Test corrections
Questions 2, 7, 11, 12, 15, 16, 18, 19, 20, 28, 29, 30, 36, 43

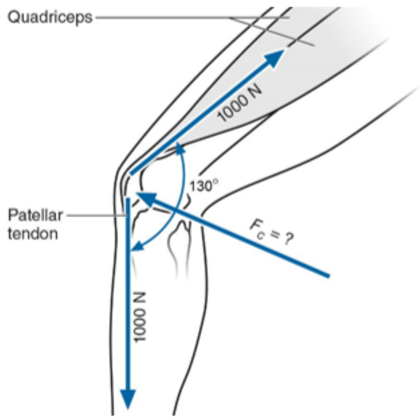
2. Assume that the arm is in static equilibrium and use the following quantities to determine the force (and direction) of the humerus acting on the ulna: The mass of the ball is 30 kg, the mass of the forearm (+hand) is 10 kg, and the biceps muscle is contracting with 800 N of force.
A.
408 N compressive force
(correct)
E.
1192 N compressive force
(incorrect)

Step-by-Step Solution:

1. Calculate the weight of the ball: Weight of ball=30 kg×9.8 m/s2=294N
2. Calculate the weight of the forearm (+hand): Weight of forearm=10 kg×9.8 m/s2=98N
3. Using the equilibrium condition for forces: Compressive Force=Ball Weight+Forearm Weight−Biceps Force. Force Substituting values: Compressive Force=294+98−800=408. Compressive Force=294+98−800=408N

Reflection:
I added instead of subtracting forces when applying the equilibrium condition, leading to the incorrect answer.

7. The quadriceps muscle pulls on the patella with a force of 1000 N while the patellar tendon then pulls on the patella with the same force (see figure to the right). The knee is in a flexed position, so the angle between these two forces is 130 deg. A compressive force from the femoral condyles is the only other significant force acting on the patella. If the patella is in static equilibrium, how large is the compressive force exerted by the femoral condyles on the patella?



A.
1061 N
(incorrect)

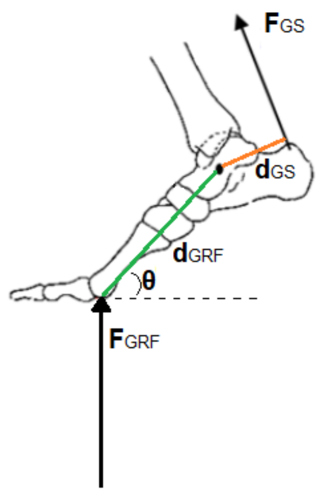
C.
845 N
(correct)

Step-by-Step Solution:

1. Forces on the patella are in static equilibrium. The quadriceps muscle and tendon pull with equal force, creating a 130° angle.
2. Use the vector component method to resolve forces and calculate the compressive force: Fcompressive=2 · Fquad · cos(Angle/2) Substituting: Fcompressive=2 · 1000 · cos(65∘)=845 N

Reflection:
I misapplied the formula, possibly misunderstanding the role of the angle or failing to divide it correctly in the cosine function. I can't recall exactly what I did wrong but clearly messed up the calculation.

11. Suppose you are doing a heel raise. You hold the top position for a few seconds, thus the gastrosoleus muscles are contracting isometrically and you are in static equilibrium. Consider the foot as a lever rotating about the ankle joint as in the picture below. If we consider body weight acting through the ankle, we get a simple lever system. The gastrosoleus muscle force (F_{GS}) is therefore providing a countering torque to the ground reaction force. Calculate F_{GS} if you know the following values:
- Perpendicular distance from gastrosoleus to ankle (d_{GS}) = 2.4 cm.
- GRF = 600 N.
- Distance from GRF to ankle (d_{GRF}) = 7.3 cm.
- Angle between ground and d_{GRF} = 50 degrees.



B.
1,398 N
(incorrect)
C.
1,173 N
(correct)

Step-by-Step Solution:

1. Calculate torque equilibrium around the ankle: Torque by GRF=GRF · dGRF. Torque by Muscle Force=FGS · dGS
2. Set torques equal since the system is in equilibrium: FGS=Torque by GRF/dGSF. Substituting values: FGS=600 · 7.32.4=1173 N

Reflection:
I probably rushed it like the other problems and did the calculations wrong or entered incorrect distances or failed to convert units properly during the calculation.

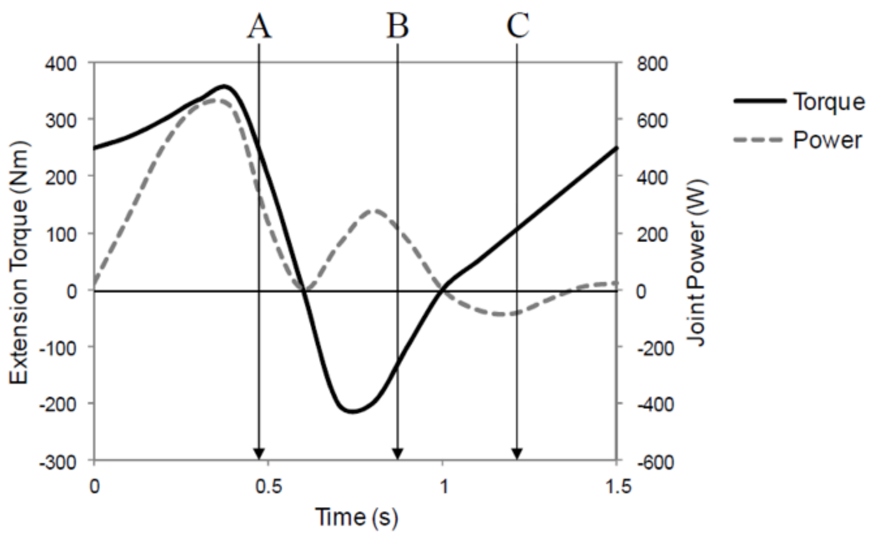
12. In the previous scenario, if you were to increase your heel raise height (i.e. theta greater than 50 degrees) and then hold that position, assuming d_{GS} stayed the same, the force in the gastrosoleus would: ____________
A.
Increase
(incorrect)
B.

decrease
(correct)

Why B is correct:
As the heel raise height increases the angle reduces, lowering the required muscle force since the torque remains constant.

Reflection:
I focused on the height's direct impact rather than understanding how changes in angle influence muscle force requirements.

14. The next four questions are based on the graph below. This graph shows the lumbar extension torque (solid line with units on left axis) and the corresponding joint power (dotted line with units on right axis) during a single rowing stroke. Three time points are marked (A, B, and C). Use the graph to help determine which of the following statements are true and which are false?



15. The dominant muscle group is contracting eccentrically at time A
True
False *(correct)*

Why Correct:
At time A, the graph shows the lumbar extension torque is positive, indicating that the dominant muscle group is contracting concentrically, not eccentrically, to extend the lumbar spine.

Reflection:
I answered this question incorrectly by incorrectly interpreting the graph and forgetting that a positive torque reflects concentric contraction, not eccentric.

16. The dominant muscle group is acting to speed up the flexion of the lumbar spine at time B
True *(correct)*
False

Why Correct:
At time B, the lumbar torque graph shows that the dominant muscle group is acting to speed up the flexion of the lumbar spine. This is consistent with the positive torque working in the direction of flexion.

Reflection:
I had forgotten about the positive side of the graph and what that meant compared to the slope of the lines and what that meant.

18. The figure below is an image of a person during walking. The arrows represent the ground reaction force vector. The front leg (right leg) is in loading response phase. Looking at the ground reaction force vector for this limb (the dashed arrow), what muscle groups at the knee would be activated to counter-act the torque created by this force?

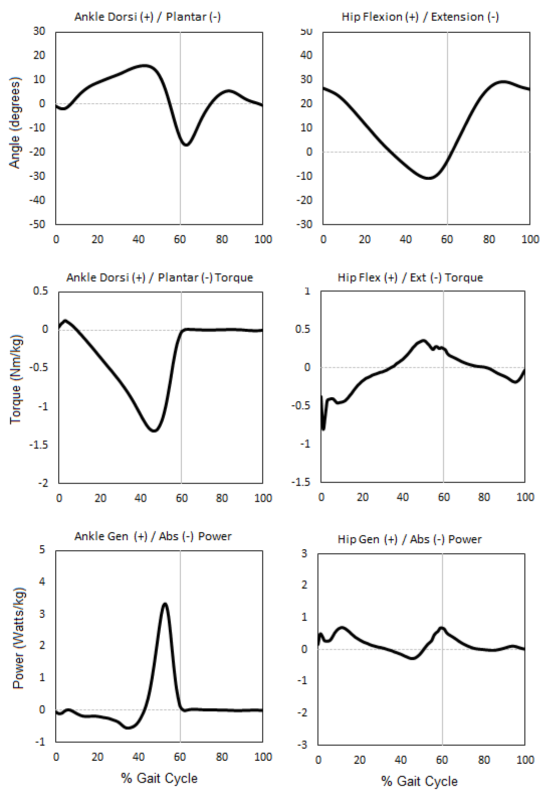
A.
Knee abductors
B.
Knee extensors
(correct)
C.
Knee flexors
(incorrect)
D.

Knee adductors

Why Correct:
During the loading response phase, the ground reaction force creates a flexion torque at the knee. The knee extensors (quadriceps group) counteract this torque to maintain stability during gait.

Reflection:
I actually knew this answer. I just mixed extensors and flexors.

19. The graphs below show the mean ankle and hip joint angular position, torque, and power during a typical gait cycle (toe off shown with solid line around 60%). Using these graphs, determine which of the following muscle actions is NOT something that happens during normal gait.



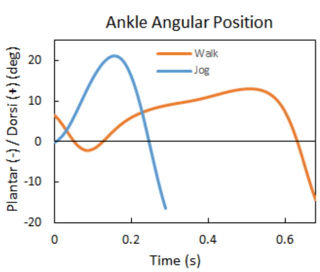
A.
Hip extensors act concentrically to extend the hip in early stance (loading response to mid-stance).
B.

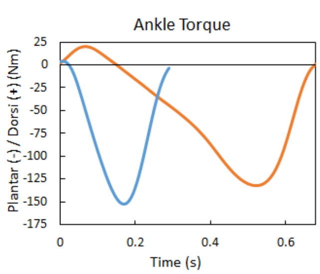
Hip flexors act eccentrically at the stance-swing transition to initiate leg swing.
(correct)
C.
The gastrosoleus acts eccentrically in mid-stance to control dorsiflexion of the ankle.
(incorrect)
D.
The tibialis anterior acts eccentrically to lower the foot to the ground in loading response.

Why Correct:
The hip flexors act eccentrically during the stance-swing transition to control and initiate leg swing. This action involves lengthening under tension to prepare for the next phase of the gait cycle.

Reflection:
I incorrectly assumed that the gastrosoleus acts eccentrically in mid-stance to control dorsiflexion, but this role is instead associated with concentric action during plantarflexion. I misinterpreted the timing of eccentric action in the gastrosoleus and its relevance to the movement phase.

20. The graphs below shows the ankle angular position (top) and ankle torque (bottom) during just stance phase for a person performing two movements: a walk (orange) and a jog (blue). Note that the x-axis is NOT time-normalized, so that you can see the timing differences between the two movements along with the magnitude differences. From these two graphs, what can you tell about the ankle power in these two movements?





A.
The magnitude of peak negative ankle power will be greater in the walk because the person spends more time in dorsiflexion.
B.
The magnitude of peak negative ankle power will be greater in the jog because the ankle dorsiflexion angular velocity is greater in the jog.
(correct)
C.
The magnitude of peak positive ankle power will be greater in the walk because the ankle plantarflexion torque is greater in the walk.
D.
The magnitude of positive work done by the ankle plantarflexors will be greater in the walk because the person spends more time in plantarflexion.
(incorrect)

Why Correct:
In a jog, the ankle dorsiflexion angular velocity is greater, which increases the magnitude of peak negative ankle power. This occurs because power is the product of torque and angular velocity, and the faster movement in jogging leads to greater power generation.

Reflection:
I focused on the time spent in dorsiflexion rather than the angular velocity, which led to my incorrect assumption about power magnitude.

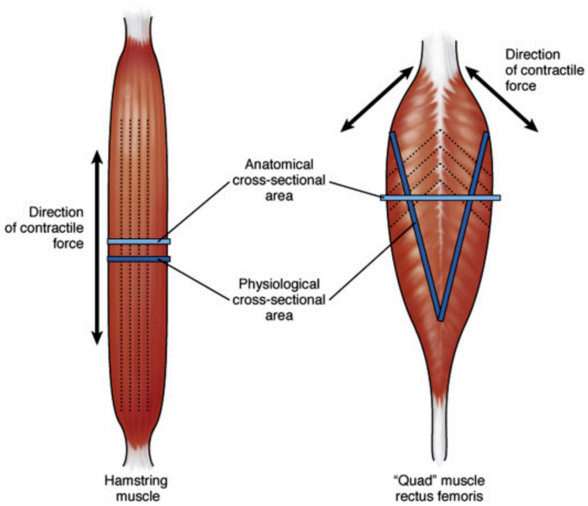
28. Choose the statement that is FALSE, completing the following:

There are more actin-myosin crossbridges at a given time point in ________________ .
A.
A low speed concentric contraction compared to a high speed concentric contraction.
B.
An isometric contraction compared to a concentric contraction.
C.
A low force concentric contraction compared to a high force contraction.
(correct)
D.
A muscle at resting length compared to lengthened.
(incorrect)

Why Correct:
In a low-force concentric contraction, fewer actin-myosin crossbridges are engaged because less force production is required. High-force contractions involve more crossbridges to generate greater tension. So that's why C is correct because it is false.

Reflection:
At resting length, more actin-myosin crossbridges are formed compared to a lengthened state, making this a true statement.

29. The following picture illustrates the architecture differences in two upper leg muscles. The one on the left is a hamstring muscle (biceps femoris) and the one on the right is a quadriceps muscle (rectus femoris). Which of the following statements comparing these two muscles is false.



A.
Both muscles are bi-articular
B.
Biceps femoris has a greater width change during a contraction than rectus femoris
(correct)
C.
Biceps femoris has a greater length displacement during a contraction than rectus femoris
(incorrect)
D.
Biceps femoris has less force generation capability than rectus femoris

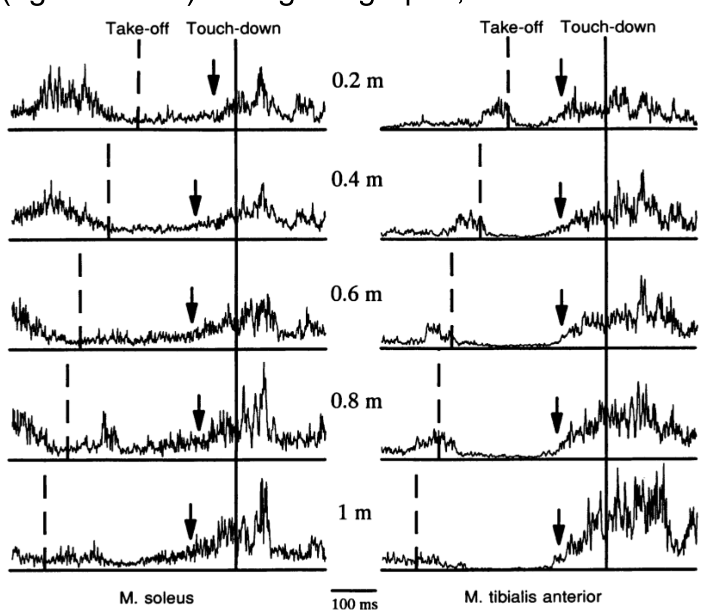
Why Correct (B is False):

B is the false statement because the **biceps femoris** does not undergo a greater width change during contraction compared to the rectus femoris. The rectus femoris, due to its pennation angle and muscle fiber alignment, is better suited for width changes during contraction. In contrast, the biceps femoris, a fusiform muscle, primarily elongates or shortens in length rather than changing significantly in width.

Reflection:

I misunderstood the muscle architecture differences, incorrectly assuming the biceps femoris has a greater width change. I failed to recognize that this characteristic is more applicable to the rectus femoris.

30. The following graphs are electromyography (EMG) traces from someone performing a landing task. The person drops from 5 different heights, from 0.2 m up to 1 m. The "takeoff", or starting point for each drop is shown by the dashed line, while the landing begins at touch-down, represented by the solid line. The arrow indicates the onset of muscle activation prior to landing (where the voltage moves above a threshold). Two muscles were monitored, the soleus muscle (left column) and the tibialis anterior muscle (right column). Using the graphs, choose the statement below that is FALSE.



A.
There is a period during flight phase wehre neither muscle is active
B.

Co-contraction of the soleus and tibialis anterior is evident prior to touch-down
C.
Tibialis anterior becomes active earlier as the jump height increases
(correct)
D.
Tibialis anterior increases in activation level as jump height increases
(incorrect)

Why Correct:
Graphs show tibialis anterior activation remains steady, regardless of jump height. But slightly activates earlier as jump height increases.

Reflection:
I misinterpreted the graphs, incorrectly attributing higher voltage to increased activation levels.

36. The following table shows material properties of several ligaments that were tested in a tensile testing machine. This table summarizes several studies, thus age ranges are not consistent. For the purpose of this question, ignore the loading rate column and assume that all tests are comparable. Using the table, choose the statement that is FALSE.

Typical Whole Ligament Structural Properties (mean ± SD)

Site	Age Range (years)	Loading Rate (mm/min)	Stiffness (N/mm)	Strength (N)
ACL (knee)	22–35	200	242 ± 28	2160 ± 157
	40–50		220 ± 24	1503 ± 83
	60–97		180 ± 25	658 ± 129
PCL (knee)	55–90	100	145 ± 66	855 ± 225
aPC (knee)	53–98	1000	347 ± 140	1620 ± 500
pPC (knee)	53–98	1000	77 ± 32	258 ± 83
AFTL (ankle)	27–83	125		206 ± 128
cALL (cervical spine)	58–95	20	47.8 ± 8	97 ± 17
lALL (lumbar spine)		6	82 ± 37	742 ± 384
	30–82	60–240	85 ± 33	843 ± 356
		10^4–13800	200 ± 100	1261 ± 369

ACL = Anterior Cruciate Ligament (Knee); PCL = Posterior Cruciate Ligament (Knee); aPC = anterior Posterior Cruciate (bundle of PCL); pPC = posterior Posterior Cruciate (bundle of PCL); AFTL = Anterior FibuloTalar Ligament (Ankle); cALL = cervical Anterior Longitudinal Ligament (Spine); lALL = lumbar Anterior Longitudinal Ligament (Spine).

A.
The ACL becomes more compliant as age increases.
(incorrect)
B.
The anterior bundle of the PCL is stiffer and stronger than the posterior bundle of the PCL.
C.
The lumber AL ligament has a higher ultimate stress than the cervical AL ligament.

D.
The ankle's AFTL is the weakest of the listed ligaments.
(correct)

Why Correct:
The anterior talofibular ligament (AFTL) is weakest based on ultimate strength and stress values in the table.

Reflection:
I likely overlooked the comparative data in the table or misread the property descriptions. I didn’t take the time to thoroughly look at the entire table and get the right answer.

43. This structure allows this bone type to
A.
spiral
B.
bend
(correct)
C.
compress
(incorrect)

without buckling.

Why Correct:
The correct answer is B because trabecular (spongy) bone is designed to bend without buckling. Spongy bone has a porous structure that allows it to withstand compressive forces and absorb shock, making it more flexible than dense cortical bone.

Reflection:
I mistakenly thought that spongy bone was primarily designed for compressive forces (answer C), but I did not fully consider its role in absorbing and distributing forces through bending. The trabecular bone’s structure is optimized for flexibility rather than just compression resistance.