Mechanics of Human Movement
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Lecture - 03 Part a
Types of Joints

Last class we looked at the classification of the joints as basically the fibrous type of joint; so based on the construction of the joint as the fibrous type.

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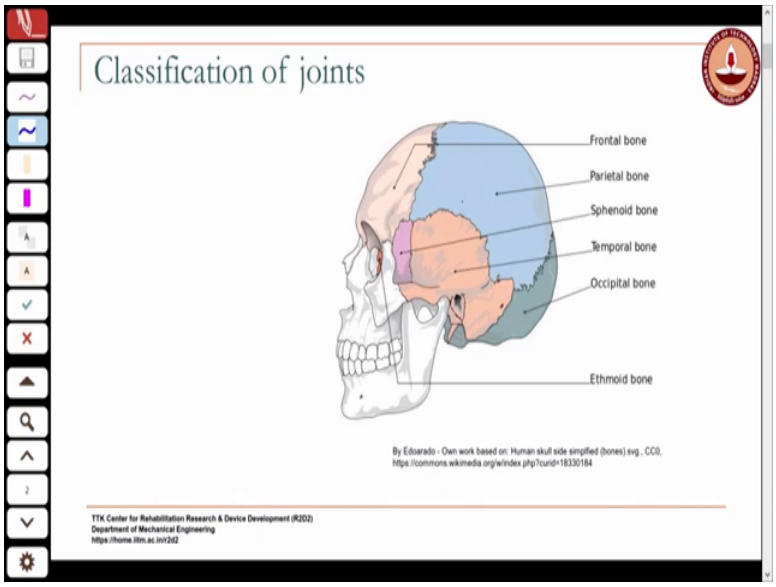

Such as the one found in the skull, which allow basically no movement between the bones.

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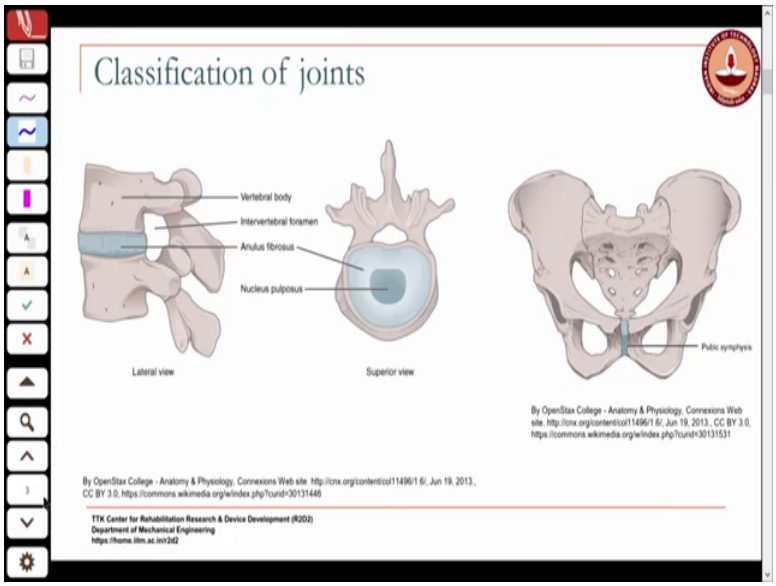

Then the second type which allow a little bit of movement are the cartilaginous joints which are like the joints between the thick fibrous cartilage between the vertebrae. And also the pubic symphysis which allow a little bit of movement, but still you know it is not a whole lot.

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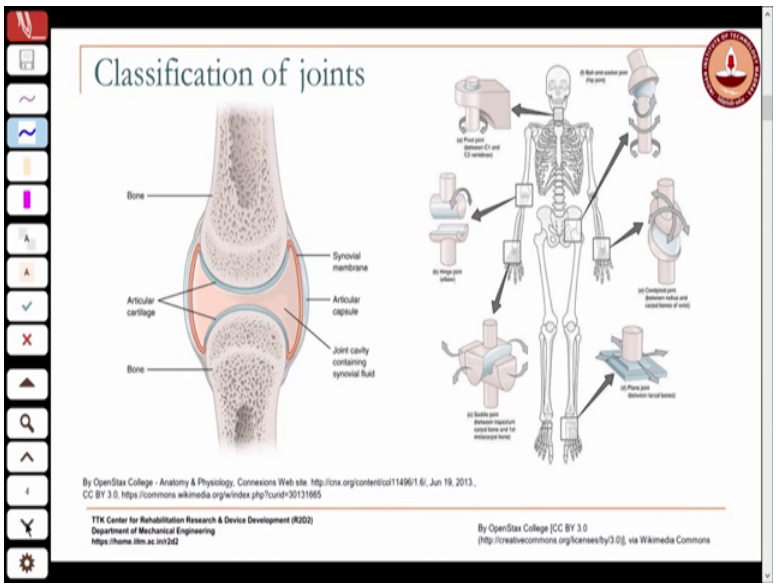

All the movable joints in the body are the synovial type of joints which have capsule which also have synovial fluid which lubricates the motion between the bones and that is and there are so many of them that they can themselves be classified based on their

function. So, different synovial there are different types of synovial joints which can be classified based on their mechanical function mainly what kind of movements they would allow at the particular joint.

So, today we will look at these types of joints.

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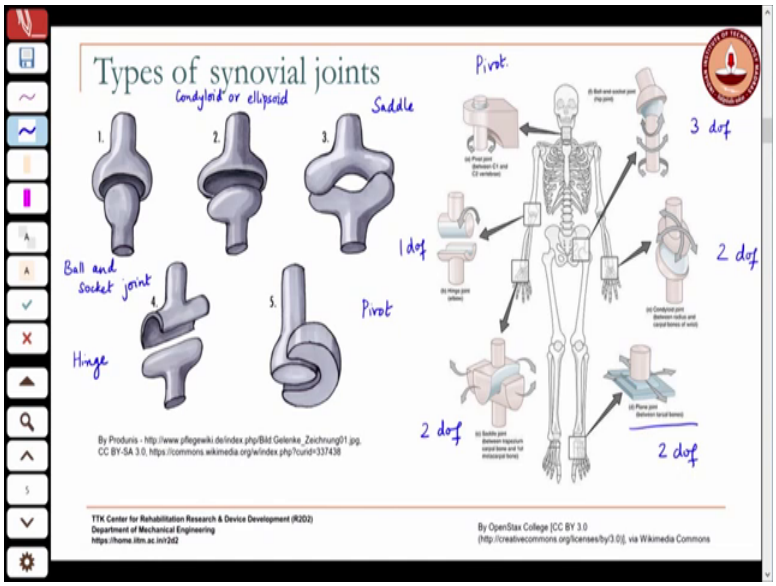

So, let us look at the types of synovial joints. So, we look at say; if you look here you can these are the types of synovial joints. You have what is known as a ball and socket joint similar to what you see in engineering; in engineering systems, you have ball and socket joint you have a ball that moves inside a cavity, and it basically will allow rotation in three different directions.

Then you have what is known as a condyloid or ellipsoid joint. This is similar to the ball and socket except that the shape of the ball, it is more like an ellipsoid, and therefore, it will only allow motion in two different planes; it will not allow motion about the longitudinal axis of the joint. Then you have a special joint called a saddle joint, where you have you know these two surfaces that interface in this manner. And this also is a joint that will allow rotation in two different planes. And then you have the regular hinge joint. What similar to a mechanical hinge joint which will only allow rotation in one plane ok. A hinge joint will only allow rotation.

So, if you notice most of the joints in the body are joints that allow rotational motion ok. There are a few joints that will allow gliding motion, translational motion, but the majority of the segments move about one another in rotation in rotation. So, you will notice that most of the joints are joints that allow rotational degrees of freedom. Then another type of joint is what is known as the pivot joint. So, the pivot joint is also like a hinge joint except it is in a different plane. So, it is called a pivot joint, then it allows the motion about the longitudinal axis that is the only difference between the hinge joint and the pivot joint, but it is given a special name, because of certain locations in the body where the motion that is allowed is the motion in the transverse plane.

So, let us look at each of these a little bit more closely ok. We will see where you can find this. So, if you look at the ball and socket joint, the most common examples will be at your shoulder and then at your hip. So, you have here at the shoulder this one does not have the it does not show the socket very clearly, but at the shoulder the clavicle forms a small it has a small cavity into which the ball of the humeral head goes into it ok, so that that articulates with the socket in the scapula its scapula to form the shoulder joints that is a ball and socket joint. And that allows shoulder motion in shoulder rotation in all three planes. So, I can do this in the sagittal plane I can do this in the frontal plane I can move rotate in the frontal plane and I can also do a rotation about the long axis of the arm.

So, I show a ball and socket joint allows three degrees of freedom. So, degrees of freedom in a joint are basically the independent motions that are possible in the joint. If you look at the only type of synovial joint that is not a rotational joint is what is known as a plane joint. A plane joint is when two bodies are moving with respect to each other in the plane. So, this slide they glide with respect to each other. And there could be a little bit of rotation perpendicular to the plane, but otherwise it is mainly a gliding motion between the joints. Those are the only joints that have translational motion in the body, but in reality none of the joints in the body are purely rotational.

So, most of them will also have some degree of sliding and translation because of the irregular shapes of the bones like when you make a door and you make a hinge, you can make a hinge such that it basically allows only that rotational motion and no other motion is allowed ok. When you make a mechanical joint, you arrest all the other motions. In the case of the body that is not always true because even though let us say

the knee joint is essentially a hinge joint it is a condyloid joint, it is or it is actually a hinge joint functions as a hinge joint, but you can have some degree of other you know motions at the joint. So, it is not a pure hinge joint as you would have in a mechanical system.

The saddle joint is a very special joint and it is really found in very I think only the only location is the carpo metacarpal joint of the thumb ok. So, it is the join between the carpal bones and at the base of the wrist I will show you figure there. And that again is a two degree of freedom joint. So, the condyloid joint which you have is again a two degree of freedom joint. Then you have the plane joint which is also predominantly two degree of freedoms; it can only allow sliding. The saddle joint is also a two degree of freedom joint; and the hinge joint is a one degree of freedom joint and so is the pivot joint. So, the pivot joint allows rotation like this about the longitudinal axis. So, let us look at each of these in some little bit more closely.

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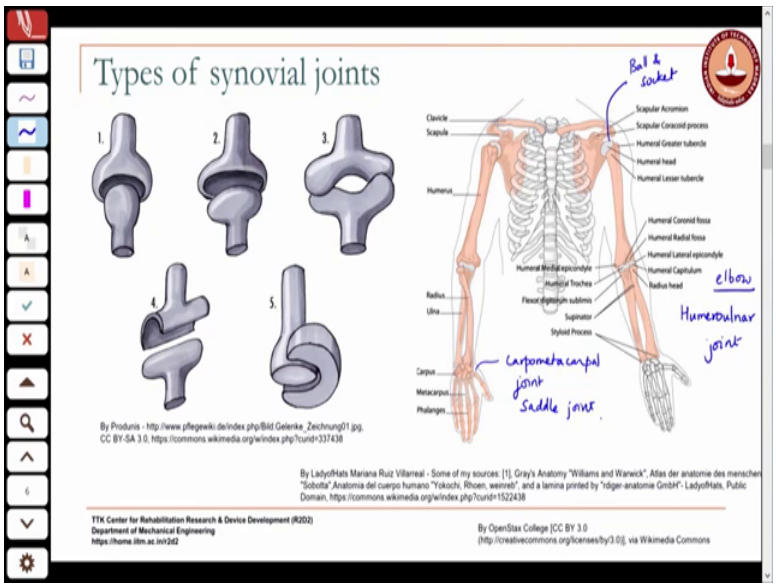

So, here you have the ball and socket at the shoulder. So, if you look at the upper limb, you have the ball and socket at the shoulder. Then your elbow is predominantly a hinge joint ok. And the hinge is the hinge between the so you have at the elbow you have two bones meeting the humerus. You have the humerus you have the radius and ulna meeting the humerus. And what happens is the hinge is formed by the ulna and the humerus. So, it is the humeroulnar joint this is what forms the elbow joint.

And structurally if you look at it, the ulna actually forms a ball and socket joint with the humerus. The ulna forms a ball and socket structurally it is a ball and socket joint, but because of the ligaments its motion is basically restricted to a hinge type motion at the joint. So, you do not have those other degrees of freedom in though even though structurally it has the ulnar head sits in the in a socket in the humerus.

Then you have this is the carpo metacarpal joint of the thumb and that is what allows the rotation in two different planes that is the saddle joint that you have here. The phalanges are another example of purely hinge joints. So, if you look at your fingers, you can only bend them in one rotate them in one direction about one axis ok. You cannot the fingers the phalanges with respect to one another; you cannot rotate in other planes. So, they are hinge joints.

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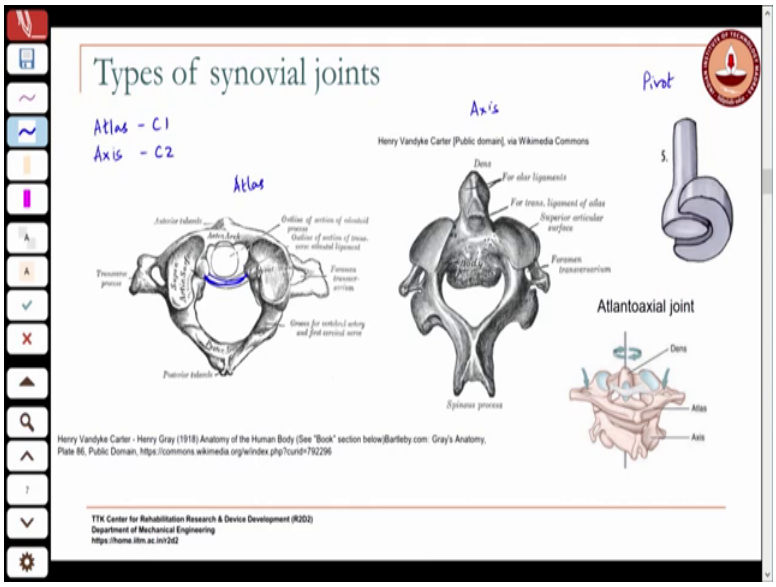

Just to show you the structure of some of the joints. So, this is an example of the what joint is this, this is the pivot joint. The pivot joint and a good example of this is what is known as the joint between the atlas. Atlas is the C 1 vertebra; and axis is your C 2 vertebra. So, this is the axis this is the atlas. So, it is the most superior vertebra the atlas.

And then you have the axis. So, the axis has a projection called the dents which actually or call the odontoid process which actually you know the atlas has a cavity like this. The axis the dents of the axis projects into this, and there is a ligament that encloses that and it is that movement of the axis about the atlas that causes the rotation of your neck. So,

the skull along with the atlas rotates about the axis about the dents of the axis and that causes the rotation of your neck from left to right ok. And this is an example of a pivot joint.

As you can see in many cases the motion is the joint is you know enclosed by just ligaments like in this case. So, this is another picture that shows the dent. So, this is the place where the I will I think I have another figure that will show you that, but your head a skull sits on the atlas vertebra and that is a condyloid joint. So, you see that cavity on the atlas. And you have projections on the base of the skull like an ellipsoid joint and that allows your rotation like this ok. When you nod your head, that rotation and then also the side rotation; the side rotation is slight, but the rotation about the center about the longitudinal axis occurs about a different joint ok. So, you have two joints in your between the skull and the cervical vertebra two major joints between those two.

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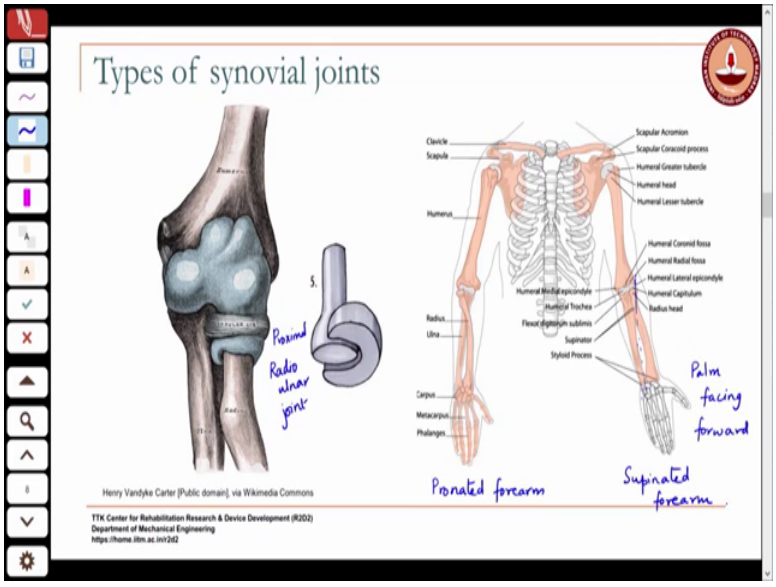

Another example of the pivot joint: so if you look at the arm, you have so here is the arm with your palm facing forward ok. This is the palm facing forward. So, in your anatomical position, this is what your palm looks like. You can see in this position the radius and the ulna are sort of parallel to one another. Now, when you do this, when you turn your pump, then the radius actually crosses over ok; it gets into this crossed configuration with the ulna and that happens about an axis like this.

So, if you take an axis like that, then it is pivoting about that axis because this radius again is at so this is the proximal part of the radius, so that is the proximal radio ulnar joint between the radius and the ulna. And it is it is got this thick annular ligament about which the radius will pivot to cause this forearm motion this forearm rotation about the axis of the forearm ok. This motion is called pronation supination. So, this is the pronated forearm. Palm facing forward like you can think of it as holding a soup bowl supination. This is a supinated forearm. So, this motion also occurs about a pivot joint. And in this case the ligament is what provides that the annulus for the pivoting. This is another example.

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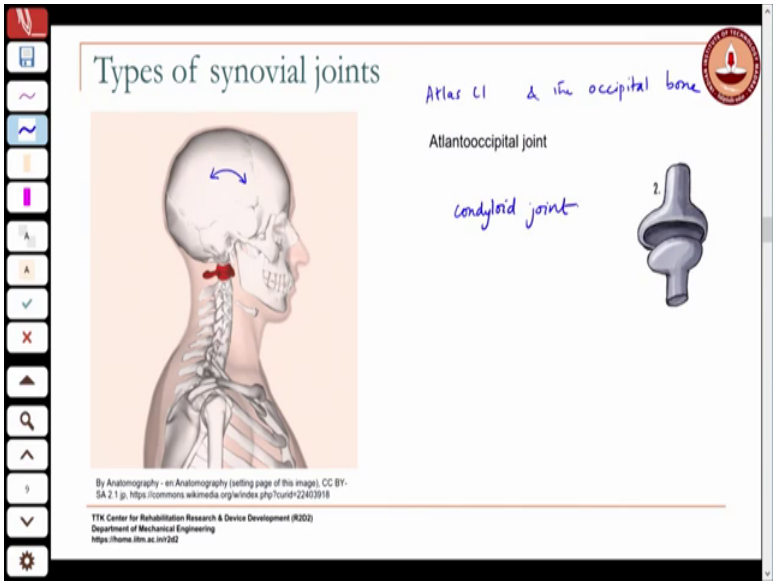

Then this is the other joint I was telling you about between the occipital bone of this skull and the atlas; atlas c 1 and the occipital bone. So, you can see that this skull pivots about that, so that is your motion the nodding motion of your head. And you can also because it is a condyloid joint; it allows some rotation in the in another direction as well. So, again it is a 2 degree of freedom joint. And then this is your axis, and it will have that projection and the whole thing will rotate about that to cause your head rotation in the transverse plane. So, this is the atlanto occipital joint, and it is a condyloid or ellipsoid joint.

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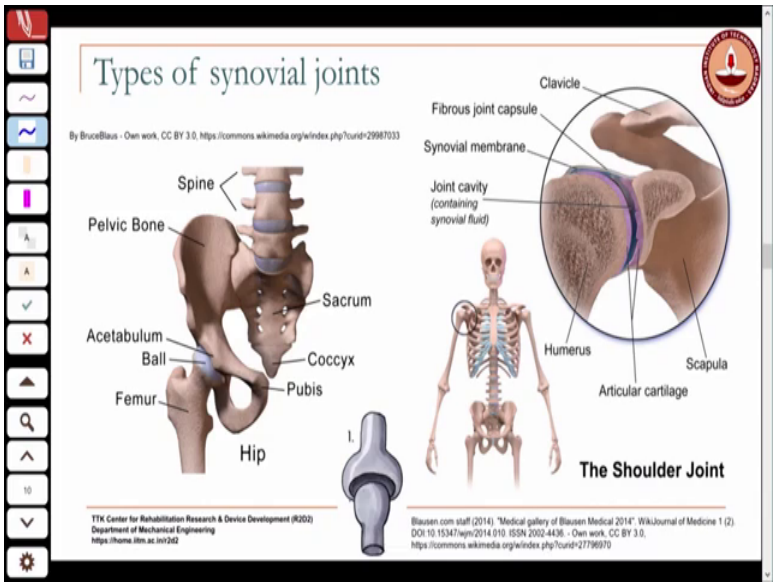

Here, these are the examples of the ball and socket joint which function as ball and socket joints right. So, they you have they give you three degrees of freedom, you have rotation in three different directions. So, you have at the shoulder for example, you can rotate in this plane you can also rotate in this plane. So, I can rotate in the frontal plane like that I can rotate in the sagittal plane. And although this model does not have it, but I can rotate in this plane as well; of course, here the joint is not truly a ball and socket joint in this model, but here the control of the motion happens, because of the ligaments surrounding the joint.

Now, at the hip, the socket is quite deep and the ball sits nicely in the socket. And so the hip is a more stable joint than your shoulder because the hip has to participate in weight bearing so that joint is more stable. At the shoulder the socket is quite shallow and the ball sits mostly outside, you have a very shallow socket in the clavicle, but sorry I am sorry in the scapula you have a very shallow socket in that, but the reason for that is you get a much higher range of motion in your shoulder joint. Therefore it is also easy to easier to dislocate your shoulder than it is to dislocate your hip because of this shallow socket ok. So, these are example examples of the ball and socket joint.

As I mentioned earlier they join between the ulna sorry the joint between the radius and the humerus is also a ball and socket, but because of the ligaments, it can only function as the hinge joint. So, we do not consider that as a ball and socket joint in function

structurally it is ball and socket, but functionally it only functions as a hinge joint. So, here you can see you have the membrane; you have the joint cavity, and the joints they are covered by articular cartilage. All these are mechanisms to reduce the friction and make the motion smooth at these joints.

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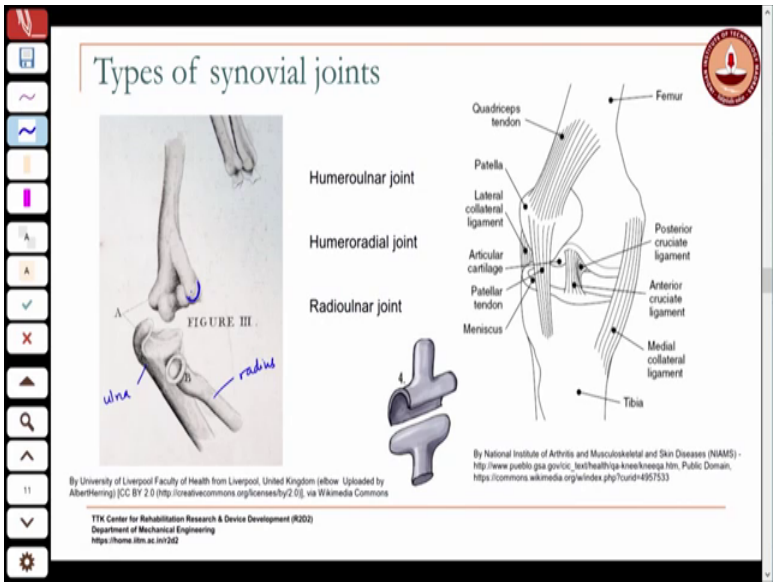

This is a good picture of why the elbow is a hinge. You can see here this is the shape of the humerus and that engages with this projection on the ulna. This is the ulna; this is the radius. And you can see this is like the socket in the radius which engages with this ball in the humerus. But again because of the ligaments together the only function has one the only function has a hinge joint.

You can see it also in this you have the ball in the humerus and then you have this shape of the humerus which engages with this projection on the ulna ok. And functions as a hinge joint the elbow functions as a hinge joint. So, any rotation that happens is the forearm rotation; it is not at the elbow. So, the elbow even though you can rotate your forearm like this, it is not technically about the elbow the elbow is predominantly a hinge joint.

The knee is another example of a hinge joint. So, you have these condyles of the knee which sit on these surfaces of the tibia, but the predominant motion at the knee is this ok. So, it functions as a hinge joint; it is the largest hinge joint in the body you do have because of the shape of the surfaces like I said before you know it is not like a

mechanical hinge, where you arrest completely all the other motions in the joint, you do have some slight rotation that is possible, and also some translation that is possible. In fact, the knee is not a pure hinge joint ok, it is a joint with the moving center of rotation, but for all practical purposes, we can treat the knee as a hinge joint.

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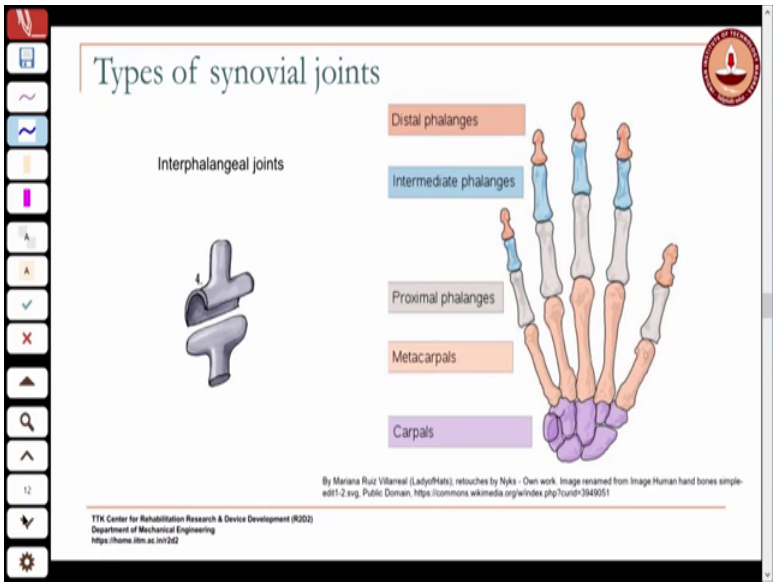

Again your interphalangeal joints between the different parts of the finger are hinge joints when the phalanges are hinge joints.

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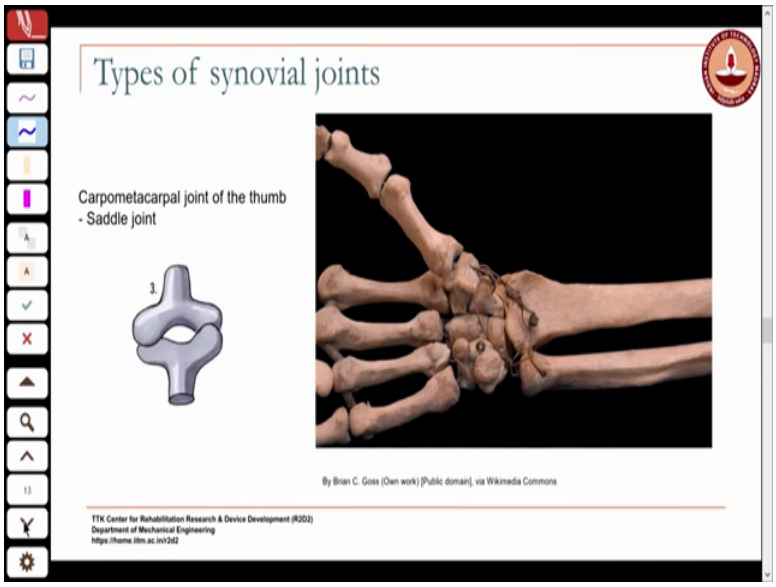

This is the saddle joint. You can see the shape here right, and the in similarly in the other plane also. It has that kind of a curvature it says that is the example of a saddle joint between the metacarpal and the carpal bone of at the metacarpal of the thumb and the carpal bones. Again this allows two degrees of freedom. So, this is an example of the saddle joint.

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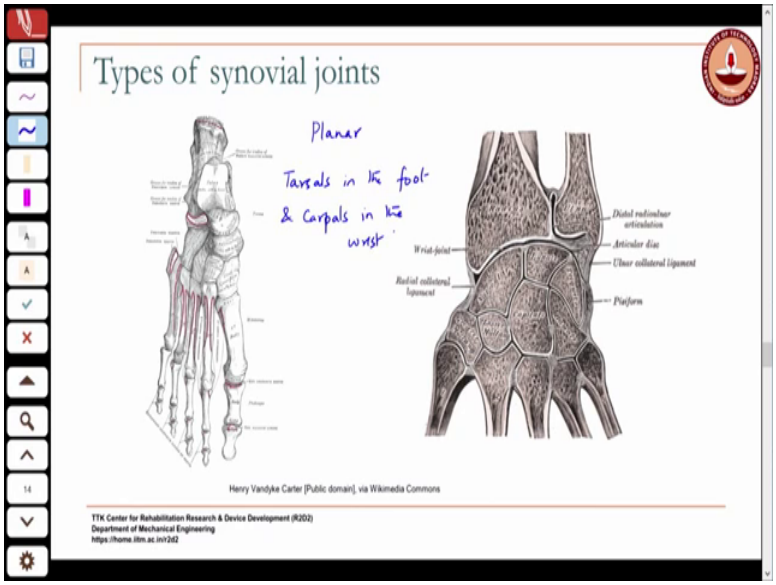

The planar joint planar or gliding joint is what you see between the bones of the carpals in the wrist and the tarsals in the foot. So, planar joint you see it in the tarsals in the foot and carpals in the wrist. So, when the other movements are happening, these bones are gliding with respect to one another ok, so that is the those are the planar joints and the synovial joints in the body. The other planar joints are the joints between two vertebrae. So, when they slide, this so when you bend like remember the joint between the vertebrae is this cartilaginous joints, so at the in the posterior part it is you can see the different vertebrae kind of interlock you know they overlap with one another.

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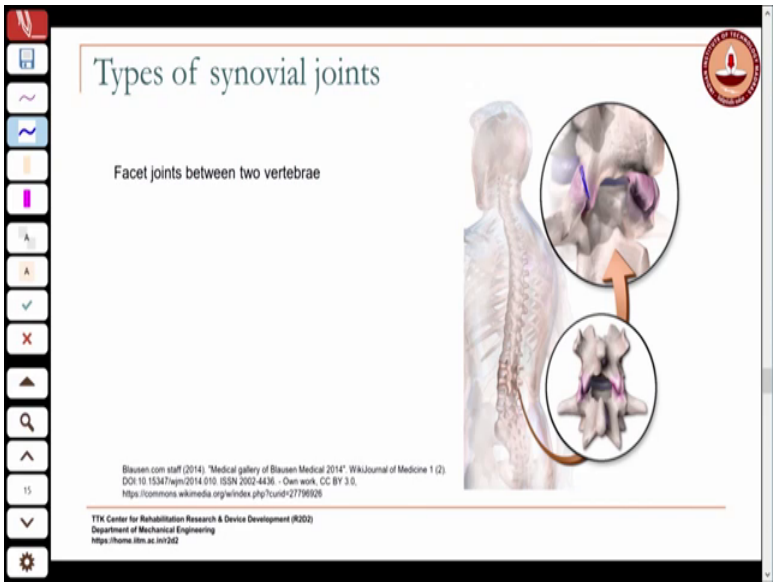

Here you can see this and the sliding motion that happens between these facets of the vertebra is another example of a gliding joint.

So, again that is those are one of few those are the places where translation happens. As you can see the major movements are not translational movements in the body; they are rotational motions. All the segments rotate about the joints to provide the major movements in to cause the major movements of the body.