Instructor Guide

Module 2: Introduction to Connective Tissue and the Muscular System

Answers to Study Questions

1. Give a couple examples of how your yoga practice may have affected your connective tissue? Answers will vary.

2. Why is connective tissue important to yoga? = Connective tissue is important to yoga because it impacts flexibility (along with other components).

3. What makes connective tissue flexible or strong? These 2 proteins come together in varying proportions to make connective tissues of varying degrees of "flexible" and/or "strong".

4. Describe how ligaments and tendons are constructed. They are a type of connective tissue; both made of similar proportions of collagen and elastin and are therefore of similar strength; however, they have a higher proportion of collagen to elastin compared to other types of connective tissue in order to impart more strength.

5. Name the location and describe the function of each type of fascia:
   - superficial fascia:
     1) location = just under the skin
     2) function = contains fat cells which help maintain body temperature at the surface
   - visceral fascia:
     1) location = surrounds the organs
     2) function = suspends the organs in the gut as well as heart and lungs
   - deep fascia:
     1) location = surrounds all the muscles

6. Describe the structure of a muscle fiber. It is made of two types of proteins called actin and myosin.

7. Describe the structure of muscle. It is made of layers and wrappings of fascia around proteins.

8. Describe how a muscle functions. Muscles contract when the nervous system tells the body to release calcium which causes the two muscles to be attracted to each other; muscle contraction involves the fascia surrounding the proteins as well as the proteins themselves.

9. Explain how the structure of a citrus fruit could be used to describe the structure of a muscle. What does each part of the citrus fruit represent? citrus fruit example from book text

Additional Activities for the Teacher to do with the Class
Discuss some examples of areas of the body that used to feel tight, weak, or painful, which have changed since you've been practicing yoga?
Reflect: How have these areas of your body changed? How did they feel before? How do they feel now?

Apply: How might you apply this knowledge of the possibility of change in the tissues when you work within your own practice of teach students new to yoga asana practice?
Answers to Study Questions

1. Define and give an example of the 'Principle of Opposing Muscles'. When a muscle meets resistance that it cannot overcome, its opposing muscle will relax. Examples will vary.

2. Explain the general purpose of Proprioceptive Neuromuscular Facilitation (PNF) technique. Therapists take advantage of neuromuscular principles to get certain muscles to activate or deactivate depending on the clients situation and needs.

3. Explain the 'principle of tensegrity using an example? The concept says that tension in a structure can maintain the integrity of the structure. One example is a suspension bridge.

4. Discuss how the nervous system could be said to be the "embodiment of the body-mind connection". Where does body end and mind begin? Answers will vary.

5. What are the functions of nerves which are found throughout the body? They make things happen as well as report back to body/mind of what has already happened.

6. Describe how the layers of connective tissue are arranged to create the structure of a bone: There is a thick layer of connective tissue surrounding the outer surface of bone called the periosteum. Inside the bone is the medullary cavity, which contains bone marrow. Along the inside of this cavity is another layer of connective tissue called the endosteum. Sandwiched between these layers of connective tissue are the crystallized minerals that make our bones hard. Primarily, these minerals are calcium and phosphorus. Within them are hollow areas that allow for nerves and blood supply to move through the bones.

7. Describe how the three types of bone cells are involved in allowing bones to respond to stresses placed on them by changing structure/thickness and shape/density? Example of the bones that come together at the top of the femur and the 'jumping up and down' example

8. Give an example of where synarthrosis occurs in the body. sutures in the skull

9. Describe how our body could be considered an example of the principle of tensegrity? Bones are the compression members connected by connective tissue which represents the tensional members.

10. Use the 'principle of tensegrity' to explain what happens when fascia gets stuck. When fascia gets stuck, it will be felt throughout the body to some degree as the whole structure is connected. Compression members will have to adjust and move to compensate for the “stuck” area.

Additional Activities for the Teacher to do with the Class
Try this example of using the PNF technique in baddha konasana: First find a partner. Have your partner come into baddha konasana pose and place your palms over their knees. Encourage your partner to press up with their knees into your palms for a couple seconds and then relax. Again, encourage your partner to press up with their knees into your palms for a couple seconds and then this time, as they relax, press down GENTLY to bring the knees close to the floor. Be sure to have your partner tell you if you are putting too much downward pressure on their knees. Do one more round of engaging and releasing this way and then switch roles.

**Reflect:** What did it feel like when you were engaging and releasing in baddha konasana position? What did you notice when in your partner’s pose when they were engaging and releasing? Did you feel like there was a change in tension in your pose after a few rounds of engaging and releasing?

**Apply:** In what other yoga poses do you think you could use this same technique to create change in the tension of the pose over time?
Answers to Study Questions:

1. Why are there so many bones and joints in the foot and lower limb area compared to other areas of the body? The foot sustains a large amount of our body weight and has to deal with multiple and sometimes conflicting functions. Stability is the heart of what the foot represents, but there are many weight bearing positions we ask of the feet, especially in yoga.

2. Describe the two primary ways that the foot is adaptable:
   1) absorbs and distributes body weight by literally changing shape depending on what we need from it
   2) adapts to the terrain underneath it, for example walking or running on uneven surfaces.

3. Give an example from daily life or yoga of what could happen if our foundation (the feet) was in some way compromised. Answers will vary.

4. How does the structure of the ankle affect function of the ankle? This structure limits how much side to side movement occurs at this joint. This structure allows for a great amount of forward and backward movement.

5. Describe how weight is spread throughout the foot as you take a step. Weight is spread across the 3 arches each time we take a step. The foot gets longer through the medial and lateral arches and wider across the transverse arch when we put weight onto our foot.

6. Describe how the arches of the foot can be said to have qualities of mula and uddiyana. The points where the foot touches the floor can be said to have mula quality as these are the points where we will root through the foot into the floor. The arches of the foot can be said to have uddiyana quality as these are the areas of the foot where we actively lift up.

7. Since the foot is our foundation, the balance of these qualities of mula and uddiyana can be transferred up into the rest of the body. Give an example of how this might show up in yoga asana. Answers will vary.

8. Describe how each of the three following components: bones, connective tissue, and muscles, contributes to creating and maintaining arches in the foot: 1) bones-genetics determines shape which can allow for or restrict movement 2) connective tissue-ligaments tie the bones of the foot together; there is also a genetic component to the flexibility or sometimes hypermobility of these ligaments, for example flat feet can be caused by genetics 3) muscles-the foot is controlled by muscles in the foot and foreleg (primarily the tibia and fibula).

9. Describe the structure and function of the posterior component of the foreleg: structure= a deep and a superficial layer. The bulk of the muscle is placed above the part that it moves. The gastrocnemius and soleus attach to the heel bone via the Achilles tendon. Function = The
posterior compartment is the strongest compartment of the foreleg. The gastrocnemius and the soleus contract to pull the heel up.

10. Describe the structure and function of the anterior compartment of the foreleg: structure = muscles in the anterior compartment of the foreleg attach to the top of the foot. These muscles make up the "anatomical stirrup" of the foot. Function = the muscles in the anterior compartment of the foreleg dorsiflex and/or invert the foot.

**Additional Activities for the Teacher to do with the Class:**

1. **“Feel the Effect”**: Stretch your calf muscles first with straight legs and then with the knees bent. Notice the different places where you feel sensation when the legs are straight compared to when they are bent.

   **Reflect:** Where do you feel most of the stretch when the leg is straight? Is it felt more in the calf or your soleus? Where do you feel most of the stretch if you sink into a squat? How much of the stretch do you feel in the calf, soleus, and Achilles tendon when the legs are bent?

   **Apply:** How might you apply this understanding of how bending the knee joint can influence where the stretch is felt to some yoga poses?

2. **“Play with the Quality of the Pose” activity**: Go into Warrior 1 and close your eyes. Lift your toes and let them fall repeatedly while paying attention to what changes above them.

   **Reflect:** What do you notice when you lift and then release your toes in a Warrior 1 position? Does the entire structure seem to collapse and then lift again with the toes?

   **Apply:** How might you apply this understanding of the effect of actions in the foot to teaching the Warrior 1 pose, if you were explaining it to students in a class?

3. **“Play with the Arches”**: Look at the qualities arches can bring to a pose. Use a simple pose like Warrior 1. Get into the pose and then let your arches collapse in your front foot. Watch the effect on the knees and therefore the hips in this leg. While the knee is in, lift your toes up and notice how this affects the rest of the body.

   **Reflect:** What changes do you notice in the rest of the body when you allow the arches to collapse in the front foot while doing a Warrior 1 pose? Do you find that your knee falls in a bit when you collapse the arches in your front foot? What do you notice when you lift your toes up? Can you sense or see the knee trying to move laterally as a result? Do you find that lifting your toes affects the position of your knee in space and causes your hip joint to move in addition to lifting the arches of your foot?

   **Apply:** How might you apply this knowledge of the relationship between the arches of the foot, the knee, and the hip to practicing or teaching a Warrior 1 pose? How might you apply this knowledge to some other poses?
Answers to Study Questions:

1. Explain how Indian cultural context for yoga asana practice influences the expectation for openness in the hips. Indians traditional sat on the floor or in a squatting position rather than in chairs for most daily activities which maintained openness in the hips.

2. Give an example of how the condition of a joint above or below the knee (tension, weakness, knee injury, or other converging history) could affect the knee joint. Answers will vary.

3. How does the shape of the femur and the angle at which it attaches to the tibia and pelvis impact movement? The angle at which the femur attaches brings the feet in under the body and closer to the midline of the body to facilitate walking.

4. How does the structure of patella contribute to the function of the knee? This bone becomes a point of additional leverage for the quadriceps to lie over and around. It redirects force over the top of itself, thereby increasing the force of the quadriceps. By changing its angle, it also helps reduce friction as the thick tendon extends the knee joint. The underside of the patella has cartilage and therefore, easily and smoothly slides on the groove of the femur.

5. What are two other actions that happen at the knee joint besides the two primary movements of flexion and extension? internal rotation and external rotation below a flexed knee

6. What is the function of the two collateral ligaments? They connect the femur above to the tibia below. They prevent the tibia from moving sideways; they help maintain straight forward movement of the knee. They also help resist external rotation of the knee.

7. What is the general function of the two cruciate ligaments? They keep the femur and tibia closely held together. They are the primary stabilizers of the knee joint.

8. Where does the ACL attach? It attaches to the front part of the tibia and then runs to the inner part of the big bump on the bottom of the femur.

9. Where does the PCL attach? It attaches to the back part of the tibia and then attaches to the inner part of the big bump on the inside of the femur.

10. Describe how the structure of the menisci make the various movements at the knee possible. The meniscus squishes or slides forward to keep the knobbly ends of the tibia in place. The knobby ends both glide and roll up the ramp of the meniscus forcing the femur to rotate in place on top of the tibia.

11. How do the hamstrings and quadriceps interact to balance forces impacting the knee joint? As the knee straightens, the hamstrings must get longer. If the hamstrings shorten, the quadriceps must get longer.

Additional Activities for the Teacher to do with the Class:
1. Try this: Step into a simple triangle pose and before your reach out to begin your fold, notice where your knee tends to point. Chances are it is pointing inward. If you bend your knee slightly, you will notice that it unlocks the hip and gets that knee pointing straight forward over the foot.

**Reflect:** Which way was your knee pointing when you stepped into the triangle pose? What happened when you bent the knee?

**Apply:** How might you apply what you learned to other poses besides triangle?

2. Play with comparing the entry and exit of a number of standing poses with both straight legs and then with bent knees. Using a bent knee on the transitions can be extremely helpful to those with SI, lower back, or knee problems. Please remember that once in the pose, you should at the very least be trying to straighten you knees.

**Reflect:** What do you notice when you enter standing posture such as extended triangle or a standing forward bend with bent knees versus straight legs? How does it feel like the weight is distributed in the two different ways of entering the standing postures?

**Apply:** How might you apply what you know about moving into or out of yoga poses with bent knees to daily life activities, for example, picking up a heavy box?
Instructor Guide
Module 6: The Hip Joint

Answers to Study Questions:

1. Describe the basic structure of the hip joint. The head of the femur (thigh bone) meets up with either side of the pelvis in the large depression (acetabulum). A piece of cartilage called the labrum is located on the surface of the acetabulum and helps make the meeting of the 2 bones a more stable connection.

2. Name some yoga poses where tight hamstrings would likely restrict movement. Basically any forward bend. Other answers will vary.

3. Name some yoga poses where tight adductors might restrict movement. Answers will vary but might include baddha konasana, warrior 2.

4. What does it mean when we say that the rectus femoris is a two joint muscle? It crosses two joints, the knee and the hip. The position of one joint has an effect on the amount of tension through the muscle and therefore on the ability of the other joint to move.

5. What are the four functions of the hamstrings? They extend the hip joint by pulling the leg backward. They flex/bend the knee. They internally and externally rotate the knee when the knee is bent at 10 degrees or more. They also assist in rotating the hip joint internally and externally.

6. What are the functions of the adductors? They adduct the leg (bring it toward the midline) and flex the hip joint (lift your leg in front of you). They also medially rotate the leg (rotate the leg inward). They can also affect the positioning of the pelvis by pulling down on the front of the pelvis and contributing to an anterior tilt on one or both sides.

7. What are the functions of the gluteal muscles? They are the abductors of the hip joint and rotators of the hip, both internally and externally. They also can flex and extend the leg at the hip. They prevent adduction at the hip joint enabling us to stabilize the hip joint while standing up.

8. Why might students with tight gluteals from large amounts of walking, running, or cycling have difficulty with poses like half-lotus, baddha konasana, or janu sirssana? The same muscles that are used in running, walking, and cycling function to both flex/extend and internally/externally rotate at the hip joint.

9. Generally, where are the deep 6 lateral rotators located and where do they attach? They are located under the gluteus maximus. They attach in various places on the pelvis and then attach at the other end to the back part of the greater trochanter.

10. What are the actions/functions of the piriformis? It acts as a stabilizer of the sacrum relative to the position of the pelvis. It functions to do lateral or external rotation and abduction of the hip joint.

Additional Activities for the Teacher to do with the Class:
1. Try to palpate (find and feel) your hamstrings and tendons of these muscles. It is easy to feel the hamstrings behind the knee. You can palpate the tendons of these muscles just before they cross the knee joint. Sit on the floor and bend your knee about 90 degrees. Place your fingers (spread them apart a bit) on the back of your thigh so that both index fingers are just touching your calf on both sides. Now, gently pull your heel into the floor and you should feel the hamstring tendons tighten against your fingers. They are surprisingly hard, almost like bone.

The most obvious tendon toward the middle and inside of the knee is that of the semitendinosus muscle. If you slip off it towards your inner thigh, you will land on another obvious tendon, this one belonging to the semimembranosus muscle. Lastly, on the other side of the knee is the biceps femoris tendon, which you can pretty easily feel as it attaches onto the head of the fibula. Now that you are clear on where these tendons are, and your fingers are still on them, rotate your lower leg internally and externally to feel the tendons move.

Reflect: Could you find your hamstrings? Were you able to feel each of the individual hamstrings tendons? What did they feel like?

Apply: Do you think knowing exactly where you’re hamstrings muscles are will change your awareness of how they are working in your yoga asana practice? How might you apply that awareness to other muscle groups?

2. Explore some postures with the class where tension in the adductors, gluteals, and/or the deep 6 lateral rotators could restrict the depth of the postures. Postures might include: baddha konasana, arda padmasana, janu sirsasana, or arda matseyndrasana

Reflect: Where did you feel tension in the body when you moved into these yoga postures? Are these places where you’ve been aware of tension before?

Apply: How do you think you could work in these poses or have students work in these poses to increase the openness in these tissues over time?
Answers to Study Questions:

1. Where does iliacus attach? Proximal attachment is broad and covers the inside of the pelvic bowl (ilium). Distal attachment: iliacus weaves its fibers together with psoas major and the two muscles attach together at the lesser trochanter.

2. Describe where psoas major is located and list the joints that psoas major crosses. The proximal attachment of psoas major is on the bodies of the vertebrae T12 through L4 or L5. It then runs down the sides of the spine and over the front of the pubic bone. Distal attachment is lesser trochanter of the femur. It crosses the following joints: T12-L1, L1-L2, L2-L3, L3-L4, L4-L5, L5-sacrum sacrum to ilium (SI joint), pubic symphysis, and hip joint.

3. What are the functions of the iliopsoas? Flexion of the hip, lateral rotation and adduction at the hip joint

4. Approximately where is our center of gravity located? top of the sacrum

5. Describe structurally how the pelvic bones are connected together. The three bones are merge together at the center of the acetabulum, the deep depression on the pelvis where the large ball on the end of the femur fits into the pelvis. The two sides of the pelvis are connected in the front by the pubic symphysis, which is a disc-like piece of cartilage. They’re connected in the back by the sacrum. The sacrum connects to the ilium at the sacroiliac joint (SI joint).

6. Describe what happens in an anterior and posterior tilt of the pelvis. Anterior-the pubic bone drops down and there is a corresponding accentuation of the lumbar curve. Posterior-the pubic bone lifts and there is a corresponding flattening of the lumbar curve in the lower back.

7. Why might using the terms origin and insertion for muscles that attach to the pelvis not be as helpful to describe pelvic movement, especially when one is out of anatomical position? The same motion in the pelvis can created either by pulling with muscles above and in front or below and in back; pulley wheel example

8. What is hip hiking? lateral pelvic tilt; lifting one hip up toward the rib cage

9. Name the ligaments that attach to the SI joint and describe where they attach. The sacroiliac ligaments attach at the front of the joint from the sacrum to the ilium. The iliolumbar and sacrospinous ligaments also attach at the front of the joint. The sacrotuberous ligament is found on the posterior side of the joint and connects the sacrum to the ischial tuberosity (sit bone)

10. How much movement is possible at the SI joint in the average person? a few millimeters

11. Describe the movement of nutation and counter nutation at the SI joint and explain what causes it. Nutation occurs when the top of the sacrum moves forward and down, with the pelvis stable. Counter nutation occurs when the top of the sacrum moves back and down. Movement at this joint is passive, but can be caused by weight bearing or buildup of force through movement at the pelvis, hip joints, or spine
Additional Activities for the Teacher to do with the Class:

1. Exploring psoas and bandhas: jumping forward and jumping back in Sun A
   One movement ties together the concepts of center of movement, center of gravity, Bandha and the psoas. The movement is jumping back from Uttanasana into High Plank (or Chaturanga) and the return to Uttanasana from Down Dog. These movements are commonly found in Sun Salutations. They are also a place where you can observe someone “floating” back and by using their Bandhas.

   At its most functional level, the movement back from Uttanasana to High Plank is an extension of the hip joint. The returning jump forward is flexion of the hip joint. What is moving through the air is the center of gravity. Control of the pelvis or more specifically the center of gravity at the sacrum is what is necessary. What muscle is closest to this area and has the ability to control the hip joint? The psoas.

   The jump back to High Plank requires the practitioner to resist gravity at the hip joint, especially when they land. The hip flexors engage in an eccentric contraction to prevent extension from happening too quickly or strongly. We slowly lengthen with tension to prevent the pelvis from sagging and falling as the feet hit the floor.

   Going the other way, once we jump from Down Dog into the air, it is the pelvis (center of gravity) that must lift and be balanced in the air. Once this happens with support from the arms, the legs must swing in against the resistance of the hamstrings and other hip extenders. This is harder to do in the air because there is less leverage. This action is a concentric contraction of the hip flexors. The strongest hip flexor? The psoas. Therefore, without a doubt, the physical aspect of the float that you see in yoga practitioners is related to the psoas.

   Reflect: Does jumping through and jumping back feel differently when you have the intention of initiating movement from the psoas? What do you notice in your movements when you set that intention?

   Apply: How might you apply what you noticed in the jump through-jump back exercise to asana practice in general? How might you expect the feeling of control or lightness to change in asana practice if you were able to maintain attention to the psoas?

2. Exploring psoas: stretching the psoas using lunges, warrior 1 with heel up or pigeon pose
   How do I stretch my psoas? Most people do need to lengthen this muscle, especially during or before building strength. The muscle is a hip flexor, which means that any strong extension of the hip joint should stretch the psoas. Lunges are a great way to stretch the psoas. You could also use a Warrior 1 with the heel up, or the back leg in a Pigeon pose.

   Reflect: What do you notice in the area of the psoas when you step into a lunge, step into Warrior 1 with the back heel up, or put the back leg in a Pigeon pose? Do you feel a stretch in the area of the psoas? Does one of the poses stretch the psoas more deeply than another pose for you?

   Apply: Can you think of some asanas where a tight psoas would restrict the range of motion in the pose?

3. Explore hip hiking

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We find a good example of hip hiking on the mat is in Parivrita Trikonasana (Revolved Triangle pose). If we’re doing the right side of this pose (right foot forward, left hand down), there can be a tendency for the right side of the body to shorten. Essentially, the pelvis hikes up toward the ribs. To correct the hip hike we pull the pelvis back on this same side.

Reflect: What do you notice about the placement of the hips in your Revolved Triangle pose? Do you notice the right side of the body shortening when you’re doing the right side of the pose? What about the left side? What happens when you actively try to pull the pelvis back as you do the pose? Do you notice a difference between sides of the pose?

Apply: What other poses might you apply what you’ve learned about hip hiking to?

4. Play with the Influence of the Placement of the Feet on the Pelvis

I visualize the pelvis as an elevated foundation or second foundation, especially in standing poses. In these asana, the first foundation is our feet. The pelvic foundation is affected by the first foundation. In other words, where we position our feet has an impact on where and how the pelvis is positioned.

Different factors can play into this, most significantly the general tension or openness in the front, back and sides of the hip joints. The more open and flexible the tissues surrounding the hip joints, the more adaptable the positioning of the pelvis is relative to the feet.

If we look at how we set up our stance for a standing pose such as Triangle and Revolved Triangle, we can easily see the effect and relationship between the lowest foundation (the feet) and the elevated foundation, the pelvis. If I set my feet up so that the heels line up with one another, my pelvis is in a particular position. If I line the heel of the front foot up with the arch of the back foot, my pelvis is in another position. If I take it even further and line my front heel with the toes of the back foot, my pelvis is in yet another position.

Depending on the individual and the tension in their hips, the foot placement may have more or less of an effect on the pelvis. Also, in each of these scenarios you can see how the body parts above the pelvis compensate for the positioning of the pelvis. If the pelvis is not straight or square relative to the feet then the spine must compensate for this. Where the spine goes, so goes the head and slowly everything must rearrange itself using muscles and tension in ways that simply aren’t necessary.

Reflect: What do you notice in the placement of the pelvis when you line up the feet in the different positions described? How do the different placements of the feet affect your feeling of balance? Does one placement of the feet feel more grounded or balanced than another? How do the different placements of the feet affect the body placement above the pelvis, for example the placement of the torso or the head?

Apply: How might you apply what you noticed about the placement of the feet Triangle and Revolved Triangle poses to standing asanas in general? How might you apply what you noticed to creating a feeling of grounding and support in standing asanas?
Instructor Guide
Module 8: The Anatomy of Energetics-Breath and Bandha

Answers to Study Questions:

1. How might you describe what it is like to have control over your bandhas? A physical and energetic connection to your center.

2. Describe the connection between breath and bandha. Breath is a way energy comes into the body. Bandha is how we learn to direct that energy.

3. What does contracting the PC muscles or activating the physical aspect of mula bandha do both physically and energetically? The PC muscles help create stability of the pelvic bowl, the abdominals, and the spine. Contraction of these muscles could also be considered the “pathway” toward turning on the energetic aspects of mula bandha by creating a conscious mental relationship with the bandha.

4. Where does the diaphragm attach? It attaches posteriorly to the spine and then circles around the bottom of the rib cage until it gets to the xiphoid process at the base of the breast bone. The fibers of the diaphragm run up and down and attach to what is called the central tendon.

5. What happens anatomically in “belly breathing”? The diaphragm contracts. As its surface moves down, it pulls on connective tissue bags that surround the lungs. As a result, negative pressure is created in the chest cavity and the lungs fill. Downward pressure is created by the movement of the diaphragm pushing the abdomen down. There can be a slight pressure downward on the pelvic floor caused by downward pressure of the abdominal contents.

6. What happens anatomically when we breathe while lifting the pelvic floor muscles and gently pulling the abdomen in? We change the pressure in the “abdominal container” created by diaphragm on top and pelvic floor on the bottom by engaging in. These changes produce a different action in the diaphragm when we breathe; the top of the diaphragm remains still. The fibers of the diaphragm then force the lower ribs to be pulled in, making space in the chest cavity. Negative pressure is then created and air rushes in.

Additional Activities for the Teacher to do with the Class:

Play with breathing in twists and/or backbends

Explore the following: as we breathe, when the diaphragm contracts it puts pressure on the abdominal contents and on the pelvic floor; the further you take your inhalation, the more pressure is put on the pelvic floor. Engaging mula bandha/PC muscles resists this downward pressure.

Now engage mula bandha/PC muscles while breathing and move into a seated twist. Pay attention to the sensations in the intercostals in particular.

Repeat the exercise one more time and move into a backbending posture

Reflect: What sensations do you notice in the pelvic floor muscles as you breathe normally compared to taking a breath with mula bandha/PC muscles engaged? Did anything change when...
you engaged the pelvic floor muscles? Where do you feel most of the breathing is happening when you breathe normally? Does where you feel the breathing happening change when you engage the pelvic floor muscles? What do you notice when you breathe with mula bandha engaged and move into a seated twist or backbend? How do the poses feel? Do you notice any restrictions in the breathing?

**Apply:** How might you expect this method of breathing (with mula bandha engaged) to affect the quality of an asana practice?
Instructor Guide
Module 9: The Spine

Answers to Study Questions:

1. Describe in general the parts of the spine and how they are connected = It consists of stacks of round short bones with a thicker, dense type of cartilage between them like a rubber bushing. These discs of cartilage are the real miracle of the spine. They are not just cartilage: they are fluid-filled. They provide shock absorption and allow for movement by maintaining space between the bones. They also create space for the nerves coming off of the spinal cord to come out from between the bones and feed their tissues and organs. These joints are referred to as anterior intervertebral joints.

In addition to the round flat part (or body) of the vertebra, there is also an awkwardly shaped area that sticks out in many directions behind it. These oddly shaped bones form the amazing ring, which protects the critically important spinal cord. The bits of bone that shoot off sideways and backward are for muscles to attach to. They also allow for or restrict movement in certain directions.

The articulations between the posterior parts of the vertebrae are facet joints (also known as posterior intervertebral joints or the zygapophyseal joints). Flat surfaces (two on the bottom and two on the top of each vertebra) join the vertebrae and help control spinal movements.

2. Describe how the structural components of the spine show an example of tensegrity in the body. Each vertebra has two compression members (if you will) that stick out to the sides. These are known as the transverse processes. In addition there is one compression member that sticks straight out from the posterior of the vertebrae. This is called the spinous process. All of these parts that stick out interact with the deepest layer of our musculature and create tensegrity. The deep rotator muscles attach from the transverse process to the spinous process below. Here we can see tensegrity quite clearly. If we add in the other muscles that attach onto the spinous process from other places such as the ribs in layers and layers, we see how each vertebra is suspended in its very own web of tension. When we step back and view the spine as a whole, we see that the entire spine has the potential to be suspended in the tension and not in compression of bones.

3. Where are the primary curves found in the spine and how are the formed? Thoracic and sacral regions of the spine; they are formed in the fetal position in the womb

4. Where are the secondary curves found in the spine and how are they formed? Lumbar and cervical regions of the spine; they are created by the actions of holding our head up and arching our back as newborns.

5. What are the movements of the lumbar spine and what are the structural differences of the spine in this region compared to other regions of the spine that make this movement possible? The lumbar spine does flexion, extension, and lateral flexion (side-bending), but little to no rotation. The vertebrae at this part of the spine are larger than other are with a good amount of space between them. The facet joints are parallel to the midline of the body allowing them to glide which allows for a fairly significant range of motion in the lumbar spine compared to other parts of the spine.
In most people, how many vertebrae are located in each region of the spine? 7 in the cervical spine (neck), 12 in the thoracic spine (upper and middle back), 5 in the lumbar spine (low back), 5 fused to create the sacrum and 4 fused to create the coccyx.

6. What are the movements of the thoracic spine and what are the structural differences of the spine in this region compared to other regions of the spine that make this movement possible? The vertebrae in the thoracic region are smaller than those in the lumbar region. They get progressively smaller as you move up the spine. Spinous processes in the thoracic region of the spine point slightly downward. Each thoracic vertebrae is attached to a rib. Facet joints of the thoracic vertebrae are parallel to your back (nearly opposite of the direction of those in the lumbar region). These structural attributes mean there is limited flexion, extension, and hyperextension in the thoracic region, but quite a lot of rotation is possible and some lateral flexion (side-bending) is possible.

7. What are the movements of the cervical spine and what are the structural differences of the spine in this region compared to other regions of the spine that make this movement possible? Orientation of the facet joints of the vertebrae is almost horizontal in the cervical spine. There is more space between vertebrae than in the thoracic region allowing for more spinal extension in this region. There is a fairly large range of movement in the cervical spine including flexion, extension, lateral flexion (side-bending), and rotation.

8. What is the location and function of quadratus lumborum (QL) muscles? It attaches from the top of the pelvis to the lowest rib and to the transverse process in the lumbar spine. It assists in spinal extension but is mostly used in stabilizing and lateral flexion of the spine.

9. What are the functions of the muscles that make up the abdominal cavity? Stabilize and move the spine, flexion of the spine, lateral flexion, rotation of the spine, also these muscles are movers of the pelvis or stabilizing the pelvis relative to the spine. They also function as secondary respiratory muscles.

10. Explain why the presence of fluid makes the vertebral discs stronger than they otherwise would be. More fluid in the discs means more pressure pushing outward against the cartilagenous wall.

**Additional Activities for the Teacher to do with the Class:**

**Fluidity of the Spine**

1. I’ll share a little intention that I use in my own practice. It stems from my work with John Scott and has played a huge role in my understanding of integrated movement. Ideally we want to have a strong and flexible spine. We also want to have a relationship with each part of our spine. Sun Salutations are a great place to explore an intention of integrating the movements of all parts of the spine. Look for the spine to undulate through the forward and backward movements in sun salutations. Try to loosen the movements a bit and even exaggerate them to see if you can assess which parts move and do not move in your spine. Then you can place a bit more emphasis on any areas that do not move so easily.
Reflect: What did you notice when you placed your intention on undulating the spine in Sun Salutations? Did the quality of the sun salutations feel like it changed? Could you get a feel for which parts of the spine felt like they moved more than others?

Apply: How might you apply what you observed about spinal movement to other yoga asana poses? Can you think of some poses where spinal movement should probably be initiated more from one part of the spine than another?

2. Grab a partner for this one if you can. What I’d like you to do is to feel the parts of the spine that are most accessible to us. Have your partner get on the floor on their hands and knees. Place your fingertips right on the spinous processes that stick up off of their spine. Start in the lumbar section and spread your fingers apart. Have your partner do all of the movements of the spine, flexion, extension, lateral flexion, and rotation. You should feel the spinous processes moving under your fingers and from that we can infer movement at the vertebral joints inside. Move your fingers up to the thoracic region and do the same thing. Notice the differences in movements between the sections.

Reflect: What do you notice in each area of the spine? What differences and similarities do you notice? What movements seem to happen most at each part of the spine?

Apply: How might the types of general movements that occur most easily in different parts of the spine apply to specific yoga asana poses?

Extra Questions

Where is the spinous process and what is its function? We can feel this part of the vertebra beneath the skin when we touch our own spine on our back. It is a location for muscles to attach to. It also impacts the ability of the vertebrae to move in different areas of the spine.

What is the transverse process, where is it, and what is its function? This is the part of the vertebra that sticks out to either side of the vertebra. There is one on both sides. They are only palpable from the outside in the cervical and lumbar region of the spine.

Where is body of the vertebrae and what is its function? The body of each vertebra is designed to support weight as the vertebrae stack on top of each other.

What is the vertebral foramen, where is it, and what is its function? Behind the body of the vertebra is the vertebral foramen. In this case, it is a hole created by all of the elements and landmarks of the vertebrae. In other words, the body of the vertebra is continuous with the transverse process, which then turns into the spinous process. Together they create a ring of bone known as the vertebral foramen, which encases the spinal cord.

Describe the location and purpose of the rotatores muscles. They are the deepest muscles of the spine. They attach from the transverse process on one vertebrae to the spinous process on the vertebra above. They create the compression members that with the vertebrae make the tensegrity-like structure in the spine.
What is the arrangement of fibers in the layers of cartilage of the annulus fibrosus and what is the function of the arrangement? The fibers of each layer of the cartilagenous ring are perpendicular to the fibers in the layer underneath it. This layering makes the disc stronger and able to support and adapt to movement.
Instructor Guide
Module 9: The Spine

Answers to Study Questions:

1. Describe in general the parts of the spine and how they are connected = It consists of stacks of round short bones with a thicker, dense type of cartilage between them like a rubber bushing. These discs of cartilage are the real miracle of the spine. They are not just cartilage: they are fluid-filled. They provide shock absorption and allow for movement by maintaining space between the bones. They also create space for the nerves coming off of the spinal cord to come out from between the bones and feed their tissues and organs. These joints are referred to as anterior intervertebral joints.

In addition to the round flat part (or body) of the vertebra, there is also an awkwardly shaped area that sticks out in many directions behind it. These oddly shaped bones form the amazing ring, which protects the critically important spinal cord. The bits of bone that shoot off sideways and backward are for muscles to attach to. They also allow for or restrict movement in certain directions.

The articulations between the posterior parts of the vertebrae are facet joints (also known as posterior intervertebral joints or the zygapophyseal joints). Flat surfaces (two on the bottom and two on the top of each vertebra) join the vertebrae and help control spinal movements.

2. Describe how the structural components of the spine show an example of tensegrity in the body. Each vertebra has two compression members (if you will) that stick out to the sides. These are known as the transverse processes. In addition there is one compression member that sticks straight out from the posterior of the vertebrae. This is called the spinous process. All of these parts that stick out interact with the deepest layer of our musculature and create tensegrity.

The deep rotator muscles attach from the transverse process to the spinous process below. Here we can see tensegrity quite clearly. If we add in the other muscles that attach onto the spinous process from other places such as the ribs in layers and layers, we see how each vertebra is suspended in its very own web of tension. When we step back and view the spine as a whole, we see that the entire spine has the potential to be suspended in the tension and not in compression of bones.

3. Where are the primary curves found in the spine and how are they formed? Thoracic and sacral regions of the spine; they are formed in the fetal position in the womb

4. Where are the secondary curves found in the spine and how are they formed? Lumbar and cervical regions of the spine; they are created by the actions of holding our head up and arching our back as newborns.

5. What are the movements of the lumbar spine and what are the structural differences of the spine in this region compared to other regions of the spine that make this movement possible? The lumbar spine does flexion, extension, and lateral flexion (side-bending), but little to no rotation. The vertebrae at this part of the spine are larger than other are with a good amount of space between them. The facet joints are parallel to the midline of the body allowing them to glide which allows for a fairly significant range of motion in the lumbar spine compared to other parts of the spine.
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Additional Activities for the Teacher to do with the Class:

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2. Grab a partner for this one if you can. What I’d like you to do is to feel the parts of the spine that are most accessible to us. Have your partner get on the floor on their hands and knees. Place your fingertips right on the spinous processes that stick up off of their spine. Start in the lumbar section and spread your fingers apart. Have your partner do all of the movements of the spine, flexion, extension, lateral flexion, and rotation. You should feel the spinous processes moving under your fingers and from that we can infer movement at the vertebral joints inside. Move your fingers up to the thoracic region and do the same thing. Notice the differences in movements between the sections.

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Instructor Guide
Module 10: The Shoulder Girdle

Answers to Study Questions:

1. Describe where the 4 muscles that make up the rotator cuff attach. All 4 attach via a common tendon that forms a shirt-like cuff that lies over the top of the humerus.

2. What things make the latissimus dorsi (with assistance by the serratus anterior) a muscle that could be considered “the psoas of the upper body”? Size, positioning, strength, function, and potential resistance.

3. Describe the movement initiated by supraspinatus? The supraspinatus fills in the supraspinosus fossa (depression and then runs laterally out to the top of the head of the humerus. It runs under the acromion process through a space between the acromion and the top of the humerus.

4. Describe the movement initiated by infraspinatus? It is located unders the spine of the scapula in the infraspinosus fossa. It fills most of the entire surface of the scapula below the spine. It’s tendon runs laterally and attaches onto the back of the head of the humerus. It is a lateral rotator of the humerus. It also works with the deltoids and teres minor to externally rotate the humerus.

5. Where is the pectoralis major located and what movements does it do? It attaches from the clavicle to the sternum and then down onto some of the lower ribs. As it heads toward the humerus it attaches onto the bicipital groove. Pectoralis functions to flex and extend the humerus as well as internally rotate the humerus.

6. Where is the latissimus muscle located and what movements does it do? It lies on the back of the body opposite the pectoralis. It attaches at the thoracolumbar aponeurosis which is attached to the sacrum. It attaches to spinous processes all the way up the spine to about T6 and to the lower ribs (12-9), then heads up to the humerus draping over the inferior angle of the scapula. It internally rotates, extends and adducts the humerus.

7. Where is teres major located and what movements does it do? It attaches from the bottom of the scapula to the bicipital groove. It assists latissimus dorsi in both adduction and internal rotation.

8. Where are the deltoids located and what movements do they do? They attach to the lateral half of the clavicle, the acromion and the lateral half of the spine of the scapula. Its fibers converge and attach to the deltoid tuberosity. The anterior portion the deltoid assists with flexion and internal rotation of the shoulder. The posterior section assists with extension and external rotation. The middle section functions to abduct at the shoulder joint.

9. How does the trapezius move the scapula? The upper trapezius can elevate the scapula and the lower trapezius can depress the scapula. All sections of the trapezius contribute to upward rotation of the scapula.

10. Where is serratus anterior located and how does it move the scapula? It’s attached on the side of the ribs in front of the scapula then heads back and between the scapula and the rib cage
to attach onto the inner border of the scapula. It moves the scapula in protraction (forward) and upward rotation. It is also a stabilizer of the scapula.

**Additional Activities for the Teacher to do with the Class:**

1. **Exploring Landmarks in the Shoulder Girdle: Find the Acromion and Coracoid Process**

   The acromion is like a ledge that juts out over the top of the humerus. One end of the clavicle attaches to the sternum. This is the single place that a bone from the shoulder girdle attaches to the axis or center component of the body called the axial skeleton. As it turns out, there is a small, cartilaginous disc between the sternum and the clavicle that helps mitigate the forces that naturally run through it. The other end of the clavicle heads out toward the shoulder itself and attaches onto the scapula at the acromion process. At this juncture, the clavicle and the scapula are bound together by ligaments. There is a beak-like projection under the lateral part of the clavicle called the coracoid process.

   **Reflect:** Where you able to find the acromion and coracoid process on your body? What did you notice about how the parts of the shoulder joint are put together?

   **Apply:** What does the structure of this joint suggest about the kinds of movements that it is most suited for?

2. **Take a Look at General Shoulder Pain in Chaturanga**

   There are two basic options for beginners. First would be to simply put your knees down on the floor before lowering down into *Chaturanga*. The second option is to move the hands slightly wider than what is traditional and let the elbows be away from the body. This will allow the larger pectoralis major muscle to get involved. They often let the elbows stick out because their triceps brachii is not strong enough to lower their body weight alone. The elbows moving wider allows the pectoralis major to get more leverage, but widen the hands a bit as well otherwise the wrists can get strained.

   If you have students who are experiencing shoulder pain, take a moment to observe. Do not just try to make them do it differently because it doesn’t look right, look at the bigger picture. Look at the line they’re creating between the front of their shoulder and their hands beneath it. Also take into consideration their general strengths and weaknesses in the practice and whether or not their simply doing too much at the moment.

   **Reflect:** What do you notice when you move into one of the two options for beginners in Chaturanga? What muscles feel like they are doing most of the work? Does one method feel more stable or controlled than the other?

   **Apply:** What might you look for in a student’s Chaturanga if they report that they’re feeling some shoulder pain? How might you modify their pose for different types of shoulder pain?

**Extra Questions**

Describe how the sternum, clavicle, and scapula attach together. One end of the clavicle attaches to the sternum with a small cartilagenous disc between them. The other end of the clavicle heads
out toward the shoulder itself where it attaches onto the scapula at the acromion process, where they are bound together by ligaments. This is called the acromioclavicular joint (AC joint).

Describe what makes the scapula relative to the rib cage an unusual joint. The bones do not touch each other; instead the scapula floats along the ribs as it moves. When the scapula moves, the humerus must move with it as they are connected together.

Where is teres minor located and what movements does it do? It attaches on the bottom of the scapula at the inferior angle and heads up to attach right below the infraspinosus. It contributes to external rotation of the humerus.

Where is the pectoralis minor located and how does it assist in moving the scapula? It’s located on the front of the rib cage and attaches to the coracoid process. It functions as a downward rotator and depressor of the scapula.

Describe the condition “winged scapula”. The inner border of the scapula sticks up off of the back. This can happen due to dysfunction of or weakness of serratus anterior.
Instructor Guide
Module 11: Hand, Wrist, and Elbow

Answers to Study Questions:

1. Describe the two main differences between movement possible in the kinetic chain of the upper extremities vs. the kinetic chain of the lower extremities. The forearm has the ability to rotate at two joints, both the wrist and elbow, while the lower leg rotates only at one joint, the knee. Changes at the proximal end of the upper body extremity kinetic chain (hand and wrist position) have the potential to impact more components at the distal end of the chain in the upper body than in the legs as the shoulder girdle + scapula is more complex than the hip joint.

2. Where are the metacarpophalangeal joints? The joints beyond the joint where the carpal bones meet their respective phalanges.

3. Name 3 flexors of the forearm describe what they do. Flexor digitorum moves the fingers. Flexor carpi ulnaris moves the carpals to the ulnar side. Flexor carpi radialis moves the carpals to the radial side.

4. Where do the flexors of the forearm attach? Their tendons pass through the carpal tunnel to get to their attachments on the hand and fingers. On their other end, these muscles attach near or on the inside of the elbow above the joint on a bump at the very bottom of the humerus called the medial epicondyle.

5. Where do the extensors of the forearm attach? On the distal end they attach via a tendinous sheath. On the proximal end, most of them cross the elbow and attach to the lateral epicondyle of the humerus.

6. Describe how the position of hand in either pronation or supination impacts the position of the elbow and the shoulder. Pronation of the forearm is usually associated with internal rotation of the shoulder. Supination of the forearm is usually associated with external rotation of the shoulder joint.

7. Describe how the position of the shoulder and scapula are related with the arms positioned overhead. Internal rotation of the shoulder is associated with retraction of the scapula, while external rotation of the shoulder is associated with protraction of the scapula.

Additional Activities for the Teacher to do with the Class:
Exploring alignment of hand, wrist, elbow, and shoulder in Chaturanga position and backbending position
Chaturanga – As we have discussed, this is dependent on the individual, but many practitioners will notice that if their fingers are pointing straight forward in Chaturanga as they lower down, the inner part of their hand lifts up and their elbows naturally want to point outward more. Experiment with this – rotate your fingers so that your index finger is pointing forward and notice what happens both to the hands and to the elbows as you lower down. Also notice the wrist angle and sensation created when you line your elbow up over your wrist.
Backbending – Take the same idea and apply it as you set up for a backbend (*Urdhva Danurasana*). When you lie down on your back to set up, instead of pointing your fingers straight toward your shoulders, try experimenting with rotating the hand and forearm so that the fingers are pointing out toward the edges of the mat on either side of you. I am not suggesting that we want to keep our hands in this position through the whole of our backbend. But doing so reveals something about the relationship between hand position, elbows and shoulders. I’ve recommended that students place their hands like this to get them up onto their head before going into backbend. At this pausing point they can rotate their hands back in the “correct” position for backbending. This gives them more space to get the hands firmly planted into the floor. As always, there are exceptions to this.

**Reflect:** What happens both to the hands and to the elbows as you lower down into Chaturanga with your index finger pointing forward? What happens when you move your body back slightly and allow the elbow to sit just behind the line of your wrist? When you play with this, do you notice a change in the amount of pressure or force that travels through your shoulders? When you set up in a backbending position as described, what happens to the heel of the hand and the elbows ability to move toward one another?

**Apply:** How might you apply what you’ve learned about the relationship between hand, wrist, and shoulder alignment to other poses? Are there other poses you can think of where you’d like to examine this alignment more closely in your practice or in a student’s practice?