>> Steve Langjahr: March 21, 2016. We have some unfinished business on this page, which is 48. We more or less left you with the basal nuclei. The basal nuclei are areas of grey matter seen here in green, which are deep within the cerebrum. Remember, when you see the word nucleus or nuclei, we're dealing with a congregation of nerve cell bodies. Which, by definition are not myelinated, and therefore they are grey. So in terms of location, the basal nuclei are obviously in the cerebrum. But specifically they are bilateral to a structure we'll get to in a moment. A structure called the thalamus. So before we move on, a remark about general issues when it comes to elements of the nervous system. You want to be able to obviously recall the name and the location. But location is not just general but specific. We want to know what division of the brain it is and what position. So the basal nuclei are part of the forebrain. And their position, or specific location is bilateral to the thalamus. Then composition -- composition means what's it made of. And that's right here. It's a bunch of nerve cell bodies. So it is, in fact, grey matter bilateral to the thalamus. Function, always a part of our concern. And we mentioned last time that this area of your brain adjusts and subdues spontaneous motor activity. Thus, it allows you to move in a coordinated, uninterrupted fashion without jerks or hesitations. And what sort of failures can you think of? What sort of conditions would reflect damage to the basal nuclei? Certainly a condition you know by name called Parkinson's Disease. And these are two of the famous victims of that condition on the left. Mohammad Ali, and on right here, you may know Michael J. Fox. So this condition is characterized by tremors and spasticity of muscles, which makes movement of course, problematic. Next, as we finish the forebrain, or at least the elements that are deep within the cerebrum, we have a system that is a bunch of structures that are lumped together, and referred to collectively as the limbic system. The word limbic comes from limbus. And limbus means at the border or at the edge. So these are structures that are congregated around fluid-filled spaces within the brain called ventricles. The limbic system is not something you can point to because it is not a specific, singular component. It's a group of many components which certainly include other elements listed separately. Such as the thalamus; even elements of the hypothalamus. So the limbic system is a group of structures responsible for some very important elements. That is, they regulate behavioral aspects of major emotional factors such as pain, guilt, rage, pleasure, and what? Sexual satisfaction. Now don't get this wrong, the limbic doesn't acknowledge pain. But it's your what? It's your response to, or how you feel about pain. Whether you have guilt of any kind. And how you react to incidences which might lead to, shall we say, an enragement. These areas of the brain are obviously overflowing into elements of sociology and psychology. And therefore the limbic system is much the concern of sociologists and psychologists, as you can imagine. Damage to, or somewhat deficits in the limbic system are not going to land you in the hospital, but they might land you in jail. What do I mean by that? If someone cuts you off on the freeway, are you going to shrug it off? Or pull out a gun and shoot them? Maybe that's a little over-stated, but aren't these elements that are wrapped up in here. So how we react to circumstances. How we react to enraging episodes. Even pleasurable episodes. In other words, how we express our feelings with respect to these ideas, is really the responsibility of elements of the limbic system. And furthermore, these are also concerned with retrieval of what? Short-term memory. That means a phone number that someone's just recited for you. Your ability to repeat it back over the next minute or so. The limbic system. Turning into the rest of the forebrain and finishing up. Aside from the cerebrum and deep within the cerebrum seen here, is a structure referenced as the thalamus. The word thalamus means, "little room" -- R-O-O-M. It's actually a bilateral area of grey matter which is medial to the base of nuclei, but also bilateral to this gap, or fluid-filled space here, which is called the third ventricle. So there are many ways to locate the thalamus. You could say, indeed it's bilateral to the third ventricle. Or you could say that it's medial to the basal nuclei. So just in case you're disoriented, let's start again. This is the cerebrum cut in a frontal view. You might recall this is called the longitudinal fissure, and this group of white matter, which moves or carries signals from the left-to-right cerebrum. That was called the Corpus Callosum. And this space, which is marked as 14, is the third ventricle. We'll be getting to that momentarily. And so this grey matter on either side is the thalamus. The thalamus can be thought of as a kind of hub -- H-U-B. It's often described as a kind of switchboard, or a relay point. Because all upcoming sensory information -- nearly all sensory information from the spinal cord makes a stop here in the thalamus. So in that sense it makes preliminary assessment of the stimulus. Where approximately did it come from? And what approximately does it represent? So with that said, it allows crude approximate assessment or appreciation of some sensations. So the thalamus, by itself, would be able to tell that there's some disturbance in the left hand. But it wouldn't know exactly which finger, or whether it's anterior or posterior. So it would send that information on. It would make a preliminary assessment, and the precise determination of whether that stimulus was in the first, or second, or fifth digit. That would be determined ultimately by the primary sensory area of the cortex. So again, using an analogy, this is like a switchboard that might be at a big institution. All incoming calls would arrive there first, and then those calls would be routed to specific areas for proper response. So in summary, it's a relay point for virtually all upcoming sensory information, which eventually will be passed to areas of the cerebral cortex. It's a function. Its location is

embodied right here. It's medial to the basal nuclei. Or you could say it's bilateral to the third ventricle. Not only does it have century responsibility, but it also gets involved in movement. Because here you can read it helps direct. Helps to plan certain motor activities. Whether it's some sort of physical performance. Whether it's dance or athletics. Or just ordinary movements of your hands and fingers. So it's not exclusively sensory, it's just mostly sensory. So to be exact again, this area that I'm circling is in fact the thalamus. So these areas of grey matter below the thalamus would rightfully and logically be called hypothalamus. The prefix hypo means under or below. The hypothalamus is much smaller than the thalamus, but certainly no less important. So among its functions is that it regulates your behavior in response to what? Fearful situations. And being very simplistic here, what are the two behavioral responses that are possible with fear? Fight or flight. You either confront or you run away. And I'm not trying to suggest that one is better than the other, but rather, that this is something that the hypothalamus decides or is concerned with. Much more commonly though, and much more in the background are its effects on the autonomic nervous system. Because as you can see, it regulates virtually all of our life support functions. Something we call vegetative functions. To vegetate means simply to be alive. So what are some vegetative functions that make any of us continue to exist, but controlling heartrate. Controlling blood pressure. And also functions like thermoregulation. What's that? Maintaining body temperature. Appetite and thirst. That's also controlled here by the hypothalamus. And sexual desire, also known as libido. And more intriguing, maybe also sexual orientation. All where? In the hypothalamus. And if that weren't enough, the hypothalamus also controls a nearby endocrine gland. The so called pituitary gland. Which you know physically sits where? It sits in the sella turcica, which is just millimeters away from the hypothalamus. So certainly the hypothalamus has a lot going on. Much of it subconscious in nature. Automatic in nature. But nevertheless, certainly an important part of the forebrain. Now before we leave and move on to the midbrain and later the hindbrain, we need to now focus on these apparent empty spaces within the brain, which we've already given a name to. And that name is ventricle. When you hear the word ventricle, what organ probably comes to mind? The heart. But the word ventricle by itself simply means "a cavity". So these are internal brain cavities. Which are not filled with air, but rather, filled with fluid. A fluid that will describe and otherwise give function to in a moment. Here we see the brain outlined in sort of orange. With the ventricles inside shown in their three-dimensional appearance. Connected in ways that we'll see. There are four ventricular spaces, hence four ventricles. So the first two are identical, and mere images of each other. And for reasons of position, they're simply called the lateral ventricles. So you have a left lateral ventricle and a right lateral ventricle. And they're pretty much shaped like a wishbone. As you can see in this transparent rendition of the brain. A wishbone. And in fact, the shape of the lateral ventricles tends to mimic or match the lobes of the brain. The lobes of the cerebrum that we've dealt with. To repeat, what's this lobe out front? F word, frontal. What's this lobe way back here? Occipital. This one is the parietal. And this one down here would be the temporal. So notice the shape of these lateral ventricles pretty much follows or has representation in each of these lobes that we've just named. So I made a lateral ventricle out of some cardboard and spray painted it. So this is one of how many lateral ventricles? So the other one happens to look pretty much the same, right? So this is how they would look seen laterally. This is how they would look to you seen frontally. Lateral ventricles. First and what? Second. Now these are connected by way of a duct to the central, so-called third ventricle. So the lateral ventricles drain in to the third ventricle by a pathway called the interventricular foramen. Previously known by an eponym. Previously, these were called the "foramina of Monroe". But we liked this better, "interventricular". Because it really tells you something. What are these two words? Interventricular? Inter means between -- between what? Ventricles. So the interventricular foramen basically carries the fluid out of the first and second ventricles down into the third ventricle. Which is deep within the cerebrum, actually between the two sides of the thalamus, which we'd just given. So turning again to Styrofoam here, this could be a representation of the third ventricle. Which is often described as a kind of donut. Because it is a flat, somewhat circular structure into which the fluid from the lateral ventricles will come. So to build this up, this is which? Lateral ventricle. And this is the other lateral ventricle. These sticks are not sticks at all, but pathways, ducts. In both cases, what? The interventricular. Which drain now into the third ventricle. Deep within the cerebrum. In fact, surrounded on both sides by the thalamus. So if I put my left fist here. And my right fist here. They would now represent the thalamus, which we previously have said is bilateral to the third ventricle. The third ventricle drains backwards through the cerebral aqueduct into the fourth ventricle. Which is actually outside the cerebrum. In fact, situated between the medulla and the cerebellum. You can see it right here. And you can see it back here as well. The what? The fourth ventricle. Not in the forebrain at all, but rather in the hindbrain as described. All of these structures, incidentally, you'll be able to see and actually dissect in lab because you're going to have a chance to dissect a brain -- a sheep brain. But nevertheless a brain, and therefore have some better holistic view of these ideas. It's very hard to lecture about this. You really have to see it and appreciate it in three dimensions. But we'll try anyway. To repeat, these are the what? Lateral ventricles. This was the third. And this is going to be the fourth ventricle, which is going to communicate with the third, by way of this path. Which is called the cerebral aqueduct. The cerebral aqueduct, which drains from the third back to the fourth. The fourth is often described as a kind of tent or pyramid, because of its triangular appearance, as you can see. Now the fluid that we're speaking of does not stop or end, or otherwise quit here at the fourth ventricle. In fact, it leaves through three -- three outlets. Two so-called lateral apertures. The word aperture means opening. And one so-called median aperture. So looking at this model from say this view, to repeat, this is what ventricle? Third. This is the fourth. And the connecting path is the cerebral aqueduct. These two outlets, bilateral from the fourth ventricle, they would apparently be the two lateral apertures. And the median aperture I must have lost on the way up here. So if I can borrow a pencil, there's the median aperture. Which is called that because it runs straight down; straight out the back. Notice this word is not medial, it's what? Median. So let's redo it one more time. These are the two what? And the ducts that connect to the third are the --? And the third drains backwards into the fourth by way of the --? And the fourth has two ways out. These lateral apertures, and this singular median aperture. But when we say "out", out where? Where are we going to spill this fluid from this point? Basically the fluid leaves the median and lateral apertures and enters the space around the brain and spinal cord. Aptly called the subarachnoid space -- abbreviated SAS. And the subarachnoid space is just that, all the way around the brain and spinal cord. And therefore, this fluid literally bathes the exterior of the central nervous system. Oh, so what, we -- I must have stepped on something here, and this thing went down again, so we're without that. That's a shame. Or maybe just the bold field. So not waiting for that to go, let's press ahead and speak for the moment of this fluid, which we've dismissed with just a name. The fluid that fills these ventricles and circulates throughout, is known to you probably already as the cerebrospinal fluid. Cerebrospinal fluid abbreviated what? CSF. Let's talk about where it comes from. Let's talk about what it's made of. Let's talk about how it circulates or moves through these ventricles. And finally, let's give some attention to its functions. So first, where does this fluid come from? It's produced 24/7 by a nest of capillaries, blood vessels, found in all four ventricles. And those capillaries are collectively called the choroid plexus. The word choroid means "like skin". Something that's very vascular. And plexus means a network. Or braided, tangled mass. The choroid plexus then found in all four of the ventricles. And it secretes CFS 24/7. Now the fluid, as we said, will leave the lateral ventricles. It will arrive and leave the third ventricle, and eventually escape the fourth ventricle through the outlets that we've just described. At that point -- and here's another view of the ventricular system. Just to reconnect with you, these are the two what? This must be the third. And back here is the fourth. So we're asking the question, where does fluid go from here? We said previously it escapes two lateral apertures, and this so-called median aperture. And moves into a space called the subarachnoid space. Around the spinal cord and around the brain. Remember, the brain -- the cerebrum -- is divisible into two hemispheres, right? And what was that crease down the middle called? Longitudinal fissure. So here I've just folded a piece of pink paper. Let's put that in an imaginary sense down the what? Down the longitudinal fissure. And then it would lay on top of the two cerebral hemispheres, something like this. And then this blue piece of paper can be shown above that. And so the net effect is that we have a space there, which is the final destination for this fluid as it returns to the area along the longitudinal fissure. A location called the superior sagittal sinus -- SSS -- which is a blood-filled sinus. And so as fluid returns to this blood-filled space, it's now essentially returned from its source. In case that's unclear, let's be reminding you that this fluid came from the circulatory system, and is going to return to the circulatory system. So CSF is a product from blood, and it's going to be returned back to the blood. That said, it is definitely not itself blood. Now what is it? It's similar to -- similar to blood plasma with far less protein. So it is very aqueous, or watery. And in terms of color, it has virtually no color. And its entire volume is about 200 ml. Which is what I have here in this water bottle. It has a slight amber cast to it, so it's not completely crystal clear. But it's certainly not red. Nor is it white or opaque. It should be transparent. That's its composition. Its functions are not necessarily obviously, but pretty important. Earlier, when we started this topic of the brain, we said your brain weighs in at about three pounds. But if you could weigh the brain, sitting as it is in the cranium, it's really floating like a bar of soap in water. And so its weight inside the cranium is almost nothing. It has what we call neutral buoyancy. It doesn't sink and it doesn't necessarily float. Remember, it's surrounded on all sides by this fluid. What is it? Cerebrospinal fluid. And that helps us understand one of its functions. If your body is accelerating on a bicycle or just walking, and suddenly the skull encounters a firm object, will that energy be carried through the cranial bones? Yes. Might you get a skull fracture? Yeah. But the brain is somewhat isolated, because it's floating in, surrounded by what? And therefore, that provides some degree of energy absorption. It provides a way to protect the brain from trauma. Whether lateral, frontal, or whatever. So shock protection is high on the list of functions. As we've already said, the brain literally floats, or at least is suspended in this fluid. So it provides internal support. And by internal I mean to remind you that this fluid is not just surrounding the brain, but also inside the ventricles that we just named. So literally you could say the brain is inflated by cerebrospinal fluid. With that remark, what would you expect or anticipate if someone let the air out of your tires? Well what happened to the tire, it what? So what would happen if this fluid that's confined to these ventricles were to be taken away? The brain would literally collapse of its own weight.

And so one of the important functions is to provide internal support to the brain. Internal meaning, as a result of its occupancy in these ventricles. And finally, the cerebral spinal fluid serves to physically transport some nutrients -- especially glucose from the blood -- and at the same time, picks up metabolic waste from the cells of the brain and returns those wastes to the superior sagittal sinus, which is naturally the circulatory system. So let's review before we go on, because this is of course complicated. This is a model of what? V word, the ventricles. How many are there? And they're connected by the ducts as we've described. What occupies or fills these ventricles? And this fluid comes from the choroid plexus. Which is found inside all of the ventricles. What is the choroid plexus but a group of capillaries, which literally and continuously secrete fluid previously in the blood stream. Here's a transverse section through the brain. And with that, these are obviously the lateral ventricles, inside of which you can see the choroid plexus. And you'll certainly see this in lab as well. This is also inside the lateral ventricles. And CP must stand for hm? Choroid plexus. So let's be clear. These are blood capillaries containing blood. But they're constantly leaking. And what is the fluid that fills this space previously found in the choroid plexus? That fluid is? Cerebrospinal fluid. Now this might seem like a lot of attention given to something with perhaps minimal function. But it couldn't be more important. And might there be occasions where this fluid needs to be analyzed? To be withdrawn. To be inspected by a laboratory. And in fact, where is that removal of CSF typically done? Are we going to drill through the cranium and probe around, and stick a needle in the lateral ventricles? I don't think so. It's much easier to get that same fluid down here below L2. And so the name of that needle biopsy really, it's called a what? Some of you know it as a spinal tap. More importantly, or more commonly it's called a lumbar puncture. And that fluid then would be taken out and examined for what? What are we looking for? Well, first we want to see if it's transparent. If it's cloudy, then it's probably the result of I word -- infection. Infection of the brain is known to you perhaps by a couple of terms. Perhaps you know it as meningitis or encephalitis. Both of which can be rapidly fatal. And if this were pink, what would that suggest? If it was pink, it would suggest some sort of trauma to the brain. Not uncommon naturally in auto crashes and so forth. So the composition of CSF can be very diagnostic. That is, if it has white blood cells in it, you would think that would be infection, and certainly the case. If it has red blood cells in it, that would be indicative of some trauma, or maybe even a tumor. So the CSF is very useful for clinical diagnosis. And with that said, what if some of these pathways were blocked? Here's an interesting look at the subarachnoid space around the brain and spinal cord. This particular spot here connects the third to the fourth ventricle. And we gave it a name just moments ago that was called the cerebral aqueduct. What if there was a brain tumor right here in the midbrain, and that tumor were to grow the size of a golf ball? Would that pinch off that duct? And therefore, would fluid pass beyond that obstruction? No. And what would happen to the fluid that's being constructed or synthesized proximal to that? Remember, this secretion is not just periodic, it's 24/7. So would these ventricles, proximal to that obstruction naturally inflate or get larger? And if they did, what would happen to the brain tissue that's surrounding these? Clearly it would be massively compressed. And there's a name for that condition that you've perhaps read about or know about. It leads to huge expansion of the skull in children. How can the skull expand? It can't expand in you and up because what? The sutures are formed. But in a child there's still soft tissue. And so the skull can expand tremendously. And that condition, when seen and diagnosed, is known as hydrocephalus. A very large cranial size. Which is really just a reflection of the pressure, which has typically built up in the lateral ventricles. And here's a look at just such a situation. Are these ventricles of normal size or huge? Those are huge. And what's getting compressed is the brain up against the bones of the cranium. So this can be -- well, here's an interesting question. It can occur in adults too. So this is a case of hydrocephalus in a child. Would that be more or less serious than the same thing happening in an adult? It's less, because the adult skull doesn't have the capacity to expand and relieve some of that pressure. So it's much less serious, although easier to appreciate in a child. If you ever get a chance to go to a medical museum, whether it's, you know, as a part of a display or perhaps at a campus, a university campus, you'll almost always see a skull like this. Which is rather striking. But this is untreated what? This is a condition of untreated hydrocephalus. Now these days, hydrocephalus never goes untreated. And so what is the treatment? How do we deal with this pressure? Typically, it has to be siphoned off. That is, the CSF has to be rerouted. So a plastic tube is inserted into, let's say the lateral ventricles. And that fluid then is siphoned off into another plastic tube, which goes down the neck under the skin incidentally, through what cavity? What cavity's this? And then it drips constantly into the very large and accepting space called the abdominal pelvic cavity. This is called a bypass or shunt. And it's used to relieve the pressure which would otherwise be very serious. That is have an impact on the brain of the individual. So to repeat, the condition's called hydrocephalus, due to some obstruction along the ventricular pathway. Questions about that? Anybody have a personal story? All right. Moving on, everything we've been talking about up to now has been the forebrain. What are the other two parts? Midbrain and hindbrain. The midbrain is just that. It's between the forebrain and the hindbrain. And it's this area which I'm encircling. Not very large in size or appearance. Somewhat hidden you could say. Hidden by the lobes of the cerebrum. And here's a sagittal view, which we can point to the area of interest. It's right here. Everything before that's the forebrain. Everything below that is the hindbrain. The midbrain is also called the mesencephalon. It includes, among others, the following structures. The cerebral peduncles. Which are situated on the anterior aspect. You can find this in your book, and it's also labeled for you right here. The word peduncle means "foot" -- F-O-O-T. Someone thought they resembled feet. I don't know how that ever came about, but these are motor projection tracks which are travelling to the pons and beyond. And also contain information coming up from below century tracks from the cord, which are on their way to what? On their way to the thalamus. So in short, the cerebral peduncles are northbound and southbound tracks. Century and motor tracks passing through so-to-speak, as you might imagine. Also passing through are fibers from the hindbrain. Passing through the midbrain to areas above. And this creates a network of structures called the RAS. And acronym for reticular activating system. Also known as the reticular formations. The important part here is exactly their function. They determine your level of consciousness. And the state of arousal of the cerebral cortex. Is your cerebral cortex aroused at this moment? I hope so. If not, you'd be asleep. So essentially the cortex can be aroused and engaged and involved in what's occurring. Or it can be subdued, which typically happens as we sleep. Level of consciousness. Are there people who have been victims of trauma or conditions which make them permanently unconscious? And what's the C word for somebody who is permanently unconscious? Coma. So coma is a result of damage to, or at least failures of the reticular formations. Also, back here -- that is, behind the cerebral peduncles -- there is a pair of two raised mounds. M-O-U-N-D-S. The Latin word for a mound is a colliculus. Collectively there are four. Two above and two below. Almost like taking four fingers and bringing them together in a cluster. Collectively, these four bumps are referred to as the corpora quadrigemina. Which doesn't have to be scary. Corpora means body. What's quad mean? And gemini refers to twins. So the Corpora quadrigemina consists of two pairs of colliculi. The superior and the inferior. Which are clearly just that. Above and below each other. The superior colliculi are responsible for -- what's it say? Visual reflex. Now when you hear the word or see the word "visual" you think seeing. But let's be clear. The superior colliculus has nothing to do with vision. That's all back here in the occipital lobe. What then is a visual reflex? If I'm walking about minding my own business, and someone quietly approaches me from the side, am I aware of that person at some point? And do I turn to look even before I see or hear that person in any meaningful way? Yes. So what do you call the turning of the head to some notion of an approaching object? That's called a visual reflex. And what value -- what survival value is that? Is it important for us to know of approaching objects left, right, or behind us? Certainly. So this gives us early warning of an approaching thing. Whatever that is. Then below here we have the inferior colliculi. Which also cause you to turn. But not in response to some visual disturbance, but rather in response to sound. And this happens all the time in a room like this. If someone were to come through that door, what would everybody do? When they hear that door open, they would turn immediately to look. And would that be a reflex? Yes. Is it a visual reflex? Probably not. It's probably an auditory reflex. And the function or value of it is the same. Is it important for us to turn and examine something, whether it's a sound or an approaching thing? Yes. It gives us early warning of something that might be threatening, or something that might be of concern. So to repeat, this is not -- these areas are not concerned with vision or hearing. But they do turn the head and neck without thinking, to an approaching object or element. Moving on to the hindbrain, which is everything else. Which is tucked pretty much in the back of the cranium. And begins with two structures which occupy the posterior crania fossa. And you know already that those are called the cerebella. Now singular is cerebellum, which means "little brain". Two hemispheres left and right. Thin layer of grey matter, also known as cortex. To repeat, what's grey matter made of? Nerve cell bodies. Why is it grey? Not myelinated. A thin layer of cortex, but it has a very pretty and impressive branching pattern of white matter. So here's a nice, tight view. Here is the cerebellum, the cortex and this white matter which penetrates. Resembling branching elements of a tree, which is sometimes then called the arbor vitae. Which means tree of life. Incidentally, this is the cerebrum. But what is this fluid-filled space that we've already given a name to? That space there is one of the ventricles. Which one? It's the last one. It's the what? Fourth ventricle. So the cerebrum would be as shown, around the fourth ventricle. The cerebellum I mean. The cerebellum is involved with the following functions. First, it's responsible for a familiar term that's more in play than it used to be. It's called muscle memory. Muscle memory is the ability to execute motor actions simply by program or memory. Some so-called habitual actions. For instance, I'm impressed by the fact that some people can play the piano, and talk to you at the same time. Amazes me. And so is that an example of a habitual action, which you can do through those programmed routines. In fact, certainly this is applicable to dance and to athletics. Very often, you'll see an Olympic performance. Let's say the uneven balance bars; the uneven parallel bars. You know what I mean? Two bars that are uneven and parallel. And these guys and gals are going back and forth and it's just amazing me -- to me, the split-second timing that they can do. And are they thinking of each of these maneuvers? Or have they done it so many times that it's just what? Muscle memory? And very often, when they make a mistake, or it comes out less than perfect, they'll say, well, you know, I was just thinking too much. Meaning, they let their brain get involved in something the cerebellum does better. Habitual actions. And even if we're not athletes or dancers, do we all walk rather well? And isn't it amazing that you don't think about walking, you just let it happen. And it's particularly amazing when you consider the terrain that we somehow have to navigate. That we're able to negotiate curbs and uneven ground. And this is all what's called "normal locomotion". With all of that said, if you had a tumor of your cerebellum, would you be paralyzed? No. But what would be the manifestation if you had injury to your cerebellum? Would you be able to move muscles? Yes. Would it be pretty? No. Would you stumble a lot? Would you fall a lot? And with all of that said, this is the area incidentally that is first to suffer from alcohol intoxication. So what do peace officers like you to do if they suspect you of drinking and driving? Get out of the car and what? Walk a straight line. If you can't do that, then chances are you have some dysfunction of the what? Cerebellum. And that would be enough to get you a breath test and maybe something more. So not only does it engage in normal locomotion, but it also adjusts muscles just to maintain posture. This is something we also take fully for granted. Are you sitting up, most of you, reasonably straight in your chair? And if you think about it, gravity is working to put you on the ground no matter what. But the moment you start to lean left or lean right, you correct that usually. And that's what we call adjusting muscles for the sake of stability and upright posture. Whether you're seated or whether you're walking. So the cerebellum is pretty important, primarily for walking and meaningful muscle activity. The pons -- which is the area just in front of the hindbrain, or I should say the cerebellum -- links the cerebellum hemispheres. And has a number of subtle functions beyond just connecting the cerebellum with the cerebrum above and the medulla below. But it also is the location of four of the 12 cranial nerves that we'll get to at another time. And it works with the medulla to control -- not instigate, but what? Control breathing. So with just that information, what would you suspect might be the consequence of injury to the pons? Would you stop breathing? No. But would your breathing be different or irregular perhaps? Yes. So that would be the expectation with respect to the pons. And finally, as we finish for today, there is the medulla. Which actually protrudes through the foramen magnum, and becomes continuous with the spinal cord. Its full name is the medulla oblongata. Oblongata Latin for oblong. It is also known as the brainstem or the lower brain stem. And it is continuous with -- that is, it becomes the spinal cord as it exits the foramen magnum. So here, just to repeat. This structure we've already discussed. That's the --? Cerebellum. This space is the --? Fourth ventricle. This is the --? Pons. And all of this is the medulla -- aka, the medulla oblongata. Its size is not a reflection of its many functions. For instance, it is here that motor nerve tracks will cross. Motor nerve tracks coming up the cord will cross and end up in opposite cerebral hemispheres. A fact that virtually everybody knows. That is, what controls muscles on the right-side of your body is the left cerebrum. Muscles on the left side are controlled by the right cerebrum. Where does this traffic get crossed? But here in the medulla, forming what's called the pyramid formations. Also here we have so-called vital centers. Which means just that. Areas of nerve activity which are vital. What's vital? Necessary for life. Controlling and instituting respiration, heart rate, vasomotor control. What's that? Vasomotor control? Controlling blood vessels, which controls blood pressure. With just that said, could you sustain -- could you survive destruction of your medulla? If your medulla is destroyed, it's game over. Why? Because what's controlled here are all of these vital functions. And also, incidentally, non-vital functions, which are important enough, such as those concerned with swallowing. Those concerned with coughing and vomiting. With that, we've made a case that the medulla is pretty important. And what about this scenario? As awful as it sounds, could you destroy almost all of the forebrain, and as long as you had a medulla, would you still be technically alive? And that's a condition tragic, called a perpetual vegetative state. In other words, you're just going to sit there, lay there, breathe, but have no mental function or capacity. So if you destroy the medulla you're dead. But as long as your medulla is working, you are -- at least legally -- alive. The end.