeah. Don't get pregnant.

[Laughter]. Only half joking. But obviously, women who have become pregnant, as joyous and as welcome as that might be. They should be advised to what? Beef up their intake of –

>> Calcium

>> Prof. Steve Langjahr: – Calcium. And not just calcium, but also vitamin D. Another condition that affects everybody as we get old. So look forward to this. Osteo what? Osteoporosis, or its precursor, which is called osteopenia. Osteoporosis, more common in men or women?

>> Women.

>> Prof. Steve Langjahr: And why? Not so much the birth thing. But women undergo a period of hormone depletion called meno –

>> Pause.

>> Prof. Steve Langjahr: – Pause. And the lack of estrogen causes their bones to get well, more porous. What's the name of this more porous? Osteoporosis. Which of these femur sections would seem to be that? Left, or right? Right. This reminds me of a game you might have played as a kid, Jenga. Remember Jenga? You pull out these pieces. None of you have played it, okay.

[Laughter]

>> Oh, I did.

>> Prof. Steve Langjahr: Google it. Okay, thanks, good. So what's the analogy there? You pull these pieces out, and eventually, what?

[Crash Sound Effect]

So which of these sections is on the verge of collapse here? Osteo what? Porosis. Do men get osteoporosis? Yes. Why not sooner? Number one, we said men have already what? A heavier what?

>> Skeleton.

>> Prof. Steve Langjahr: So they have more to lose. That is, it's not going to be affecting them, necessarily. And they have the hormone, T word, which women don't. Finally, osteomyelitis, which is an infection of bone. You say, wow! That can't happen. Bones can't get infected. Well, they can. Anything can be infected if it's contaminated with bacteria. Now, bones are isolated from most bacterial infections. Except when they break, right? So if you had a fracture, and your bone is sticking out in the world here, look forward to what? Osteo – osteomyelitis. So treat your bones well, exercise, vitamin D, calcium intake.

>> Why does the skull get, like it's harder to break [inaudible]?

>> Prof. Steve Langjahr: Simply because it gets heavier. Why is that?