

OLLSCOIL NA hÉIREANN
The National University of Ireland

National University of Ireland, Galway.

Trinity Examinations, 2000/01
Fourth Year Biomedical Engineering Examination

BIOMECHANICS

Prof. J.J O'Connor
Prof. J.F. McNamara
Dr. P.E. McHugh
Ms. M. Tyndyk

Attempt Five Questions in total
Time Allowed: 3hours

- 1 (a) What are the two main types of bone at the macroscopic level? Discuss briefly the structural difference between them and main role of each of them. (7)
- (b) Give details of the composition of the inorganic and organic phases in bone. (6)
- (c) What is the basic structural unit of bone called and how is it structured? You may write on Figure 1 below and insert it in your in your answerbook. (7)
- 2 (a) Specify three types of bone cells, and describe their function and location in bone. (8)
- (b) Describe fully, with the aid of a diagram, the mechanosensory role of osteocytes. (12)
- 3 (a) From the engineering point of view, bone is called a “sandwich construction” – why? Explain the terms bone stiffness and bone strength. Specify factors that impact on the overall bone strength. (6)
- (b) Specify the main loading modes in bony fractures and describe the types of fractures that occur under specific load conditions. To which is bone most and least resistant? You may draw diagrams. (7)
- (c) What is bone modelling and bone remodelling? Discuss and give some examples. (7)

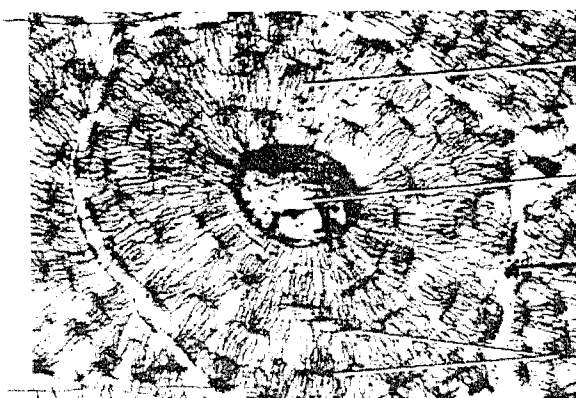
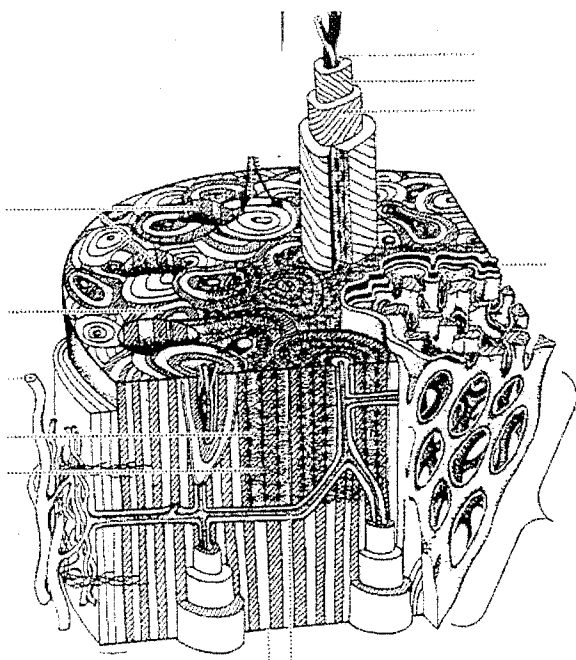


Figure 1

4. Give a full description of osteoporosis? What is the relationship between bone activity and volume of bone in osteoporosis? You may draw a diagram. How does this disease impact on the structure and material properties of bone? (20)
- 5 (a) Give a full description of the lever in the context of the human body. Discuss three types of levers and give examples. You may use diagrams. (8)
- (b) A schematic of an arm holding a ball is given in Figure 5. For the data given below, compute the value of the biceps force (B). (12)

Assume:

- Forearm weight (G) is 15 N
- Center of mass of forearm is 15 cm from elbow center of rotation
- Weight of ball (W) is 20 N
- Ball center of mass is 30 cm from elbow center of rotation
- Biceps tendon is inserted 3 cm from elbow center of rotation

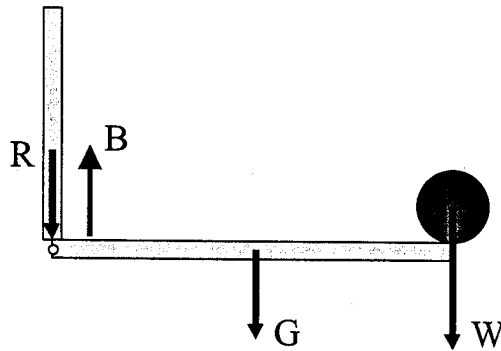


Figure 5

- 6 (a) Describe fully the structure and role of the intervertebral disc. (7)
- (b) Based on your knowledge of vertebral geometry and bone loss, explain fully how the cortical shell may play an increasingly dominant role in carrying spinal loads as the body ages. (8)
- (c) During the day, individuals tend to lose up to 1 inch in height. They regain this height at night as they sleep. Give a full explanation of why this happens. (5)

7. A man lifts a 50-kg mass from the ground (Figure 7). Calculate the erector spinae muscle force. This is not a correct posture for lifting. Sketch the correct posture and calculate the corresponding erector spinae muscle force. Discuss the effects of increasing abdominal pressure during the lifting exercise. (20)

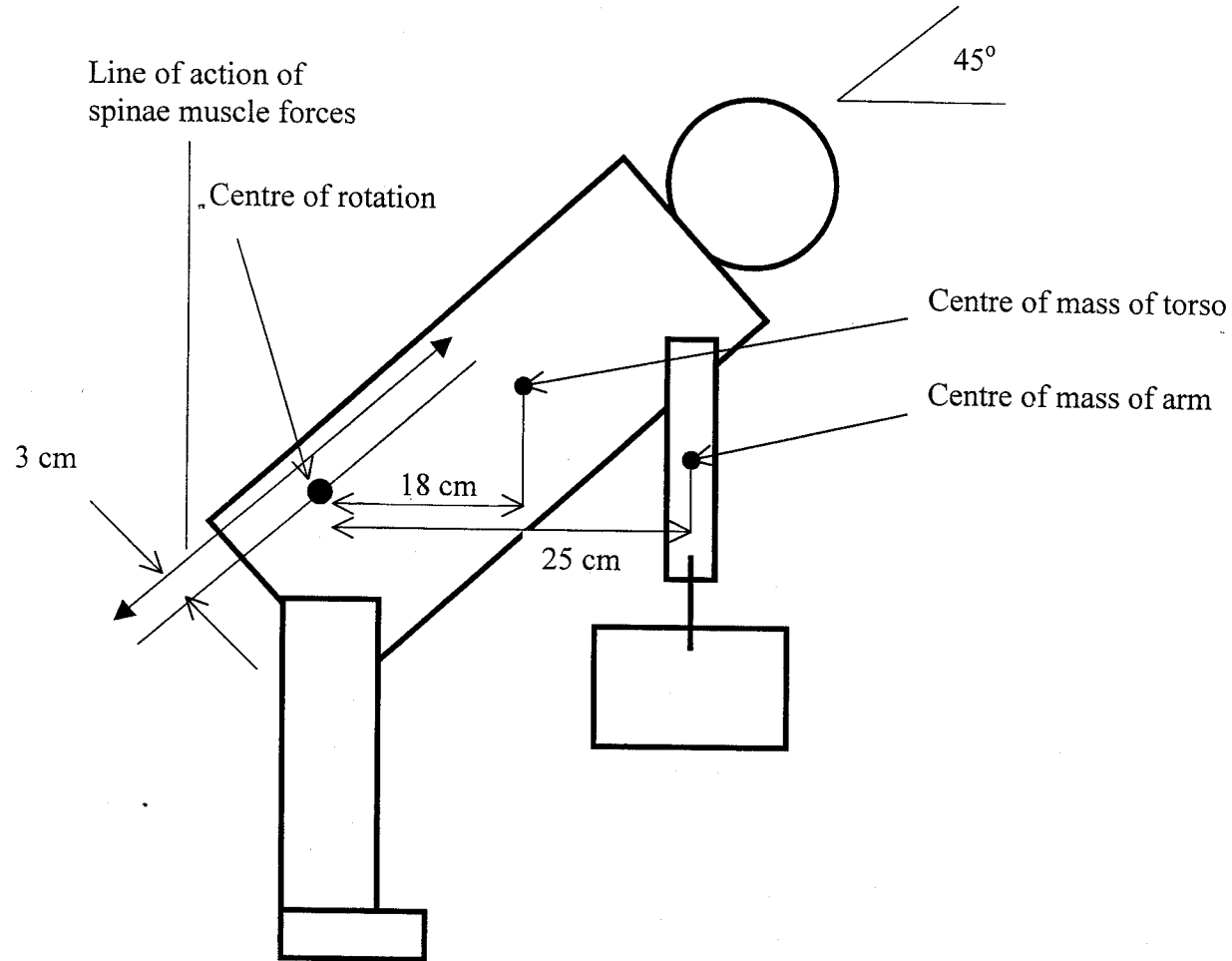


Figure 7