Joint Structure and Function 6th edition Levangie Test Bank

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Chapter 2: Joint Structure and Function

Multiple Choice

1. Which of the following statements is true concerning fibroblasts?
A. They synthesize the extracellular matrix of connective tissue.
B. They are not normally present in healthy connective tissue.
C. They are responsible for breaking down bone tissue.
D. They are circulating cells.

ANS: A
Rationale: Connective tissue is made of cells and extracellular matrix. Fibroblasts are a type of resident cell that not only serves a role as the cellular component but actually synthesizes the extracellular matrix in which the cells reside. Fibroblasts play a large role in the synthesis of collagen, which is the fibrillar component of most extracellular matrixes.

2. Which of the following statements is true concerning nutrition of articular cartilage?
A. Articular cartilage can easily repair itself due to its very efficient and effective nutritional system.
B. Nutrients are found in large proportions in the more superficial layers of articular cartilage.
C. Nutrients from synovial fluid can pass into articular cartilage when external pressure is applied.
D. All forms of joint loading will cause poor nutrition to articular cartilage.

ANS: C
Rationale: Articular cartilage in adults is highly porous, but compression is necessary to allow for fluid mechanics, which will provide nutrition to the multiple layers of the structure. Articular cartilage is devoid of blood vessels in adults, and the movement of fluids caused by intermittent compression and rest to the cartilage allows nutrients to be carried from the deeper layers, closer to the subchondral bone (where there is a blood supply), to the more superficial layers.

3. Which of the following statements is *true* concerning articular cartilage injury?
A. A superficial laceration is capable of healing itself by filling in with fibrovascular tissue.
B. A deep cartilage lesion does not extend beyond the tidemark.
C. A deep laceration may heal by forming new fibrocartilage.
D. A superficial lesion is likely to heal faster than a deep one.

ANS: C

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Rationale: Unless an injury breaks through the uncalcified cartilage layer, known as the tidemark, it is unlikely that it will heal. If an injury breaks through this layer, it is likely that the blood supply from the subchondral bone may play a role in forming new fibrocartilage in place of hyaline cartilage. This may lead to endochondral ossification over time, but it is the only opportunity cartilage has for self-repair.

4. Which of the following *best* describes the structural composition of the extracellular matrix of bone?
A. Glycosaminoglycans, glycoproteins, water, and proteoglycans
B. Collagen fibers, glycosaminoglycans, water, and mineralized bone salts
C. Collagen fibers, glycosaminoglycans, glycoproteins, water, proteoglycans, and mineralized bone salts
D. Glycosaminoglycans, glycoproteins, water, proteoglycans, and unmineralized bone salts

ANS: C
Rationale: Each extracellular matrix has a combination of fibers (collagen) and an interfibrillar component (proteoglycans and glycoproteins). The proteoglycans can further be broken down into polysaccharide chains called glycosaminoglycans (GAGs). In addition to this normal combination of components, bone contains mineralized bone salts (calcium and phosphate crystals), which give this structure its hard surface.

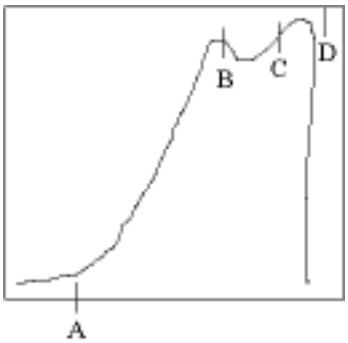
5. Which of the following statements is *true* concerning the biomechanical properties of ligaments, if the rate of application of the force is increased?
A. The ligament stores less energy to failure.
B. The ligament requires more force to rupture.
C. The ligament has decreased stiffness.
D. The stiffness of the ligament is unchanged.

ANS: B
Rationale: All viscoelastic tissues exhibit rate-dependent properties that cause a change in tissue behavior based on rate of application of a force. When viscoelastic materials are loaded rapidly, they exhibit greater resistance to deformation than when loaded more slowly and require more force to failure than when loaded more slowly.

NARRBEGIN: Figure 2-6

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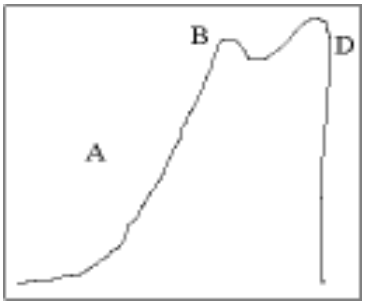


NARREND

6. For the stress-strain curve in Figure 2-6, identify the point of ultimate failure.
A. Point A
B. Point B
C. Point C
D. Point D

ANS: D
Rationale: The point of ultimate failure occurs at the end of the plastic region when the material has undergone maximal deformation and has ruptured.
NAR: Figure 2-6

NARRBEGIN: Figure 2-7



7. The plastic portion of the stress-strain curve pictured above lies between:
A. Point A and point B
B. Point A and point D
C. Point B and point D

ANS: C
Rationale: This is the region of the stress-strain curve where permanent deformation takes place.

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NAR: Figure 2-7

8. In Figure 2-7, point A can best be describes as:
A. The point indicating the end of the elastic modulus
B. The point where permanent deformation of the tissue begins to occur
C. The point where "uncrimping" of the tissue ends
D. The point where the greatest amount of force is being applied

ANS: C
Rationale: In tendon and ligaments, collagen fibers are reported to straighten out during the initial application of a force.
NAR: Figure 2-7

9. As a clinician, you are attempting to produce permanent elongation in a severely contracted flexor digitorum profundus tendon. Which of the following general strategies concerning treatment will be *least* effective in achieving permanent lengthening of the tendon?
A. Apply force slowly to decrease the stiffness of the tendon.
B. Apply a short duration force, keeping the force in the elastic range.
C. Apply enough force to cause microfailure of some fibers in the tendon.
D. Use a splint that will apply a low load to the tendon (at the beginning of the elastic range) for 3 weeks.

ANS: B
Rationale: If a muscle has undergone prolonged shortening and is now considered to be in a state of contracture, one must make permanent changes in the stress-strain curve of that tendon in order to regain the length of the structure. There are several ways to accomplish changes in the stress-strain curve of a tendon. One of the most effective ways to apply a low load over a long period of time is to utilize the phenomenon of creep to cause permanent deformation. Another way to address this issue is to push the fibers to the end of the plastic range or slightly into the plastic region of the stress-strain curve, causing microfailure of the structure and thus causing permanent change in length.

10. When describing the biomechanical properties of cancellous and cortical bone, which of the following statements is true?
A. Cancellous bone is stiffer than cortical bone and can withstand less strain before failure.
B. Cortical bone is stiffer than cancellous bone and can withstand less strain before failure.
C. Cancellous bone is stiffer than cortical bone and can withstand more strain before failure.
D. Cortical bone is stiffer than cancellous bone and can withstand more strain before failure.

ANS: B

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Rationale: The stress-strain curves for cortical and cancellous bone are different. The tougher, outer cortical bone is stiffer than cancellous bone. This means that it can withstand greater stress but less strain than cancellous bone.

11. When a bone is repeatedly loaded with low-level forces over an extended period of time, fatigue fractures may occur within the bone. This is due to:
A. Increased stiffness, decreased yield strength, increased permanent deformation
B. Decreased stiffness, increased yield strength, no effect on deformation
C. Decreased stiffness, decreased yield strength, increased permanent deformation
D. Increased stiffness, increased yield strength, no effect on deformation

ANS: C
Rationale: Repeated loading of bone can cause permanent strain and lead to bone failure. Bone loses stiffness and strength as a result of creep strain.

12. Which of the following is true about the biomechanical properties of a ligament (or tendon) if the width of the ligament is doubled?
A. Greater elongation before failure
B. Less elongation before failure
C. Increased strength before failure
D. Decreased strength before failure

ANS: C

13. Which of the following joints has two or more degrees of freedom of osteokinematic motion?
A. Third proximal interphalangeal (PIP) joint
B. Proximal radioulnar joint
C. Radiocarpal joint
D. Humeroulnar joint

ANS: C
Rationale: The radiocarpal joint allows for motion in two different planes. Flexion and extension occur in the sagittal plane about a coronal axis, and radial/ulnar deviation occurs in the frontal plane about a sagittal axis. All of the other joints listed are uniaxial joints with only one degree of freedom.

14. Which of the following would constitute a closed kinematic chain activity of the left shoulder complex?

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A. Using your left arm to push yourself out of a chair
B. Throwing a Frisbee with your left hand
C. Combing your hair with your left hand
D. Waving with your left hand

ANS: A
Rationale: Pushing yourself out of a chair using your arm would be considered a closed kinematic chain activity. Because the arm is bearing weight through the arms of the chair, which are in contact with the ground, this would mean that the distal segment is fixed, and the body is moving about this fixed segment.

15. Which of the following statements is true concerning "joint play" of a joint?
A. Joint play is not considered a "normal" motion at the joint.
B. They are typically tested by application of an external force.
C. They can be performed voluntarily by a subject.
D. They occur only in the close-packed position of the joint.

ANS: B
Rationale: Joint play is the movement of one articular surface on another that is not under voluntary control. The joint must be in a loose pack position in order to allow movement when an external force is applied.

16. A man is sitting on a chair. He brings himself up into a standing position. His tibiofemoral joint moves from a flexed position to full extension during the maneuver. Which of the following best describes what is happening at the tibiofemoral joint during this maneuver? Think in anatomical terms.
A. Anterior glide of the proximal tibia on the distal femur
B. Posterior glide of the proximal tibia on the distal femur
C. Anterior glide of the distal femur on the proximal tibia
D. Posterior glide of the distal femur on the proximal tibia

ANS: D
Rationale: The activity of rising from a chair would be a closed kinematic chain activity, which means that the proximal joint surface will be moving on the distal joint surface. In the case of the tibiofemoral joint, this means that the convex femoral condyles will move on the concave tibial plateau. Because this would constitute a convex surface moving on a concave surface, the roll and glide of the joint surfaces will occur in opposite directions. As the person comes to a standing position, the femur will roll in an anterior direction, and the joint surface will glide (or slide) in a posterior direction.

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17. Which of the following statements is true concerning the close-packed position of any joint?
A. Capsular structures are loose.
B. Ligaments around the joint are slack.
C. The joint is relatively easy to separate with distraction.
D. There is a maximum area of surface contact occurring.

ANS: D
Rationale: The closed-pack position of a joint occurs when there is maximal congruency between joint surfaces, and the ligaments and capsule are maximally tight. This position normally occurs at the end of range of motion and makes passive movement of the joint surfaces very difficult.

18. Cartilage primarily receives its nutrition from _____.
A. its high level of permeability
B. diffusion
C. a process of joint loading and unloading

ANS: C
Rationale: Although the synovial fluid providing nutrition to cartilage has a low degree of permeability allowing for some diffusion, the process of joint loading and unloading provides a larger-scale exchange of synovial fluid, allowing the more nutrition-rich fluid into the cartilage.

19. To increase a patient's wrist extension range of motion by using an accessory motion gliding technique, the therapist would want to perform a(n) _____.
A. posterior glide of the carpals on the radius
B. anterior glide of the carpals on the radius
C. anterior glide of the radius on the carpals

ANS: B
Rationale: This concept might be a bit more advanced, but students should understand that an arthrokinematic gliding motion anteriorly at this joint will support the osteokinematic motion of wrist extension.

Short Answer

20. Describe the arrangement of fibers in hyaline cartilage. Why is this arrangement suited to its function?

ANS: The outer layer (zone I) has parallel fibers suited to the function of reducing friction

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between contacting surfaces. The middle layer (zone II) is a lattice-work arrangement, allowing this layer to change shape to absorb shock and squeeze fluid in and out. The inner layer (zone III) contains fibers that are also aligned perpendicular to the bone surface to secure the tissue into the calcified layer of cartilage (zone IV).

21. Describe what happens when cartilage undergoes compression. What are the factors that determine the response, and how does each factor affect it?

ANS: When cartilage is compressed, the protein molecules (proteoglycans and glycoproteins) release some of the water content that is squeezed into or out of surrounding tissues. Collagen fibers may permit deformation of the tissue. The proportion of fluid exuded and tissue deformation are dependent upon the magnitude, rate, and duration of load. When a load is sustained for a period of time, the permeability of the cartilage decreases over that time period. Similarly, the rate of deformation is indirectly proportional to the magnitude of applied load. That is, for a unit compression of 1, the cartilage deforms unit 1. For a unit compression of 2, the cartilage may only deform an additional 1/2 unit.

22. What are the characteristics of viscoelasticity, and which of the following tissues exhibits viscoelasticity: ligaments, tendons, hyaline cartilage, fibrocartilage, or bone?

ANS: Viscoelastic materials exhibit elasticity (ability to deform and return to its original shape immediately) and viscosity (ability to resist shear). Viscosity gives the tissues time and rate-dependent properties; that is, the deformation response of the tissue varies according to the duration of load and the rate of load. Each of the tissues listed above is viscoelastic.

23. Define stress and strain.

ANS: Stress is the force applied to a tissue per unit area. Strain is the deformation that occurs in a tissue in response to an applied stress and is expressed as the change in shape (length, width) over its original shape (length or width). Stresses and strains may be tensile, compressive, shear, or torsional.

24. Define modulus of elasticity, stiffness, brittleness, and ductility.

ANS: The *modulus of elasticity* is the ratio of stress to strain at any point in the stress-strain curve. A large applied load that results in only a small deformation will have a high modulus of elasticity. The steeper the stress-strain curve, the higher is the modulus of elasticity. Because the material does not readily respond to an applied load, it is considered *stiff* (therefore, stiffness is

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equivalent to the modulus of elasticity). A tissue is *brittle* when the plastic region is very small or absent—that is, the material undergoes very little deformation prior to ultimate failure. A *ductile* material, in contrast, can undergo considerable deformation prior to failure.

25. How is the synovial fluid within a joint formed? Of what is it composed?

ANS: Synovial fluid, which is produced by the synovial layer of the capsule, is composed primarily of plasma and hyaluronic acid, with a glycoprotein called lubricin. Hyaluronate is responsible for reducing friction between the synovium and joint surfaces, and lubricin reduces friction between the joint surfaces (cartilage-on-cartilage).

26. Define the motions of spin, slide, and roll as they relate to intra-articular joint motions? Which is most common within a joint?

ANS: Spin is rotation about a fixed axis. Slide is a pure translatory or linear movement of one surface upon another, and roll would be rolling of one surface upon another (as in a rocking chair). Generally, intra-articular surfaces slide and roll upon one another in an attempt to produce as close to a pure spin as possible. This is rarely, if ever, achieved.

27. What is the general effect of immobilization on connective tissues? What are the implications for these changes?

ANS: The responses can be numerous. Because the collagen fibers in tendons, ligaments, and capsules orient themselves according to the tensile stresses imposed, reduction in these stresses will result in a random arrangement of fibers which, once stresses are re-imposed, cannot resist the original magnitudes of load. There is also a loss of proteoglycans (therefore water). Both the water loss and the random arrangement of fibers result in a tissue that is stiffer and will move more rapidly to failure, especially at points of insertion. Cartilage, which is dependent upon compression and release for nutrition, will gradually deteriorate. Because the trabeculae in cancellous bone respond to imposed stresses, reduction of stresses will result in thinning of trabeculae and reduced strength of the bone (more readily fracturing under smaller loads).

28. What are the mechanisms by which overuse may affect connective tissues?

ANS: Sustained loads on tendons, ligaments, or cartilage can lead to excessive deformation (plasticity) and threat of failure. Repetitive loading may reimpose a load before a tissue has returned to its initial state, thus increasing the likelihood of exceeding the yield point (elastic limit), resulting in inflammation and microfailure.

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29. Define the terms *hypermobility* and *hypomobility* as each refers to human motion.

ANS: Mobility of joints is assessed passively and refers to the amount of motion that is *available* (rather than that which someone necessarily uses actively). Hypermobility refers to excessive joint mobility. It generally results from inadequate support from structures such as joint capsule or ligaments (torn ligaments, plastic ligaments, or high elastin content). Hypermobility may also result from inadequate muscular support (e.g., weak or hypotonic muscles) around the joint. Hypomobility refers to limited joint mobility. It generally results from bony limitations to motion (e.g., large bony prominences, bone spurs), adaptively shortened joint capsule or ligaments, or excessive muscle support around the joint (e.g., hypertonic muscles or adaptively shortened muscles).

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