

Um, we're gonna kick off with the anatomy and physiology of the musculoskeletal system. Now we talked about the musculoskeletal system as a whole but for ease of teaching I'm actually going to divide this into two so we'll deal with the skeletal system and joints tomorrow, have you first, and then go into muscles and see how skeletal muscles work and we'll look at their structure and so on. And then next Tuesday we'll look at some pathologies associated with the musculoskeletal system. So we'll deal with the skeletal system first and we'll look at the functions and there are many functions of the skeleton some of which are blatantly obvious others uh may take you a little bit by surprise. So, first of all, we can consider its function of support and in particular it supports the soft tissues, so if I could grip this lady's skull, the cranium and just suddenly whip it out along with the rest of her skeleton, a bit like the trick with the table cloth where they snatch the table cloth and leave the plates and things she will just become a massive soft tissue, she'll just become a bit of a blob of jelly, okay. Because the skeleton is inside and its supporting everything, it's giving structure, it's giving framework. We refer to a skeleton that's inside the body, supporting the soft tissues as an endoskeleton. So a human skeleton is an endoskeleton. Endo meaning within. Secondly the skeleton provides a system of levers and this of course facilitates movement and locomotion. And related to point number two the skeleton forms joints at various places and joints of course are for articulation mostly. There are some types of joints, which are for joining bones together to form a different structure we'll look at that later when we look at joints in more detail but on the whole most joints are for articulation. The skeleton is also for blood cell production and this comes from the bone marrow so all of our blood cells originate from the bone marrow and the bone marrow is found within the centers of most bones. The skeleton is also for protection and again this is protection of soft tissues. So for example the cranium, we talked about the cranium last week. Where's the cranium? Yeah, well done. It's this dome shaped region at the top here, the cranium protects the brain, obviously. The rib cage protects the lungs, lungs and the heart. The orbit, does anybody know where the orbit is? Yeah, it's the part of the facial bones that surrounds eyes, the socket that the eyes fit into. Think about it if somebody's going to hit you in the face and they're going to try and give you a black eye, the majority of their fist is going to hit the brow ridge and this part here and these are the two areas of the orbit with the eye recessed slightly within it. So, that the soft delicate tissue of the eye will be protected or partially protected from such a blow. The pubis. Does anybody know where the pubis bone is? Down here somewhere, okay. The pubis is actually part of the pelvic girdle and it's at the front here, literally just underneath where your pubic hair is and that's protecting the bladder. You may think well, okay, it's protecting the bladder, but why it's not as if your bladder is as important as your brain or your lungs or your heart or whatever, but your bladder is very important primarily because it's a storage tank for a toxic substance and that toxic substance is urea which is in urine and if the bladder gets disrupted in some way or torn or ruptured then what happens is you leak urine into the pelvic and abdominal cavities and that's will poison those vital organs that we find within those cavities. So, it is pretty important that it gets protected. Now, if we think about the skeleton as a whole we can divide it into two regions. The first of these is the axial skeleton and then secondly the appendicular skeleton. And we need to think about the component parts of each of these so I'm going to take the axial skeleton first and we'll look at that in quite a bit of detail. Now within the axial skeleton we have the skull, the

vertebral column, the rib cage and the sternum. Think about where all these things lie. So we've got the skull, the vertebral column, which is the backbone, the rib cage and the sternum which is the breast bone at the front. So all of those bones lie centrally to the body. Their part of the central axis of the body, hence its name the axial skeleton, so their the line of bones that run through the center axis of the body. So let's look at the skull first of all. The skull as a whole is formed from bone plates that are fused together. When you think of bones you tend to think of them in standard format as the long bone, so you've got the long bit of bone and the two heads at either end which articulate and form joints and so on. But in actual fact bones can adopt lots of different shapes and the way in which their put together can give us very diverse structures. So if we think about the skull, first of all, the skull is made from many different bones that are fused together in a particular way to give us this structure, okay. The moveable part of the skull is the lower mandible or the lower jaw, the rest of it is fused and the lower mandible articulates at the TMJ, that's what we call it for short, does anybody know what TMJ stands for? Yes, well done, the temporal mandibular joint. The temporal mandibular joint of course is up here. Temporo because part of the joint is formed by the temporal bones on either side of the head and mandibular because it's the lower mandible that's articulating with it. And that allows us to move our jaws up and down and from side to side, which will facilitate biting and chewing actions. The rest of the skull is formed from fused bone plates that don't move. Now at the time of birth, the bone plates of the cranium are not fused. And there are regions of cartilage between them, does anybody know what they're called? These regions of cartilage. Fontanelles, so why do you think newborn babies should have that particular arrangement within their cranial cavities? So, it's easier to give birth, yes. Think about what the baby has to do during the birth process, it has to come down through the pelvic area, down the birth canal and that's a relatively narrow gap. Now, baby's heads are quite large and their disproportionately large compared to the rest of the size of their body because of course they are already born with these very big well functioning brains so that they can learn and so on. If the skull was completely fixed, as it is in adults, then there's going to be absolutely no give in it whatsoever, so this thing is going to come head first down the birth canal and it's not going to pass because there's no give in this big block like structure. The fact that the skull plates aren't fused and we've got the softer cartilage means that the bone plate of the skull can give a little bit so that it will facilitate birth much easier. That's the function of the fontanelles. Now, once the baby's born and as it starts to develop and grow through infancy the bony plates will get bigger and the regions of the bony plates if my fingers represent the bony plates and the region in between is the fontanel that region gets smaller and smaller and smaller until the bony plates unite and then form the rigid cranium and that happens at approximately eighteen months of age. So the fontanelles facilitate birth and they slowly disappear after birth and cranial plates are fused at approximately eighteen months of age and that's one of the reasons that you have to be particularly careful with newborn babies heads because the cartilage isn't incredibly hard firm cartilage, like the cartilage of joint heads or the bone heads, it does have a certain degree of flexibility with it and of course just under that you've got the very delicate brain and some of you who have dealt with newborn babies maybe noticed that when your baby's asleep you can just very gently stroke over the top of its head you see the top of the head dimple up and down a little bit, yes, that's the region of the fontanel, the main

central fontanel. So that's the cranial cavity itself now, you will see when you look in your textbooks and so on that there are different bones making up the cranial cavity. If you're going to go on to specialize in homeopathy it's worthwhile learning those bones, if you're not then to certain extent it's up to you whether you want to learn them or not, knowledge of the names won't necessarily help you in clinical practice, but for homeopaths we have this book called Repertory, and the Repertory is just full of symptoms from all parts of the body and that tells you which remedies are relevant to those symptoms and if you look under headache in the Repertory, it's got a thousand and one entries as to where exactly the headache is and it will stay things like, is it an occipital headache, is it a parietal headache, is it a frontal headache, and these names, the occipit, the parietal region, the frontal all refer to the bones of the cranium, okay, so it's worthwhile knowing where they are if you're going to go on to study homeopathy. So we'll just quickly run through them, we have the frontal region, the temporal bones and these are at the temples, then the parietal bones and the parietal bones are big bones forming each side of the cranial cavity. Then we have the occipital region which is right at the back here, so those bones together will help to form the cranial cavity itself the bony part of your skull and you've got your skeletons on your desk, they're not 100% accurate in terms of these definitions that it gives you, but if you look at the skull and the cranial cavity you will see little wavy lines and those are lines of fusion of the bony plates, so if you want to have a look at those and just pass them around and you'll see that the skull, the uh, cranial part of the skull is actually made up of the different bony plates fused together. Now moving down into the face, the face is made from several different facial bones and again the bones are fused together to give us structures such as the orbits for the eyes, the nasal bones, the cheek bones, the upper jaw, okay. Again, I don't think it's necessary for you to learn the names of these different bones in particular, if you want to do that for your own learning then fine. Something we do need to be aware of though are sinuses. We'll mention sinuses again when we do the respiratory system, now sinuses are air filled spaces within the bones of the skull. So for example we have the frontal sinuses and the maxillary sinuses and there are various other ones. You can complete the list yourselves when you do your reading around the area and all of the sinuses connect into the nasal passages and the nasal pharynx and the function of the sinuses, well two main functions, first of all they facilitate resonance to the voice and if you hum you can hum and you don't get any sort of resonance, it's a very, very flat sound but if you project your sound into the sinus cavities, you actually feel the vibration and you can feel the vibrations up in your nose area and in your cheek area and you get a greater degree of resonance of the sound, does anybody here sing? No choral singing or anything like? Yeah. And again you know exactly what I'm talking about, you and try project the sound into the sinuses and you get extra resonance and you feel the vibration, okay., Again think about when you have cold, very often colds will cause infection of the sinuses or inflammation of the sinuses so they won't resonate as well and your voice changes, doesn't it? It all becomes a bit nasal, a bit of a flat voice; secondly, the sinuses lighten the skull. Think about your skull, this big region of bone, it sits on top of your body of course, it's the first point that's opposing gravity and your skull is generally a heavy structure and it's all just sitting on your necks and it pivots all around on that and it has to be supported all the time that you're upright and think about how many hours a day you're upright, so it makes sense to have the structure as light as possible and the sinuses are

regions where the bone is hollowed out in order to make them lighter and that allows us to keep the head upright a little bit more, it takes some of the pressure off the neck. Now the sinuses are lined with mucous membrane and the secretions draining to the nasal passages and pharynx. Okay. So that's the skull, not a lot more to say about it, so we're going to deal with other areas of the axial skeleton now and we'll move into the vertebral column. Now the vertebral column of course is the back bone and it's formed from twenty four moveable bones that is bones that will articulate with each other plus the sacral plate and the coccyx. So we have twenty four moveable bones in the main length, the main drop of the vertebral column and then we have something at the end called the sacral plate and the coccyx, now the column, the vertebral column is split into different regions and these are the cervical region, the thoracic region, the lumbar, sacral and the coccyx or coccyxgial region. And we have a certain number of bones within each of these regions, there are seven cervical vertebrae, twelve thoracic vertebrae, five lumbar, five sacral and these are fused together and there are four coccyxgial and these are also fused together and we give the vertebrae different names according to which region of the back that we're talking about and which number of vertebra it is that we're referring to. So, for instance the cervical vertebrae are numbered C1 through to C7, the thoracic T1 through to T12, and so on and it's handy knowing the numbers of the vertebra and which part of the back you're in, which part of the back you're discussing, it may be that when you're practitioners you get referrals from other complimentary therapists and a complimentary therapist is an osteopath or a physiotherapist or a chiropractic practitioner or something like very often the referral letter may refer to the person's problem as being with T3 to T4 so you know that you you're working with the third and fourth thoracic vertebrae and so, so it's handy to know them as well because when we do the nervous system and we look at the spinal cord, which of course is running down through the vertebral column, the vertebral column protects the spinal cord. We will talk about spinal nerves and the spinal nerves are also labeled T1, S1 and so on. Now, we need to think about certain adaptations within regions of the vertebrae and in particular C1 and C2 are very interesting so we will look at the first and second cervical vertebrae. Now these are given separate names, C1 is the atlas bone and C2 is the axis. And there's a particular arrangement associated with these that allows movement of the head. So, with regard to the first two vertebrae we have the C1 and C2, the atlas and the axis bones and they allow free movement of the head, they allow us to move our head in all sorts of positions so we can shake our heads from side to side and we can nod our heads up and down and that of course gives you a full round movement all over the place when you think about that moving your head and that's extremely important because if you think about it most of our major sense organs, the eyes, the ears, the nose and so on are actually in our head, the sense organs are detecting what's going on in the environment, so we need to be able to move our head around in all sorts of places to facilitate picking up cues and stimuli from the environment, that's just one example. If you look at your skulls and you look underneath the skull you see a hole here and now this hole is called the foramen magnum, that just means big window and it's an opening that part of the spinal cord comes through so the brains tucked away up in there and the brain will then turn into the spinal cord and it comes through this hole. Just above it you can see two projections that are smoothed off either side of the hole, either side of the foramen magnum, yeah. Now those two projections, these sort of semicircular projections fits into cupped shaped regions on the

atlas bone and if you have a look at your skeletons, at the first and second cervical vertebrae, you can do this yourselves in a second, but if you have a look there you can see that little region there and that little region there, yeah. If we put that on top of it, you can see that those two parts of the skull fit into it, it's a little bit like a cradle and that allows the skull to then move up and down in a nodding motion so you have the cup part on the atlas and then this region of the skull which fits inside it like that, and then it rocks backwards and forwards like a cradle and that would happen on either side, so that's the association between the skull and the atlas bone. The easy way to remember which is which bone is think about your Greek mythology, Atlas was somebody who, I think he stole fire if my memory serves me correctly from the Greek gods and his punishment was to hold the world up, so the atlas bone in a sense holds your head up, just like Atlas had to hold the world up. Now we need to consider the association between C1 and C2 that is the association between the atlas and the axis. Think about what an axis is, an axis is a central point around which something can move, and that's exactly what the axis bone provides. So axis bone has a small bony projection that associates with the atlas and this small bony projection is called the occipital peg. So if this hand is the axis bone, i.e. C2 it has this little bony spur sticking up and this fits into the atlas bone, like that, so this is the atlas bone with the skull sat on top of here and then this bony spur, this bony peg fits just underneath the atlas bone like that and that means that the atlas bone can spend slightly around it and that facilitates the shaking of our heads, so we have this special arrangement where the little peg sticks up and again that's shown on your skeletons. So if you take your heads off and look down the vertebral column, just there can you see it? Just there? Yeah? You will see the little bony spur, you want to pass that around and have a look? Sticking up. This also has another name, which you may see in some textbooks, which is the odontoid process, slightly more technical name. In your textbooks, I think it takes out these bones separately and shows you their structure, but the front of the axis bone looks like that. Yes, that's the front of the axis bone and then the front of the atlas bone looks like that and it would come across the front of that process. Okay. The other thing that's interesting as well is that all mammals, doesn't matter what we're talking about, all mammals have just seven cervical vertebrae, so we have seven cervical vertebrae, a giraffe has seven cervical vertebrae, albeit whacking great big ones, a mouse, if you think about a mouse, a mouse doesn't have an obvious neck does it? No, but it still has seven cervical vertebrae, just very small ones, a whale, again no obvious neck, it still has seven cervical vertebrae. It's quite an interesting fact, we need to move down now into the thoracic vertebrae, now we said that there are 12 thoracic vertebrae, and they obviously articulate with each other to allow movement of the spine, but they also articulate with the ribs, so you have a look at the backs of your skeletons and you'll see that the rib cage comes around the back and then the points of the ribs will articulate with particular vertebrae and these are the thoracic vertebrae that they are articulate with. So this junction between the backs of the ribs is of course forming the back part of the rib cage. Now we need to have those points of articulation between the ribs and the vertebrae because it allows expansion of the rib cage on inhalation. Again, we'll go over this when we do the respiratory system but if you put your hands on your rib cage and take a very deep breath your rib cage will come outwards slightly and upwards slightly and part of that movement is facilitated by the articulation of the ribs at the back with the thoracic spine. Okay. Think about the handle

of a bucket, you've got your bucket, it's got two little loops at the side and then the handle that fits into them, yeah. And the handle can be laid against the side of the bucket or the rim of the bucket and then you pick up the handle in order to pick up the bucket, that action of the handle with the rings at the top of the bucket is a similar action to what your thoracic vertebrae and your ribs are doing in association with each other, obviously not as wide a degree of movement but it's a similar action and we can think about the lumbar vertebrae. These are the largest of the vertebrae and of course they lead down into the sacral region. So, we're talking about these large vertebrae down here, these are the vertebrae of the low back. They're large because of course they're taking a lot of weight. They're taking most of the weight of the upper body. They're also a main point of articulation, so if you think about the widest sphere of movement of our vertebrae, we tend to have it exerted by our low back, so there's a lot of force exerted on them, so they need to be bigger bones in order to cope with all of that. The cervical, thoracic and lumbar vertebrae, all of what we call spinous processes coming off them and these are the little bony projections that stick outwards and these are the things that you can feel now if you'll just run your fingers down somebody's back, you can feel the points of them. Now they're different sizes for different vertebrae but they're extremely important because they form the point of attachment of the muscles of the neck, upper back and lower back. We'll look at muscles a little bit later on in more detail, but as you can see this is back view, so this is a very large back muscle called the latissimus dorsi and we would have one on the other side here, this one's been removed so that you can see the muscles underneath and that this is all attaching to the spinal processes running down the side of the back and this side would also attach to the same point and then up here we have the trapezius, another big muscle again this side as been removed for a clarity of what's going on underneath it, but you can all see that this is attached at this point, again to the spinous processes. Okay, um, as I said different lengths to them dependent on how much muscle is attaching to it and the sacrum and coccyx we can cover together. The sacrum forms the back plate of the pelvis. So if we think about the pelvis, the pelvic girdle it's all this region here and it is made up of different bones that are fused together, but the back part, just here is formed from the sacral region of the vertebral column and you can see that very clearly on your skeletons, if you have a look at the back part of the pelvis, and you can see that it forms a joint with the rest of the pelvis, this is the sacral iliac joint. And lots of people because of bad technique in the gym, bad posture, accidents, whatever, have problems with their sacral iliac joints. You can find that osteopaths are very often manipulating them, so the sacral iliac joint is where the sacrum joins the ileum part which is this region here of the pelvis, see you can see one on either side. It's not a joint where you have wide sphere of movement but it does facilitate a very small amount of articulation. The coccyx is the remains of our tail. Yeah, the coccyx is the rudimentary tail, the coccyx is just made from four very small fused bones right at the very end, and because their what we refer to as a vestigial organ, i.e. something that's being lost in evolutionary terms, the coccyx doesn't naturally have a function. If you feel right down to the very bottom of your spine, between your butt cheeks you'll find the endpoint of the coccyx. Generally, quite a sensitive area. Very good homeopathic remedy for a bruised coccyx. Most people have heard of arnica for bruises and falls and knocks and things like that, arnica is fantastic, but pastille, especially if it's become bruised through childbirth or something like that. Yeah, no,

friendly enough I mean such a silly little area, but damned painful if you damage it and it can take quite a long time to sort itself out as well. That's almost the vertebral column, but we just need to mention the intervertebral discs, which we find between the vertebrae, does anybody remember what sort of cartilage they're made from? Fibrous cartilage. Remember hyaline is the really hard tough stuff, doesn't have any give in it that we find over boneheads at joints. Fibrous is where they're still tough but there's a little bit of spring left in it, there's a little bit of give and that allows articulation of the vertebral column because the discs can get squashed a little bit as the bones move against each other, okay? So, now let's consider the sternum, the sternum is the breastbone and it's made from three different regions. So you may think that at the front here you just have the one bone, you don't, you've got three separate regions which then work together to give you this central structure, that the front of the rib cage attaches to. Okay, so the breastbone is to bring the front of the rib cage together. The first part working from the top down is the manubrium, then we have the sternum itself, the true sternum so to speak, then we have the xiphisternum, this is made from xiphoid cartilage. So, if you think about your own chests, and think about the sternum region at the front what we have are these two bones here, what are these bones? The collarbones, the posh name for them? The clavicle and they run together to come to the front and we have this little depression, now this little depression is called the suprasternal notch, notch because it's like a little depression in the area. Supra means above or higher than, sternal the sternum. So that's the very start of the sternum as a whole and this is a little depression in the manubrium, which is the first bit, if you run your fingers down from there, you come to a ridge, okay. Can you find the ridge? My fingers are rolling over mine at the moment, just a short way down, just an inch or two down, that first part is the manubrium and this ridge area is the end point of the manubrium, below that we come into the sternum itself, the actual sternum bone itself and then if you run your fingers further down, put a bit of pressure on, suddenly your finger dips off and then you get a little squashy bit at the end. And that's the xiphoid cartilage. Well, if you, no, it doesn't hurt. If you push on it, it's a little bit uncomfortable, but it shouldn't hurt as such, yea. So those are the three regions, the manubrium up here and then you come to that ridge, that bony ridge and so that's where the manubrium, the plates of the manubrium fuses to the sternum and then down from the sternum to the bit that you can depress in and out which is the xiphisternum or the xiphoid cartilage, okay. Now, we said that the sternum is where the ribs come together at the front and it's the point of articulation for the front region of the rib cage, the sternum is joined to the ribs via the costal cartilage and we mentioned this last week when we were just talking about cartilage in general as a tissue and this is the front part of the rib cage that comes around to the central sternal area and we said that if you push the bottom of your rib cage it has give in it, it will move in and out a little bit, yeah, and if you come further round you come to the solid bone, that doesn't have any give in it and this region of cartilage, costal cartilage, facilitates expansion of the chest along with the articulation of the ribs at the back and you can see that very clearly on your skeletons. Last week we talked about finding that point if you follow the ribs round and you feel the ribs you come to that ridge that you can feel and ridge is the point where the bone is ending and the costal cartilage is starting. So, it's the association that we have with the rib cage and the sternum, the ribs themselves are very easy to discuss, we simply have twelve pairs of ribs and that's it, there's not a lot else we can say about them. We will

discuss the rib cage in more detail when we come to the respiratory system and then we'll look at the musculature between each of the ribs and so on, things called intercostals muscles and we'll see how they function again to facilitate the movement of the rib cage so that we can expand and deflate the lungs. So, what I want to do now then is to move on and think about the appendicular skeleton, this is formed from bones, that in a sense hang off the axial skeleton. If you remember that the axial skeleton is the part of the skeleton that forms the central axis to the body. The appendicular skeleton is everything that's hanging off that, so here we're talking about the limb bones, the arm and leg bones, the shoulder blades, the clavicles, the collar bones, and also the rest of the pelvic other than the sacral plate and coccygeal region, so the remainder of the pelvic girdle, now. Something that's worthwhile doing, it's very easy to get to grips with, but you really should know it, is to know the more technical names of the bones and the common or garden names for the bones and I suspect that you probably know most of them, but we just need to run through the list just to clarify. I say this because of my experience once as a homeopathic student sitting in clinic with the fully qualified homeopath, so the homeopath was taking the person's case and I was sat in the corner, just observing, and the patient as they went through the history and the patient said, oh yes in 19886 or whatever, I broke my tibia and the homeopath, just in the point of being nice, said, oh, how is your arm now, is it all fine? So, yeah, you've got that already. The tibia of course is a bone in the leg. Not in the arm. So, a real clanger was dropped, so it's very important that we just run through this, although you're probably familiar with a lot of the names already, just so that you never find yourself in that position. Okay, so we'll deal with the upper part of the body first, so the shoulder blades, the scapula, the scapuli for plural, this is a triangular shaped bone that forms part of the shoulder girdle, the collar bones, clavicles, remember we have two clavicles. In my experience teaching people, students very often think that you just have one clavicle and it just goes all the way across here, okay, you don't, you have one and then two, separate bones. The upper arm bone, this long bone here, is the humerus. The lower arm, here, we actually have two bones, one big bone and one smaller bone. Which are they? The radius and the ulna. And again you should know which is which. The radius is the smaller bone, which is line with your thumb, so it's the upper bone and the ulna, by default, of course, is the bigger bone underneath it, the radius is here and the ulna is here. It's the head of the ulna that forms your elbow bone. Then we come to the wrist bones. Several bones which we give a collective name, carpals. Lots of people get tarsals and carpals mixed up, the tarsals are your feet. Not your feet, not your toes, your ankle bones, and remember T for tarsals, T for toes. Then you'll remember that their the ones down to do with your feet, okay. So the carpals are in the wrist. Then we come to the bones of the hand, they are the metacarpals and then the bones of the fingers, the phalanges. Some of these we've already done, of course, in the sense of the breastbone, of course, is the sternum, the ribs, they have a technical name as well so we won't worry too much about that. The vertebrae we've though about already. The pelvis, the pelvic girdle and the pelvic girdle is also a big region formed by different bones that are fused together. We really only need to consider the sacral-coccygeal bit at the back, the pubis part, which we've already said is where you've got these two small bones at the front just under your pubic hair protecting the bladder and the ileum. So part of the pelvis is called the ileum and that's this big bony region here, so your hip bone which is this first bone across here is known as the

iliac crest, it's the top part of the ileum, this bigger plate and of course you have one on the other side. Now the reason that I call that one out is so you know where this particular bone is and know its name is because we often use this iliac region as a landmark as an identifying part of the body, so we have things like the iliac fossa and so on and we'll be discussing that when we do the digestive system and abdominal contents in a little bit more detail. So, coming down into the lower limb. We've got the upper leg bone, which is the femur and the lower leg, again we have two bones, they are they? Tibia and fibula, and again my experience teaching this stuff is that there's often a lot of confusion with these two bones, not any confusion as to which is which but all sorts of confusion as to their names. So I've heard all sorts of combinations of tibia, fibula and also tibula and fibia, okay, so make sure you're quite clear as to which they are, now, with regard to which is which. Again we have one small bone and one bigger bone, so if you think about that part of your body, running down the front here we have the shin bone, okay, so my fingers there are bordering the shin bone, that's the bigger bone of the two and this is the tibia. The tibia is the shinbone, the fibula is a much smaller bone and I can't really feel that because it's behind this calf muscle running down just behind and slightly to one side of the tibia, okay. The tibia is the shinbone at the front, strong bone, now we have a very small bone here, which is the kneecap, what's the posh name for the knee cap? The patella. So, your elbow joint is in a sense synonymous to your knee joint, but with the knee joint you find this extra bone called the patella, you don't have an elbow cap, only a knee cap, okay. So think about that. When we do joints we'll see why we have that arrangement but you think about what it might be at the moment, so coming down from the tibia and fibula, we come into the anklebones and the anklebones are the, the tarsals. Now, the wrist bones, the carpals, and the ankle bones, the tarsals all have separate names, again, if you want to learn the individual names that's fine, but it isn't vital with regard to clinical practice. You will have people coming to you with a wrist problem or with a ankle problem rather than talking specifically about a problem with their talus bone or something like that. However, having said that there is one of the tarsals that you should know the name of and that is the calcaneus, and the calcaneus is the? It's the heel bone, um, yeah, the calcaneus is the heel bone and it's one of the, it's the biggest of the tarsals of the ankle bones and it's particularly important because it forms a major region of the foot and also it's for the attachment of a huge tendon called the Achilles tendon. So if you have a look at your skeletons and you have a look at their feet, you can see this bone here, quite a large bone, forming quite a large part of the foot is the calcaneus, so we would see a tendon attaching down here on to it and then running up into the back of the leg, the back of the lower leg, but we'll look at tendons a little bit more when we do muscles. Then we come to the bones of the foot, the flat part of the foot, they are the? Metatarsals, and the toes? Phalanges again. Okay. So just make sure that your aware of those common names and the more technical names. There are other more specialized bones that we haven't talked about, we will talk about those when we do other areas of the syllabus, so for instance up here, there's a little small wishbone shaped bone, does anybody know what it's called? The hyoid bone, yeah, well done. That's the attachment of the tongue and the larynx, and we'll talk about that when we do the digestive system. And then, of course, in the ear we have the smallest bones in the body. The auditory ossicles, these are the ear bones and we'll talk about those when we do the anatomy and physiology of the ear and hearing, okay? Now, let's think about

structure of bone. Now, a common misconception is that bone is this inert material, okay. It's just made of salts, it's this hard stuff inside you and that's it. That is, that is wrong, that is a common misconception, bone is actually dynamic and bone contains living cells, okay. So bone is dynamic, that means it will change with time and it contains living cells. And the bone is composed of an organic matrix and inorganic salts. Now the organic matrix, last week we talked about matrix and we know what matrix is. Do you remember the baking of the cake with the currants and sultanas and things, yeah? And we said that the cake mix was the matrix. So here, the matrix of bone, the organic matrix of bone is collagen based and the inorganic salts are things such as calcium salts, magnesium salts, phosphates, carbonates and various other things. It's a cocktail of things. Inorganic means, that pertaining to mineral ions, metal ions, as we said it, calcium, magnesium, sodium, lithium, all that sort of stuff. Organic is to do with nonmetallic substances, primarily carbon, hydrogen, oxygen. Now this arrangement of having the organic matrix and the inorganic salts deposited within it is very, very important because it means that bones are strong and durable, but not brittle. If the bones were just made out of the inorganic salts, the calcium salts, magnesium salts, phosphates, carbonates and so on, they'd still be firm, they'd still be hard but they would be very brittle and do the various stresses and strains that are put on the skeleton as we go about our movements, the bones would fracture very easily, if they were just made out of organic matrix they wouldn't be brittle, they'd be quite flexible and bendy, but they wouldn't be particularly strong. If you put a bit of pressure on them, a bit of strain on them, the bone itself would bend and you wouldn't have good controlled movement. So we have a mixture of the two, which means that the bones are hard, they're durable, they can have a lot of pressure and strain put on them, but they're not brittle, okay. What happens with osteoporosis is that the level of calcium and other salts, particularly calcium, within the bone starts to decrease, so the bones start to lose their strength so we things like fractures as a very common feature of osteoporosis. So you put the calcium back in, you put the other salts back in and the bones will then get their strength back. We'll talk about osteoporosis in detail next week. Something that is sometimes done in teaching labs when teaching about bones is to take a long bone of an animal of some sort, a sheep's long bone or something like, clean it up, take all the fleshy bits and what have you off and then put it in a tank of hydrochloric acid and put it in a tank of dilute hydrochloric acid, leave it for two or three days and then come back to it. Take it out, give it wash and you basically still have the bone there, you can see it, the same shape, the same dimensions, except you'll be able to tie it in a knot because what happens is that the acid will dissolve away the inorganic salts and just leave behind the organic matrix and the organic matrix is a bit rubbery, because its so flexible and soft. Okay. So can you all see quite clearly how the association of these two things facilitates the strength of bones, but also stops them from being brittle? Yeah, very important fact. Now bone is secreted by bone cells and bone cells are all formed from a type of cell called an osteoblast. And osteoblasts can divide into two different types of cell they can turn into osteocytes and these are bone forming, and osteoclasts and these are bone destroying. So we have this box standard bone cell called and osteoblast and under stimulation that can divide to turn into osteocytes, which will build bone and osteoclasts, which will break down bone. An obviously in your healthy individual, there's a balance between the activity of these cell types. You may think, why on earth should you have cells which

will specifically breakdown bone? Well, they're important during the repair of fractures and next week we'll have a look at the process of events that happen when somebody breaks the bone and we'll go through the healing process and so on and we'll see there how important the osteoclast activity can be. They're also important in helping to maintain the skeleton at the optimum for what you do with your body. So, for instance, my skeleton as it stands at the moment will have a certain density associated with it. Now, I don't do a huge amount of exercise, but I'm not a couch potato, it's just that I don't have time, which is a wonderful excuse. But when I do have time, I'd rather sit on the settee and watch a good film or something. Okay. But, if I were to start going to the gym, start running, pulling weights and so on. And I were to build up my musculature through doing all of this extra work, what you would see is that my bone density would increase because I'm forcing my skeleton to take on a lot more strain like pulling heavy weights and so on. I'm building a bigger bulk, which needs to be supported and moved around by the skeleton and by default the skeleton needs to become denser. Does that make sense? So again, we would see it change. It's part of what we refer to as being dynamic, so we see osteocyte activity increase in order to make the bone denser. If I were to then stop doing that exercise and lose that muscle bulk, no longer put a lot of strain on my bones, then the bone density would decrease back to what I needed for my normal daily functions and it would be the osteoclast activity, which would be then increased in order to decrease it down. Does that make sense? Okay, there's this constant balance between the osteocytes and the osteoclasts in terms of helping maintain bone density. Now, it's not quite as simple as that. There are a lot of other factors involved as well, but that's what the cells are doing. And let's just look at the general structure of a long bone. So this could be any long bone. It could be the femur, it could be the tibia or whatever, it goes something like this. See that the bone, generally speaking is split into two regions, we have the head and the shaft. The heads of the bones are called the epiphysis and the shaft is known as the diathesis. So the epiphysis to either end and the diathesis in the middle. Now if we think about what is in the bone and what is making up the bone structure, well. The center of the bone is called the medullary canal and this is where we find the bone marrow, so this is full of living cells and these are the cells, which will give rise to the blood cells. So, within the bone marrow we will find cells that will give rise to the blood cells and because we have living cells in there, of course, they require a blood supply and a lymph supply and so on and you will see, I don't know if you can see on your skeletons, possibly on the skulls you may see, but if you have a look at this diagram at one of the breaks, you'll see small holes leading into the bones. These are points at which arteries and veins and lymphatic vessels and so on, actually go down into the center of the bone marrow. So the bones are punctuated by these small holes. Then we have two sorts of bone making up the overall bone itself. We have compact bone and spongy or cancellous bone. Compact bone we find in greatest amounts in the shaft and compact bone is very dense. So its very dense bone. And of course, this means that its very strong. And then in the bone heads you can see that we have this spongy or cancellous bone, now this bone arrangement is like a series of bony struts and stars that fill out the bonehead and they make the bonehead light but strong. So, it's like a series, almost like a honeycomb sort of arrangement of bone, filling out the inside of the bonehead. Now the reason why we have this variation is because if the bone head was made of solid, compact bone the bone itself would be exceedingly heavy and if

all you're bones were made up like that, you're skeleton would be very heavy and we'd need this whacking great musculature in order to move it about and that would make us quite a cumbersome organism. And we're actually quite a light, very mobile organism capable of climbing and running and so on, so we want an average skeleton. We don't want it to be too strong, too heavy, so we have this variation in types of bone that make up the long bone, okay. The periosteum, peri meaning surrounding, osteum the bone. So this is a covering that surrounds the bone and the periosteum is very tough, very fibrous, and it's actually adherent to the bone. So it covers the bone, it's very tough, very fibrous and it's adherent to the bone, it's stuck onto the bone surface. And its function is protection, so the periosteum protects the bone, it's a very tough membrane covering the bone. Those of you who, I don't know may be have bones for your dogs or something like that or you've deboned a chicken or whatever, if you then pick the bone up, it's very slippery, isn't it? Have any of you noticed that? Yeah, the bone's very slippery and it may slip between your fingers or something. That's because you're sliding over the periosteum, you're sliding over the covering of the bone. Now if you were to take a knife and scrape the periosteum off, or maybe cook the bone and then take it off, the bone underneath is very dry and rough, yeah. So it's the periosteum that's forming this covering over the bone and it's stuck onto the bone, okay? And then at the ends, covering either bonehead we have the articular cartilage. So this is the thick pads of cartilage that we find would cover the boneheads and help to form the joint. What sort of cartilage is that in it? Hyaline cartilage, well done. So, we've covered most of the skeleton, but what we need to do now is to look at joints, so we need to look at these actual points of articulation of the bones. And it's of course the joints that facilitate our movement and locomotion. Now, a joint is a site at which two or more bones come together. It's a site at which two or more bones come together. And there are various forms of joints, the first sorts of joints that we can think of are suture joints. And suture joints are fixed joints. So they're non-movable. And they joint bone plates together and there may be a very small amount of fibrous tissue between the joint, so there may be a very small amount of fibrous tissue between the joint and they're sometimes called fibrous joints, but sutures. You know what sutures are don't you? Sutures are stitches where something's sewn together, because the way the bony plates have come together, it forms a joint that looks like it's been stitched. And if you look at the skulls of your skeletons, you can see these wavy lines, something like that, where the bone plates have fused together and in between each of these plates where the line is, there would be very small amounts of fibrous tissue, just helping to hold everything together. So we see these suture joints in the skull, we can see them in the pelvic girdle where the different bones of the pelvis are fused together, we can see them along the line of the individual bones of the sacral plate. And they're completely fixed and immovable. If you think about something like cranial osteopathy, cranial osteopathy, well most cranial osteopaths that I know say that they don't actually move the bony plates, but what they do is to move the fluid underneath them, something called cerebrospinal fluid and they can alter the movement and the direction of conduction and so on within that. I do know one or two that say they can move the bony plates, I do hope that's not the case, okay. That may be possible with a very young child of course because the bony plates aren't fused, okay, but certainly not in an adult. The second type of joint that we can think of the cartilaginous joints and these are joints where there are small cartilage pads between the bones and the

pads can be compressed slightly, so they can be squashed slightly, there's a little bit of give within them. And these types of joint facilitate small spheres of movement, for example the joints between the vertebrae where the small cartilage pad would be the intervertebral disc and if you think about it we've got relatively very small spheres of movement between each particular vertebra, yeah, each particular vertebrae can flex a little bit against the next one. Once they're all doing it together, then that can give us a wider sphere of movement of the whole vertebral column, but each one is just facilitating a small amount of movement, okay? And then the biggest group of joints that we have, the more interesting ones are the synovial joints. These allow a much wider sphere of movement, they're all lubricated by synovial fluid and this fluid is produced by synovial membrane, which is one of the membranes that we discussed last week. What we have here is a classic example of synovial joint and don't try and draw this, it's in your Ross & Wilson books, so this is an example of the knee joint and you can see the head of the femur here and the head of the tibia, now the whole joint is held together by ligaments, and the ligaments are represented in red. Okay. So ligaments are structures which hold bones to bones, so they're structures that will attach bones to bones, tough, strong, structures. So in the knee joint, here, you can see we have something here in red called the capsular ligament. Now, it's only shown on one side for clarity, but again, as I said last week imagine these diagrams in 3D, so imagine it coming out at you and then going back into the wall and this capsular ligament will come around the front and then go into the wall around the back and it forms a cuff almost around the joint, holding the top part of the bone and the bottom part of the bone together and then, because the knee joint is a bigger sort of joint we also see ligaments in the center of the joint and in the case of the knee, we have the cruciate ligaments. This word cruciate simply meaning "cross shaped," because the cruciate ligaments look like the letter X. And you can see them here fixing to the bottom part of the bone and to the top part of the bone well within in the joint itself, but in the center of the joint, so if my fists are the boneheads, just imagine coming between my fingers little stringy bits that then keep these two boneheads in place and then imagine a cuff of ligament all the way around the outside of my fists and then you've got the idea between the capsular ligaments and these internal joint ligaments like the cruciate ligaments, okay. So they're holding the whole joint together. In blue, you can see that the joint is lined with synovial membrane and the synovial membrane is secreting the synovial fluid. The synovial fluid would be filling this internal area, okay, so synovial fluid is filling the internal area of the joint and it's lubricating the joint, it's slight oily in substance, okay. So, that's the synovial membrane and the fluid, over the boneheads in green you can see the cartilage. This is the tough hyaline cartilage that's protecting the head of the bone and facilitating the movement of one bone against the other at the joint. In this particular diagram, we've also got the patella shown in cross-section and you can see, again, the patella has a region of cartilage behind because the patella can move quite easily within in the knee joint. If you'll get a hold of your knee caps, relax your leg, get a hold of your knee caps, you can wobble it from side to side and up and down and it needs lubrication in order to do that. Now something else that you can see within this joint, that isn't necessarily found in all synovial joints are bursas and a bursa is basically a sac of thick fluid which is for protective purposes. We find them in bigger joints and the bursas, in a sense, act like cushions, they're like shock absorbers. If you think about the knee, what do we do with the knee? Well, of course, it's used for

flexion and extension of the leg as we walk or run, but we also kneel down a lot and when you kneel down, the joint itself becomes more exposed, so the bursas help to protect the joint from the pressure of the ground as your knee goes down. If you run, that joint gets flexed and extended a lot, it gets a lot of wear and tear again the bursas will help as shock absorbers they help to protect the joint from shock, okay? You've heard of the condition called bursitis? That's inflammation of these bursas, so this is representative of your very standard joint. We could translate what we've got here into the shoulder joint, the elbow joint, the hip joint, of course the bones would be different shapes and so on, but we would still find the same basic components, we would find the ligaments, we would find the articular cartilage, we would find the synovial membrane and so on. Okay. So this is just giving you a general overview of that particular joint. Um, let's just think about the function of the patella since we have got the knee joint up there. Now, we said that your elbow joint is in a sense synonymous to your knee joint. The knee joints rely on flexion and extension of the leg, the elbow joint flexion and extension of the arm. But we don't have an elbow cap of some sort. Now, if you think about the knee, the knee is a much bigger joint and if you flex the leg, okay, so the knee joint, we flex it, what I'm actually doing is that sort of thing, so as I flex the leg the knee joint yawns open and you can see over the front here, protecting the very delicate inside of the joint, we've got the patella. So the patella is purely there for protection of the joint as the leg is flexed. If it wasn't there you'd have the whole inside of the joint vulnerable and if that got damaged in some way it's greatly going to effect articulation of the leg, so which is then going to affect mobility. Stick us out in the wild and of course that means as an animal, you fall easy to prey, you can't forage as well. Now if you think about the elbow, the elbow will still yawn open as a joint but we've got the head of the ulna having a projection on it and this projection comes forward and protects the inside of the elbow joint itself and you can see that quite clearly on your skeletons. If you look at the head of the ulna you can see that it comes up around the bottom part of the humerus. The legs here on these skeletons are not 100% accurate because as Annette's just spotted if we open that, well we've got a big yawning gap, okay. What would actually happen, the patella for the purposes of the skeleton has been fixed. The patella actually hangs in mid-air in front of the joint. There's a big tendon going over the front of it and you can see that, um, on this diagram here. The musculature. Have a look at this at the break and what have you. Here we have the patella tendon which is coming over the patella and the patella is fixed within that, otherwise it sort of floats at the front of the joint and when you expose the joint by flexing leg, the patella moves slightly, but right as your sitting straight it comes up at an angle so that it would then fill this space. Okay, and you can do that yourselves if you roll your trouser legs up or whatever and you hold on to your knee cap and then flex the leg, you'll see that the knee cap moves slightly so that it still maintains position over the exposed area of the joint. Okay, let's stop for lunch and we'll look at some spheres of movement afterwards. We were talking about synovial joints just before lunch and we were saying that these were the bigger joints, wide spheres of movement and so on. You need to appreciate that synovial joints can fall into different categories themselves so that we can talk about ball and socket joints. Ball and socket joints are where one head of the bone is ball shaped, its this circular shape, and it fits into the socket of the accompanying bone that makes up the joint. So, my fist would be the ball part and then we have a socket and the ball fits into the socket. Ball and socket joints

give a wide sphere of movement, so wide sphere of movement and we see ball and socket joints in the hip and in the shoulder, these are nice big ball and socket joints. And you can see them very, very clearly on your skeletons. If you have a look at your skeletons, you can see the hip joints and you can see where at the head of the femur we have the ball part here and it fits quite nicely here into a socket space in the pelvis. And if you look at the shoulders again, you can see a ball region on the head of the humerus and that fits into a socket on the scapula on the shoulder blade, so nice wide spheres of movement. We can also consider hinge joints as a type of synovial joints. Hinge joints. Now, hinge joints are joints that will allow movement in one plane. So if you think about the hinges of a door, the hinges of a door allow the door to open and close within in one particular plane and classic hinge joints are the elbow and the knee. So if you think about your elbow joint, it allows you to flex and extend the arm, just within in that one plane. I can't waggle my lower arm from side to side at the elbow the way the joints constructed doesn't facilitate that, nor can I bend it further back because, again, the shape of the joint will block the movement. Again, if you look at your skeletons, and if you look at the heads of the ulnas, you'll find that as we discussed that forms the elbow, but it will also block movement past a certain point, so you can flex very, very easily, but you can't extend way back, it's blocked by the shape of the joint, so it's a hinge and it's exactly the same with the knee. The other thing that you can commonly see as I straighten my arm, yeah, my arm is perfectly straight, there is no dip at this point, but some people, their arms actually bend upwards, yeah, that lady there, her arm does it quite nicely. Stick your arm up. Okay, can you see the bow in it? Yeah, yours does it a little bit, come on stick your arm up, so you can see. If you look at her arm, it goes in slightly here whereas mine is very straight. So, it's just slight differences in the way that the joint is constructed. And then, we have gliding joints. Gliding joints. If you think about something gliding it makes you think that there's a very wide sphere of movement, it's almost like something free standing, setting off on route, um, that's a slight misnomer, what we have here are a series of bones which can glide next to each other. And when you have a series of bones all stuck together and they've all got this ability to glide a little bit against their neighbors, it gives us a wide sphere of movement and we see this in the wrists and the ankles. And wrists and ankles are complex joints because we got several different bones there which will articulate against each other and it gives us very wide spheres of movement. And as I move my hand around, I can feel my wrist bones grating and flicking as they're gliding next to each other. Now, obviously, all of these joints will facilitate movement and we need to think about some terms for the spheres of movement. A person can be assessed as to how well they can satisfy a certain movement so for example, my hip is fine and dandy and I can move my leg around in very good spheres of movement whichever way I choose to move it. So, there's very good articulation around that joint. But it may be a person with severe osteoarthritis of the hip could only pick their leg up a little bit or if their swinging their leg, as I can swing my leg very easily, they may have a very small degree of movement before they start to get a lot of pain or before the joints seems to lock and that would be an indication as to how severe the joint was diseased, how far the disease had progressed and again if you work closely with chiropractors and osteopaths and what have you, you may get referral letters which will say a particular sphere of movement is limited, okay. And then normally, assessed there's either a percentage so they will say that there is 25% reduction in this movement

or that movement or um the movement should be 180 degrees and its only 75 degrees or something like that. So there are different ways that they can be assessed, so just be aware that that's a possibility. But we need to think about what some of these movements are. So, I'll give you a list of them and then I'll show you what they are. So the first is flexion and extension, abduction and adduction, circumduction, rotation, pronation, supination, and inversion and eversion. So, we'll think about what the spheres of movement are. Flexion and extension. Flexion is dead easy, its simply bending. So we have flexion of the limbs and my arm is flexed and obviously its flexion at the elbow joint. Extension is the opposite, extending the limb. So, very, very easy. Abduction and adduction, next. These often get people confused because they're very similar words, but if you think about the body, we have a midline to the body and abduction is taking something away from the midline. So, my right arm is now abducted, okay. Think about the word abduct. So, if I want to abduct Kelly, what am I going to do? I'm going to run away with her, I'm going to take her away somewhere. So, its abduction, it's taking away from the midline. Yeah, and you can abduct the leg of course. Adduction is movement to or across the midline. So its to or across the midline. Circumduction is a wide sphere of movement, so if I do this with my arm, that is circumduction. Okay, so with circumduction you can see that we have, as my arm passes over, we have abduction. Comes across the midline, adduction and I can straighten and flex my arm as I do it. So, circumduction in the sense is a wide sphere of movement combining all four of those, yeah. Okay. Rotation, now you may think that is rotation, but in this sort of terminology it isn't. Rotation is rotation along a midline, so if I put my arm out, the bones if you like are the midline to my arm and that is rotation. So, its rotation along the midline. Now, pronation and supination, we can discuss pronation and supination with respect to the hands and the feet. Now, seeing pronation and supination with the hands is very easy, with the feet its slightly more tricky, so I'll show you with the hands first and then we'll finish up and I'll come back to the feet. Pronation is holding the hands out with the palms down, so that is pronation. Supination is palms up. Okay, so you know one is palms down and one is palms up, but how do you remember which is which? Well, easy. Think of the word supination and then think about carrying a bowl of soup. Yeah. You're going to carry a bowl of soup like that, you're not going to carry it like that. Makes sense doesn't it? Yeah, so, supination, pronation. And inversion and eversion, we can talk about fee being inverted or everted, so I'll show you what's going on there. Okay, that's my foot, just sole level, turning in like that is inversion. So, I'm turning the sole of my foot into the central midline of the body, that's inversion and then turning it out, such as that is eversion. Okay, so inversion and eversion. Now, we need to think about pronation and supination of the feet. Have any of you been to see osteopaths or chiropractors or things? Some of you have? Have you been told that you pronate or supinate? No, yes did you say? What do you do? Pronate. You pronate. Most people tend to pronate, I pronate. Um, generally speaking if you think about the flat of your foot, you have the arch and it should all be nice and level. People who pronate, the arch tends to dip inwards. If they supinate, the arch is slightly more exaggerated and it tends to turn more towards the outside. Obviously, you can't do this and this with your feet, yeah, they don't work like that, they're not attached to your body in that way. But you can still pronate or supinate with respect to the arch. So you can look at your own feet and see whether or not you pronate or supinate. You see the arch of my foot there, if I

hold my foot in that position, that's not natural to me, but the arch is relatively normal. If I now stand as I do normally, do you see it all fall in slightly to the midline? That's pronation. So, normally it would be like that, I stand normally and it does that. Supination would be taking it out even further and I pronate on both. So as I stand here the arches of my feet are both dipping in slightly, that doesn't mean so as I'm flat footed, they're just dipping in slightly. Have a look at your own feet just now. Five minutes. Have a look at your own feet; see if you can work out what you do. Obviously, if you severely pronate or severely supinate, that can then cause all sorts of problems so it can cause problems with your joints, your ankle joints, your knee joints, your hip joints, because whatever is slightly out somewhere on the body, it means that it is going to feed into another part of the body, uh, and that can actually feed up into your back as well and it can throw your back out a little bit. So you may go to your osteopath with a low back problem and they don't really bother with your back too much because they assess that the problem is actually to do with the leg and possibly to do with pronation and supination, which is maybe throwing the hips out, which is then throwing the back out a little bit. So if they can correct it low down, everything else should fall back into place. Okay. And we see that an awful lot with the musculoskeletal system, that there are knock on effects through other parts of the body. So for instance, I had a very bad road accident, quite a few years ago, and my back is slightly miss aligned as a result of that, especially towards the upper part, so my shoulders are thrown slightly out. You may have noticed. I carry this one slightly higher than this one and that's because I have...