KINE 3301 Biomechanics Test 3 Topics

1. Define viscoelastic, hysteresis, creep, force relaxation, energy absorbed, energy returned, elastic region, plastic region and yield point in a stress - strain curve
2. Draw a stress-strain curves for elastic, ductile and brittle materials.
3. How does velocity (rate of loading) affect the response of the spring and damper (dashpot) in a viscoelastic material?
4. Explain the relationship between magnitude of force and repetitions and injury
5. How does the differences in bone cell orientation and collagen orientation in cortical and spongy bone affect their stress-strain relationship?
6. Draw and explain the effects of loading rate on stress-strain curve for bone.
7. Wolff's Law - Effects of stress upon bone, ligaments, tendons and muscle.
8. Explain the effects of age on maximum strength to failure for ACL ligament.
9. Explain the effects of immobilization and exercise on strength to failure of ACL ligament.
10. Yield point - the maximum stress that a biological tissue can withstand without sustaining permanent deformation.
11. Define muscular preactivation, why is preactivation necessary, how does the CNS know how much and when to preactivate a muscle?
12. Biomechanical descriptors of the mechanisms for injury:
    a. magnitude of force
    b. rate of force application
    c. point of force application
    d. direction of force application
    e. number of repetitions of loading
    f. state of training & critical limits of tissue
    g. amount of muscular preactivation
13. Minimum time for Neuromuscular system to respond to a stimulus [80-200 ms] <u>includes a and b</u> below.
    a. (1) reflex time 30-120 ms
    b. (2) muscle time to peak 50-300 ms
    c. (3) Ft = mVf – mVi
    d. (4) It may take from 30-2000 ms to slow down the body's momentum.
14. Systems in the body capable of absorbing force: a. bone by deformation or bending; b. cartilage by sponge like action squeezing out synovial fluid; c. ligaments & tendons by lengthening; d. muscles by eccentric contraction.
15. Describe the role of osteocytes, osteoclasts and osteoblast in bone remodeling.
16. What is the objective of bone remodeling? Each day bone stiffness and cell orientation is arranged so that typical loads induce 400 – 1000 microstrain.
17. What are the advantages of curved bones? (Lanyon) The will deform in a predictable direction, and they are able to differentiate between different levels of loading.

18. Physical educators (see p 186) should follow these principles to optimize healthy bone loading:
    a. Children should perform 120 – 200 jumps / day, for 5 days/week.
    b. Different types of jumps should be performed each day or each week. For example: week 1 – jumping rope, week 2 – hopping…., week 3 – shuttle run…
    c. Static loads are not as effective as dynamic loads.
    d. Spreading the activity over 3 – 5 days is far more effective than doing the jumping/hopping activity all in one day.
19. Coefficient of friction: a. cartilage-synovial fluid-cartilage (.002); b. ice - water - ice (.03); c. steel - oil - steel (.05). Functions of cartilage 1. attenuate force; 2. reduce friction.
20. Describe the normal functioning of cartilage and synovial fluid in walking for the knee joint.
21. How does cell structure and arrangement affect the viscoelastic behavior of cartilage? The response is due to arrangement of chondrocytes and forcing synovial fluid through a limited number of holes in cartilage. The outer shell (articular surface) is hard and it spreads out the load, while the cartilage tissue below the articular surface is more compliant, thus it attenuates the load.
22. Explain how the viscoelastic response of cartilage affects the stimulus for adaptive remodeling of bone tissue. Under high loading rates, the cartilage is stiff, protecting the bone. Under low rates of loading, the cartilage is less stiff and it passes the low onto the bone to induce a stimulus for remodeling.
23. Once articular cartilage is worn down from excessive loading, what can be done to encourage it to grow back?
24. **Titin** transmits force to adjacent Z-disks. This force transmission is parallel to the muscle fiber.
25. Hill's 3 component muscle model: Explain the parts of the model and both the anatomical & mechanical responses they model. Give examples of the utilization of stored elastic energy.
26. Describe the mechanical action of the actin myosin filaments in concentric contractions, eccentric contractions, isometric contractions, give the amount of force generated and ATP utilized.
27. Relationship between oxygen uptake and eccentric and concentric work at a fixed load, if the force is constant what will the EMG look like for eccentric and concentric, if the EMG is constant, what will the force look like for concentric and eccentric.
28. Describe the actions from the stimulation of a nerve to the development of tension in a muscle.
29. Where does the EMG signal come from?
30. Describe the effects of the electrodes upon the shape and amplitude of the EMG signal.
31. Compare EMG amplitude and duration with force-time curves for fast and slow twitch fibers.
32. Draw and explain the length-tension for a sarcomere (force – length graph).

33. Draw and explain the force-velocity curve. Include an explanation of how the force per actin-myosin bond affects the force-velocity curve. How many myosin motors are attached at each velocity? What role does the force generated from an individual actin myosin crossbridge and elastic strain play in the concentric, isometric and eccentric force – velocity relationship?
34. Draw and explain EMG recruitment and firing rate, electromechanical delay (EMD) for the following muscular contractions:
    a. Ramp Contraction (subject takes 3 sec to go from 0 – 100 % MVC
    b. Ballistic Contraction (subject takes 300 ms to go from 0 – 100 % MVC
35. Explain Henneman's size principle. Are there any conditions in which the size principle is not followed?
36. For a 50% MVC contraction that is held for 1 second, would FT motor units be needed?
37. Describe the motor unit recruitment for a 50% MVC contraction where the subject was instructed to generate 50% MVC as rapidly as possible.
38. Describe the motor unit recruitment for a 50% MVC contraction where the subject was instructed to generate 50% MVC in a ramp fashion taking 4 seconds to reach 50% MVC.
39. What evidence is available to illustrate the unique role of fast twitch motor units in eccentric contractions?
40. Draw and explain how actin-myosin generates force under isometric, eccentric and concentric contractions. Include force generated by crossbridges, elastic strain force, and energy utilization (ATP).
41. Explain electromechanical delay (EMD) and how it is modeled in Hill's 3 component model.
42. Define the stretch – shorten cycle. What factors affect the extra work performed during the concentric phase of the stretch-shorten cycle?
43. Describe the functioning of sensory receptors (golgi tendon and muscle spindle).
44. When a muscle spindle is stretched at a level that exceeds the currently set sensitivity of the spindle what 3 responses are initiated at the spinal cord level by the Ia neuron?
45. How is the sensitivity of the muscle spindle set?
46. What is the difference between the Ia, II neurons from the muscle spindle and the Ib neuron from the golgi tendon organ?
47. When does the Ia neuron stop sending impulses to the spinal cord after the onset of a stretch reflex?
48. Depending upon the movement conditions the golgi tendon organ can cause excitation (positive force feedback) or inhibition (negative force feedback), give an example of each.
49. What is the difference between feedback control and feedforward control?
50. What is the minimum time threshold of force application that absolutely requires feedforward control?