Surname	Date	Tutor
First name(s)		

BioWelsh

GCE A LEVEL

BW-A2-OptionB-W1

WORKSHEET 1 – OPTION B MUSCULOSKELETAL ANATOMY

BIOLOGY – A2 unit 4

Variation, Inheritance and Options

Suggested time: 3 hours 20 minutes

For Tutor's use only

Question	Maximum Mark	Mark Awarded	Question	Maximum Mark	Mark Awarded
1.	9		9.	10	
2.	10		10.	10	
3.	10		11.	9	
4.	10		12.	10	
5.	9		13.	11	
6.	12		14.	10	
7.	9		15.	9	
8.	11		Total	149	

ADDITIONAL MATERIALS

In addition to this worksheet, you will require a calculator and a ruler.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen or correction fluid.

You may use a pencil for graphs and diagrams only.

Write your name and the date in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided in this booklet. If you are working on screen, write your answers on paper and number each one clearly.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets at the end of each question or part-question. The worksheet is out of **149** marks.

The assessment of the quality of extended response (QER) will take place in question **15**.

The quality of written communication will affect the awarding of marks.

This worksheet is written by BioWelsh in the style of the WJEC A level Biology examination, following the WJEC specification (topic Option B). It is not an official WJEC paper.

Tutor only

Answer **all** questions.

1. A student examined prepared slides of three types of cartilage with a light microscope. **Image 1.1** shows the three tissues, labelled **A**, **B** and **C**.

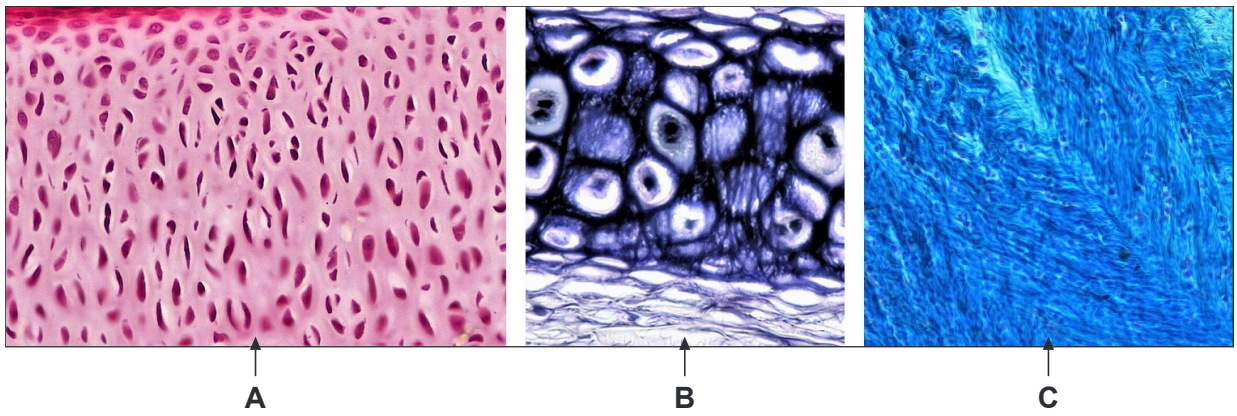

Image 1.1

(a) Identify the type of cartilage shown in **A**, **B** and **C**. [3]

A .....

B .....

C .....

(b) State **one** place in the body where the tissue in **B** is found. [1]

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(c) Explain how the structure of hyaline cartilage suits it to its role at the ends of the bones in a synovial joint. [2]

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(d) Explain why a torn meniscus of white fibrous cartilage in the knee takes many months to heal. [2]

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(e) Suggest why white fibrous cartilage, and not hyaline cartilage, forms the intervertebral discs. [1]

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Tutor only

2. A student investigated the two components of bone using three chicken leg bones of similar size. Each bone was dried and weighed. Bone 1 was left untreated. Bone 2 was left in dilute hydrochloric acid for five days, which dissolves the mineral. Bone 3 was heated strongly in an oven for three hours, which destroys the protein. Each bone was then dried and weighed again, and bent gently by hand. **Table 2.1** shows the results.

Table 2.1

Bone	Treatment	Dry mass before / g	Dry mass after / g	Result of bending
1	none	9.6	9.6	rigid; did not bend
2	acid	10.2	3.4	bent easily into a curve
3	heated	9.8	6.5	snapped with little force

(a) Name the main organic and inorganic components of the matrix of compact bone. [2]

Organic .....

Inorganic .....

(b) Calculate the percentage of the dry mass of bone 2 that was removed by the acid. [2]

Percentage removed = ... %

(c) Use **Table 2.1** to explain the function of each component of the bone matrix. [3]

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(d) Suggest **two** variables, other than the size of the bones, that the student should have controlled. [2]

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(e) Explain why the student dried each bone before weighing it. [1]

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Tutor only

3. **Image 3.1** is a drawing of one Haversian system from a transverse section of compact bone, made from a slide viewed with a light microscope.

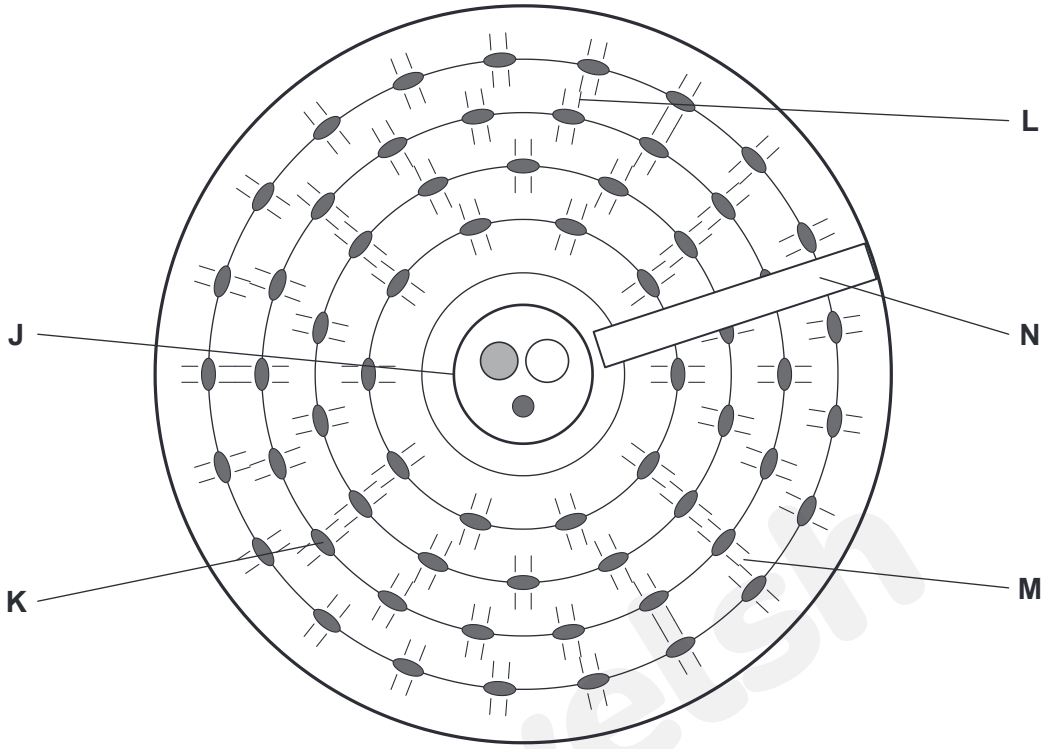

Image 3.1

(a) Identify the structures labelled **J**, **K**, **L** and **N**. [2]

J .....

K .....

L .....

N .....

(b) State **two** structures found in **J** in living bone. [1]

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(c) Explain how bone cells deep inside compact bone are supplied with oxygen and glucose. [3]

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The Haversian system in **Image 3.1** was drawn at a magnification of × 250. Its diameter in the drawing is 60 mm.

(d) Calculate the actual diameter of the Haversian system in μm. [2]

Diameter = ... μm

(e) The cells in **K** include osteoblasts. Describe the role of osteoblasts in the formation of region **M**. [2]

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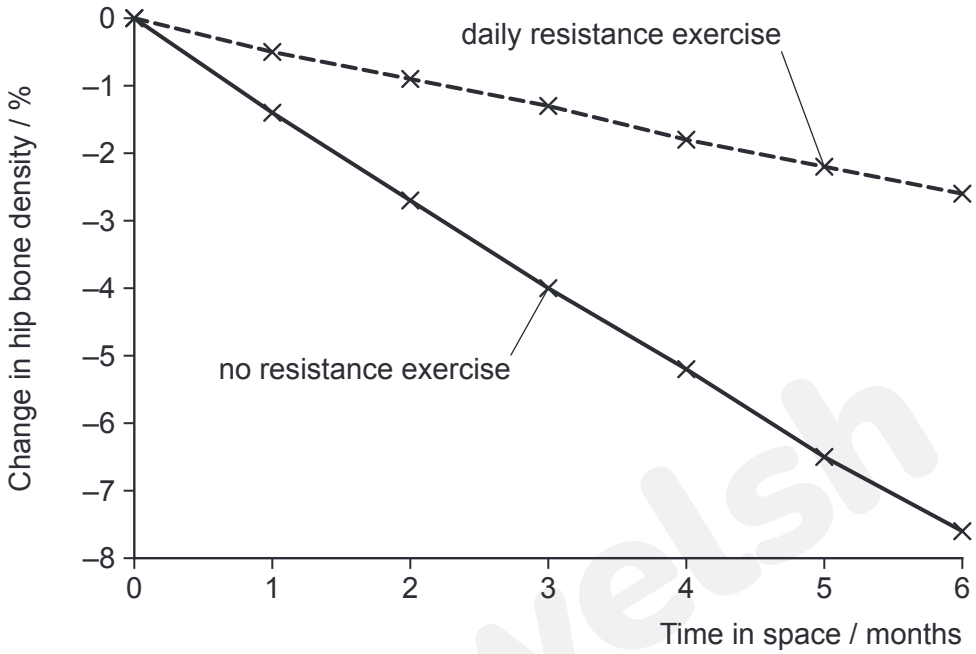
Tutor only

4. In the weightless conditions of the International Space Station, astronauts lose bone mass from their legs and hips. A study measured the hip bone density of two groups of astronauts during six months in space: one group did no resistance exercise and the other used a resistance exercise machine every day. **Graph 4.1** shows the results.



Graph 4.1

(a) State the functions of osteoblasts and osteoclasts. [2]

Osteoblasts .....

Osteoclasts .....

(b) Calculate the mean rate of loss of hip bone density per month in the astronauts who did no resistance exercise. [1]

Rate = ... % per month

(c) Explain why hip bone density falls in astronauts in space. [2]

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Tutor only

(d) Use **Graph 4.1** to evaluate the use of daily resistance exercise to protect astronauts' bones. [3]

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(e) The concentration of calcium ions in the astronauts' urine increased during the flight. Explain why. [2]

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5. Vitamin D is made in the skin when it is exposed to ultraviolet light from the sun. **Table 5.1** shows the mean concentration of vitamin D in the blood of a group of adults living in Wales, measured at four times of year.

Table 5.1

Month	Mean vitamin D in blood / nmol dm^{-3}
February	34
May	52
August	71
November	46

(a) Calculate the percentage increase in the mean concentration of vitamin D from February to August. [2]

Percentage increase = ... %

(b) Explain the pattern shown in **Table 5.1**. [2]

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(c) Explain how a lack of vitamin D can lead to rickets in a child. [3]

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Tutor only

(d) State how osteomalacia differs from rickets. [1]

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(e) Suggest **one** change to the diet that would help an adult with osteomalacia, and explain how it would help. [1]

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Tutor only

6. Osteoporosis is diagnosed using a DEXA scan, which measures bone mineral density. The result is given as a T-score: the number of standard deviations the patient's density lies above or below the mean for healthy young adults. **Table 6.1** shows the T-scores of three women aged 68.

Table 6.1

Patient	T-score
R	+0.3
S	–1.7
T	–3.1

(a) A T-score of –2.5 or below is used to diagnose osteoporosis. Identify the patient with osteoporosis and state what is meant by osteoporosis. [2]

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(b) Suggest why patient **T** has lost height and developed a rounded, hunched upper back. [2]

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(c) Suggest why the risk of osteoporosis rises sharply in women after the menopause. [1]

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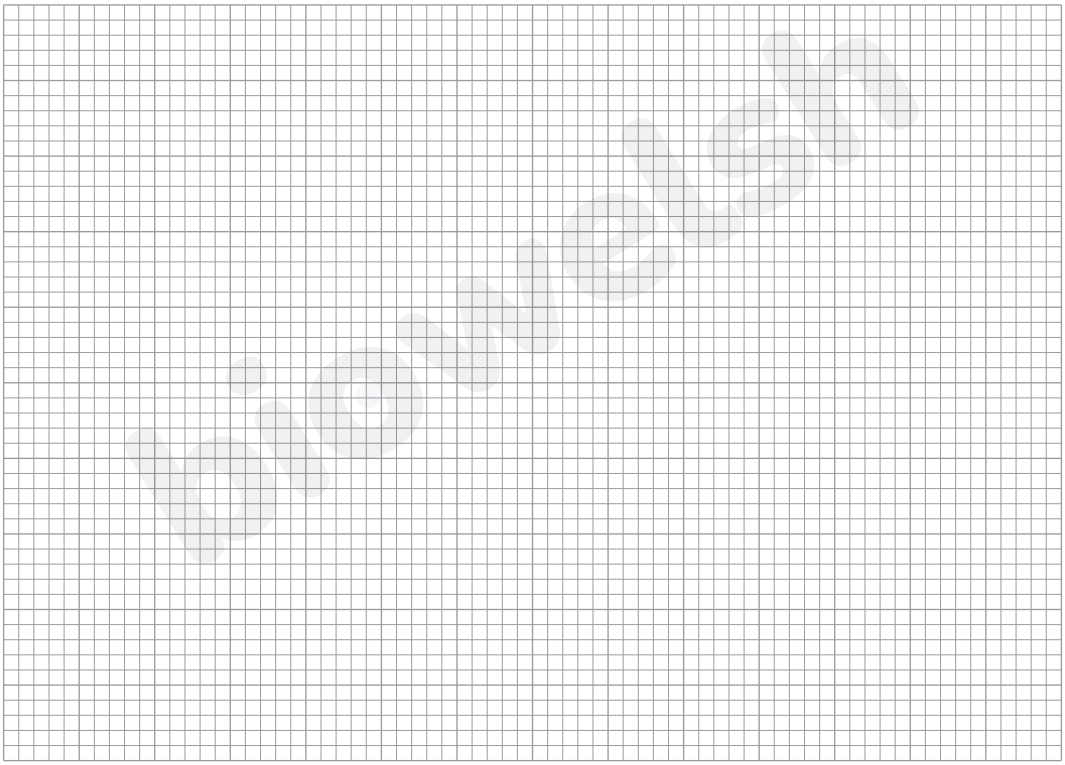
Tutor only

A drug that reduces osteoclast activity was tested on women with osteoporosis. One group took the drug and a second group took a placebo for three years. **Table 6.2** shows the mean change in hip bone density.

Table 6.2

Time since start of treatment / years	0	1	2	3
Mean change in density with drug / %	0	+2.8	+4.1	+4.9
Mean change in density with placebo / %	0	–0.9	–1.8	–2.6

(d) Plot the data in **Table 6.2** as two line graphs on the grid below. Join the points with straight lines and label the lines. [4]



(e) Explain the difference between the two groups. [2]

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Tutor only

(f) Brittle bone disease also causes bones to fracture easily. Explain the cause of brittle bone disease. [1]

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Tutor only

7. **Image 7.1** is a light micrograph of skeletal muscle cut in longitudinal section.

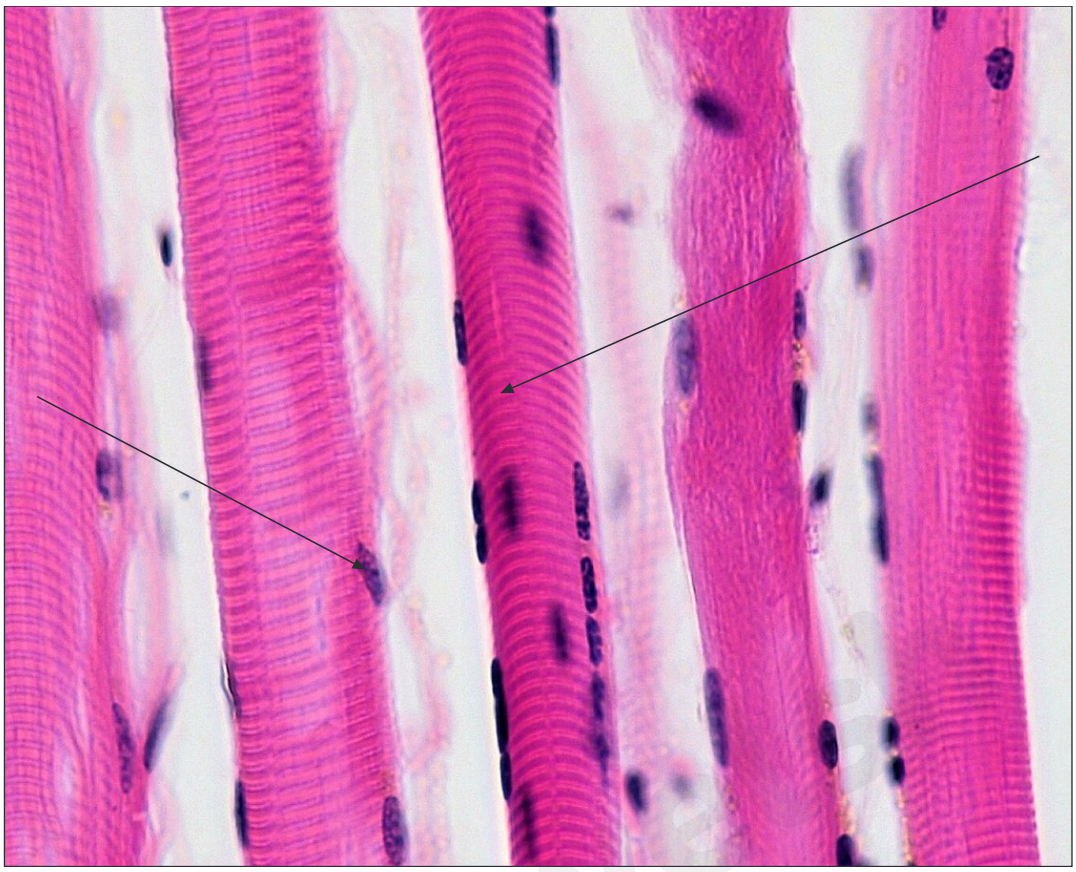

Image 7.1

(a) Identify **P** and **Q**. [2]

P .....

Q .....

(b) Explain why each structure labelled **Q** contains many nuclei. [1]

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(c) Name the membrane that surrounds **Q**, and the structure inside **Q** that stores calcium ions. [2]

Membrane .....

Calcium store .....

Tutor only

Image 7.2 is an electron micrograph of part of a muscle fibre.

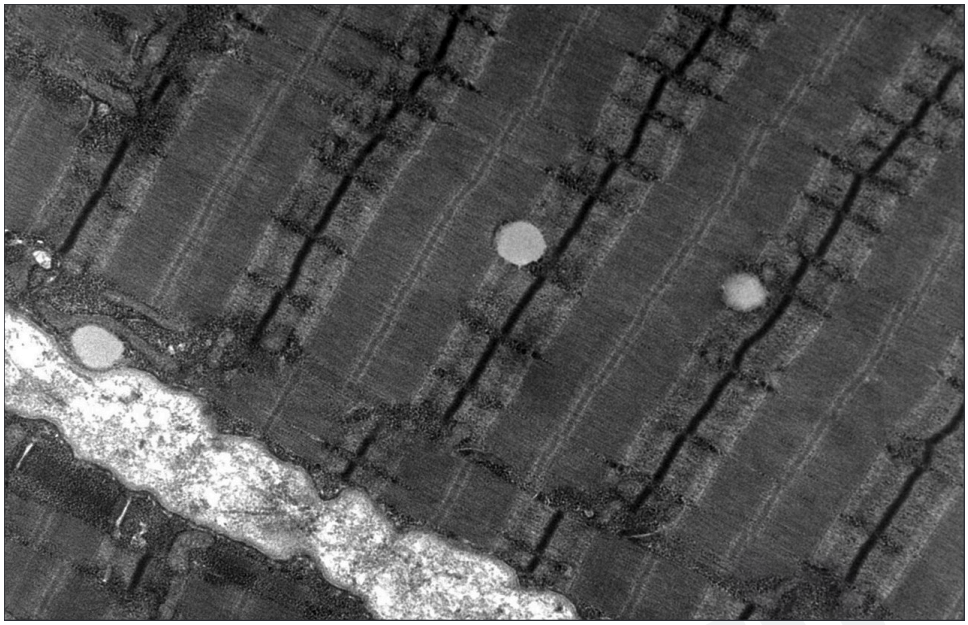

Image 7.2

(d) Explain why skeletal muscle appears striped in **Image 7.1** and **Image 7.2**. [2]

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(e) Muscle fibres in a sprinter's thigh muscle contain many myofibrils but few mitochondria. Suggest what type of fibre these are, and explain your answer. [2]

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Tutor only

8. **Image 8.1** shows part of a myofibril. Dotted lines **1**, **2** and **3** show where three transverse sections were cut. The sections are shown below the myofibril as **X**, **Y** and **Z**, but not in the same order.

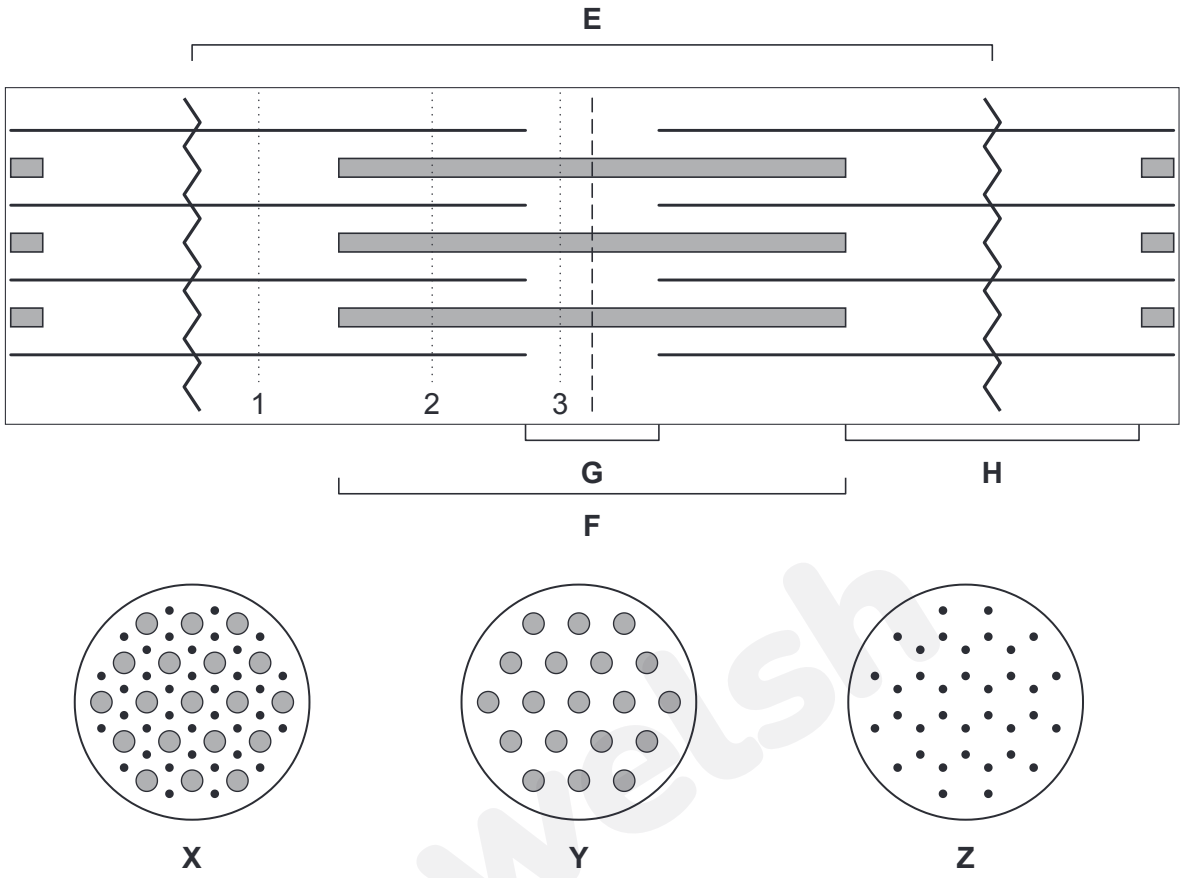

Image 8.1

(a) Name the regions labelled **E**, **F**, **G** and **H**. [2]

E .....

F .....

G .....

H .....

(b) Identify which section, **X**, **Y** or **Z**, was cut at position **3**. Give a reason for your answer. [2]

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Tutor only

(c) Describe and explain what happens to the lengths of regions **F** and **G** when the muscle contracts. [3]

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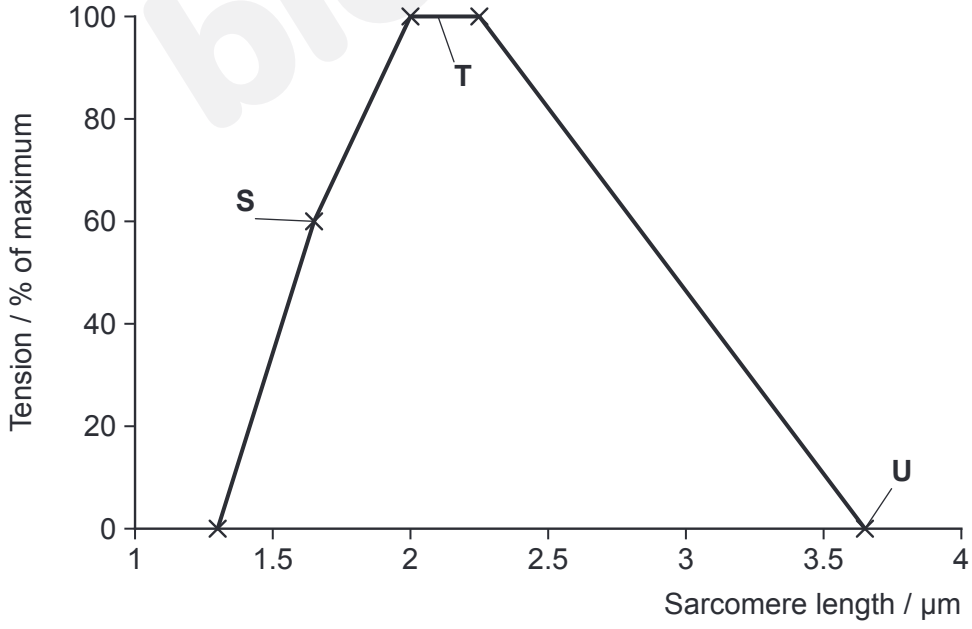
(d) The sarcomere shortens from 2.5 μm to 1.9 μm. Calculate the percentage decrease in its length. [2]

Percentage decrease = ... %

Graph 8.2 shows the tension produced by a muscle fibre when its sarcomeres are held at different lengths.



Graph 8.2

(e) Explain why the tension at point **U** is zero, but the tension at point **T** is at its maximum. [2]

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Tutor only

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Turn over.

Tutor only

9. Dantrolene is a drug that blocks the release of calcium ions from the sarcoplasmic reticulum. It is used in hospitals to relax muscles in emergencies. **Table 9.1** lists five events in the contraction of a skeletal muscle fibre, in the wrong order.

Table 9.1

Letter	Event
V	Tropomyosin moves, exposing binding sites on the actin
W	Calcium ions are released from the sarcoplasmic reticulum
X	Myosin heads bind to actin, forming cross-bridges
Y	Depolarisation spreads along the T tubules
Z	Calcium ions bind to troponin

(a) State the correct order of the events in **Table 9.1**, using their letters and starting with the first event. [2]

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(b) Explain how dantrolene causes skeletal muscles to relax. [3]

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(c) Describe the role of ATP in the cross-bridge cycle. [3]

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Tutor only

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(d) A few hours after death, the muscles of the body become stiff and rigid. Suggest why. [2]

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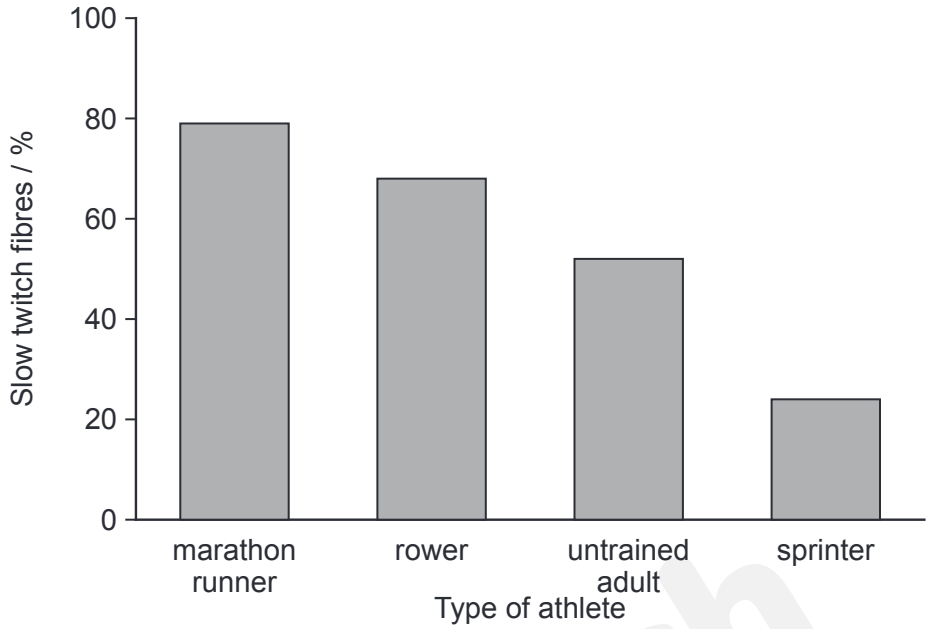
Tutor only

10. Muscle samples were taken from the thigh muscle of athletes who trained for different sports, and of an untrained adult. The percentage of slow twitch fibres in each sample was counted. **Graph 10.1** shows the results.



Graph 10.1

(a) Calculate the ratio of slow twitch fibres to fast twitch fibres in the sprinter. Give your answer in the form 1 : n. [2]

Ratio = 1 : .....

(b) Explain why the percentage of each fibre type was recorded rather than the number of fibres. [1]

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(c) Slow twitch fibres are darker in colour than fast twitch fibres. Explain why, and explain how this suits them to the marathon runner's event. [3]

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(d) During the first ten seconds of a race, a sprinter's muscles use creatine phosphate. Explain how creatine phosphate provides energy for contraction. [2]

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(e) Explain why the sprinter's muscles fatigue quickly, but a marathon runner's muscles do not. [2]

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Tutor only

11. A hospital recorded the fractures treated after accidents at a skateboard park during one summer. **Image 11.1** shows four types of fracture of a long bone, labelled **W** to **Z**.

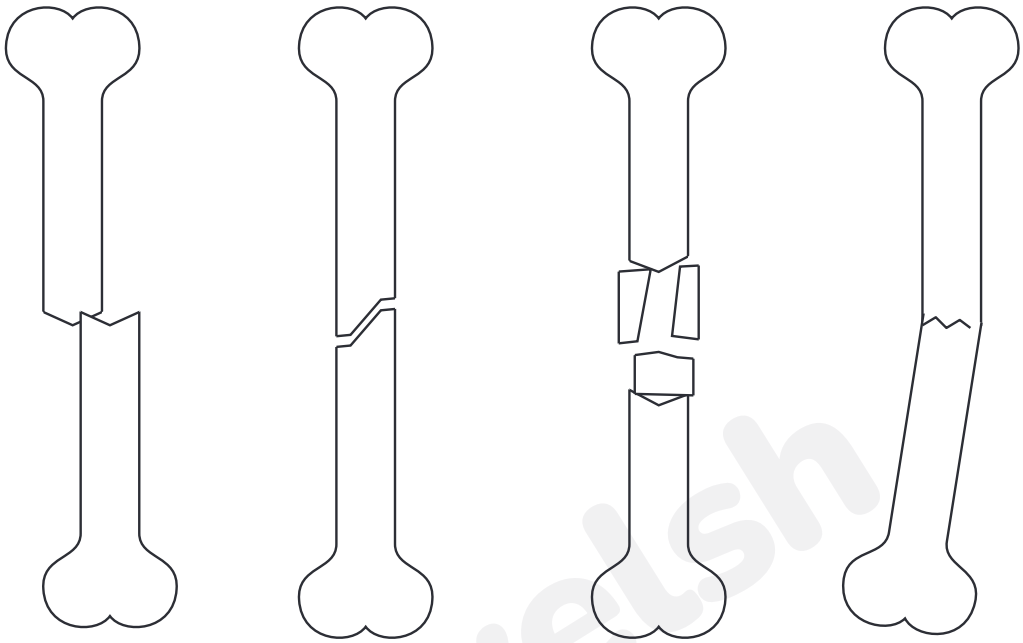

Image 11.1

(a) Name the types of fracture shown in **W**, **Y** and **Z**. [3]

W .....

Y .....

Z .....

(b) Suggest why fracture **Z** was seen only in children. [1]

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Tutor only

(c) The bones broken most often at the park were the radius and the clavicle. Complete **Table 11.2** to show whether each bone belongs to the axial or appendicular skeleton, and the part of the skeleton it belongs to. [2]

Table 11.2

Bone	Axial or appendicular	Part of the skeleton
radius	.....	forelimb
clavicle	appendicular	.....
sternum	.....	.....

(d) An open fracture is one in which the bone breaks through the skin. Explain why an open fracture is more serious than a closed fracture. [1]

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(e) Fracture **W** was treated with surgery. Describe how the fracture would be treated so that it heals in the correct position. [2]

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Tutor only

12. **Image 12.1** shows two vertebrae, **A** and **B**, each seen from above. They come from different regions of the vertebral column.

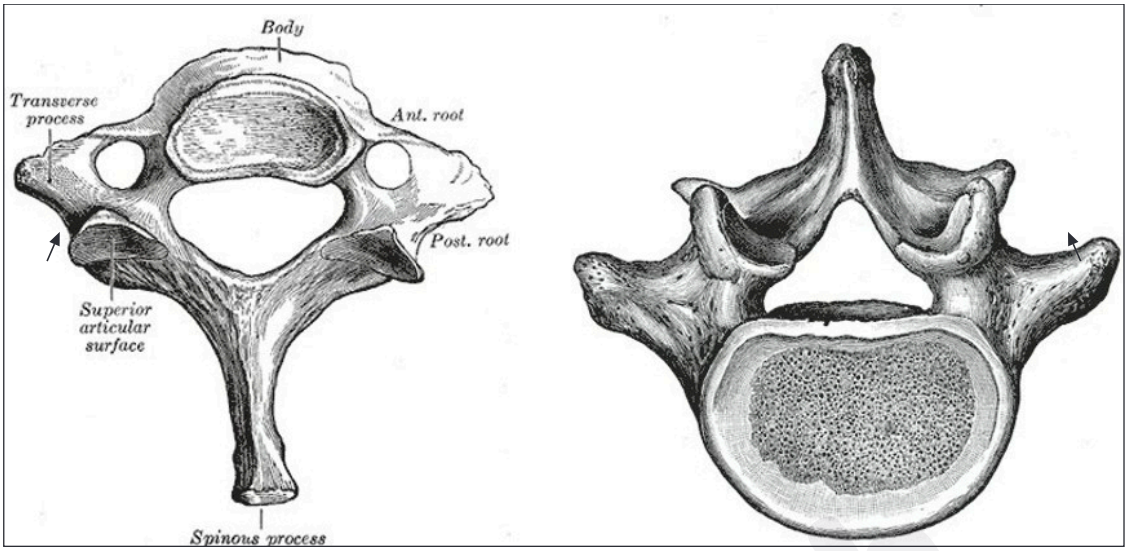

Image 12.1

(a) State **two** functions of the vertebral column. [1]

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(b) Identify the region of the vertebral column that **A** and **B** each come from. Give **one** feature of each vertebra that supports your answer. [4]

A region .....

Feature .....

B region .....

Feature .....

(c) Explain how the structure of vertebra **B** is related to its function. [2]

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Tutor only

Image 12.2 is an X-ray of the spine of a 14-year-old, seen from the front.

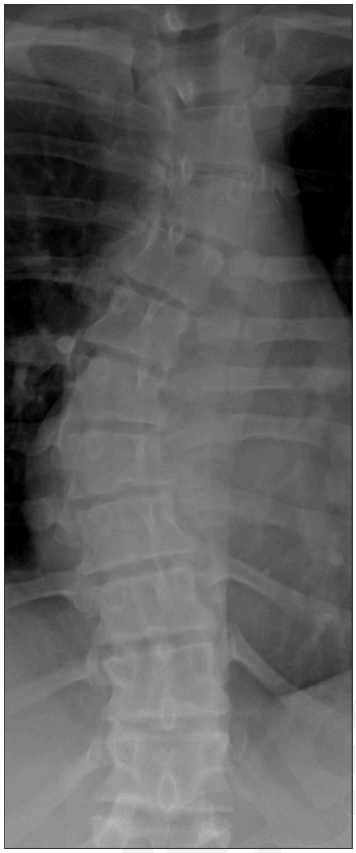

Image 12.2

(d) Name the condition shown in **Image 12.2**, and suggest **two** treatments that could be offered. [3]

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Tutor only

13. **Image 13.1** shows the structure of a synovial joint.

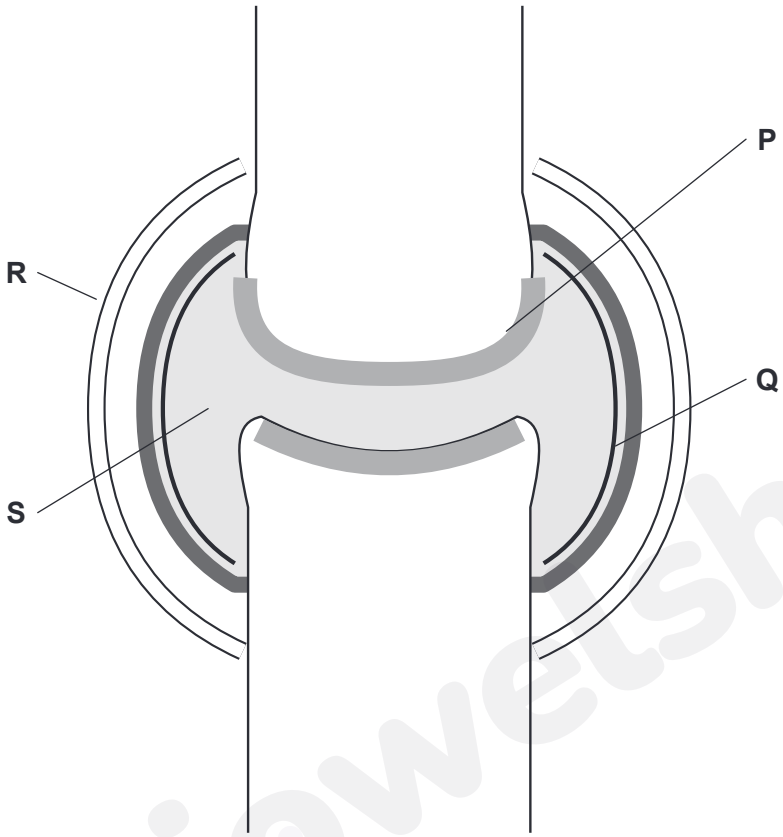

Image 13.1

(a) Name the structures labelled **P**, **Q**, **R** and **S**. [2]

P .....

Q .....

R .....

S .....

(b) Describe the roles of **S** in the joint. [2]

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Tutor only

(c) The knee and the hip are both synovial joints. State the type of joint at the knee and at the hip. [1]

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Image 13.2 is an X-ray of the hip of a 72-year-old with pain and stiffness when walking.

Image 13.2

(d) The patient has osteoarthritis. Describe the evidence in **Image 13.2** that supports this diagnosis. [2]

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(e) Explain why rheumatoid arthritis is described as an autoimmune disease, and name the tissue it attacks first. [2]

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Tutor only

(f) Suggest **two** reasons why a hip replacement may be recommended for this patient rather than drugs alone. [2]

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Tutor only

14. **Image 14.1** shows the forearm of a person holding a kettle steady, with the forearm horizontal.

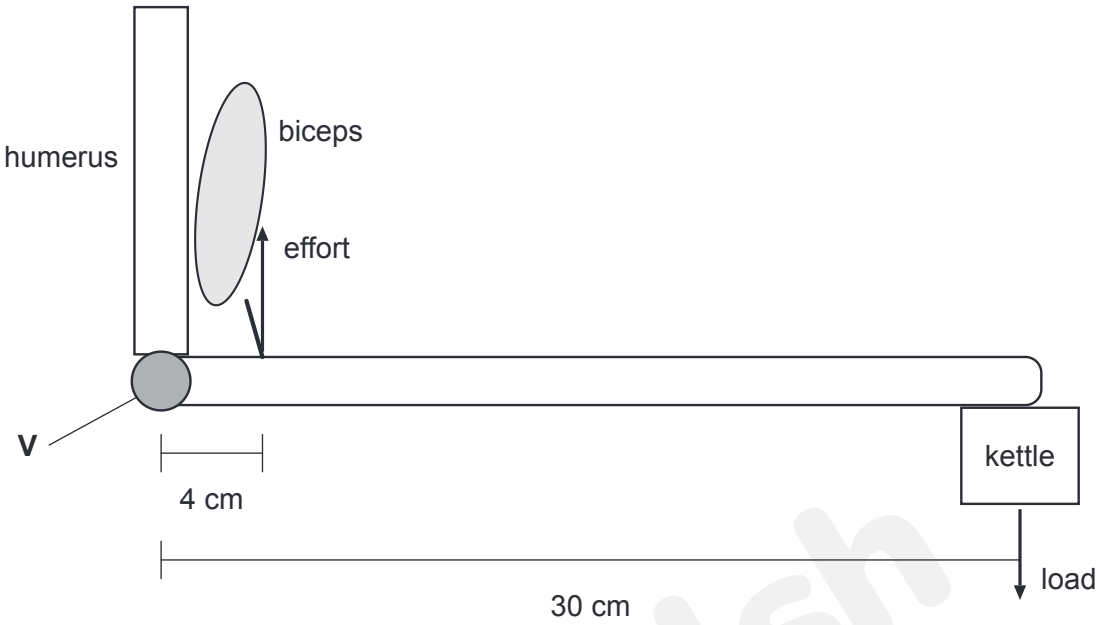

Image 14.1

(a) Name the joint labelled **V**, and state its role in the lever system. [1]

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(b) State the order of lever shown in **Image 14.1** and explain your answer. [2]

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(c) The kettle has a mass of 1.5 kg. A mass of 1 kg has a weight of 9.8 N. Calculate the force the biceps must exert to hold the kettle steady. Ignore the weight of the forearm. [3]

Force = ... N

Tutor only

(d) Suggest the advantage of the biceps being attached so close to the elbow. [1]

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(e) The person then straightens the arm to put the kettle down on a low table. Explain how the biceps and triceps work together to straighten the arm. [2]

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(f) Explain the importance of tendons being inelastic. [1]

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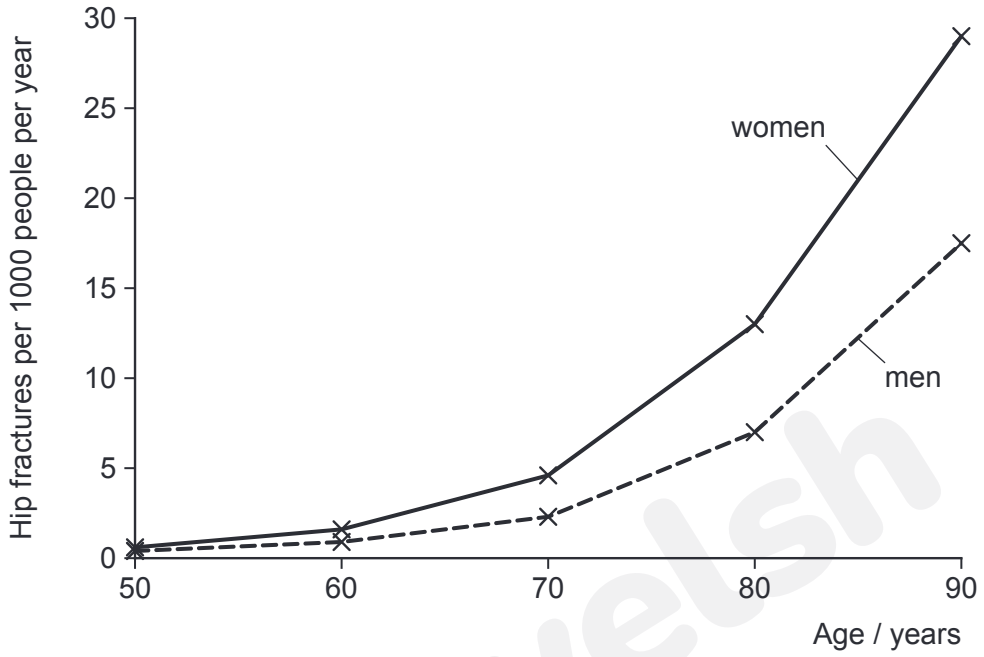
Tutor only

15. Hip fractures are one of the most serious injuries in older people. A study recorded the number of hip fractures per 1000 people per year in men and women of different ages. **Graph 15.1** shows the results.



Graph 15.1

Describe the structure of compact bone and explain how osteoblasts and osteoclasts maintain it. Use **Graph 15.1** and your knowledge of osteoporosis to describe and explain the pattern of hip fractures in men and women. Describe how a hip fracture in an older person is treated, and explain why treatment and prevention are both important. [9 QER]

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END OF WORKSHEET

9

A Tutor Meets Tutee project

BioWelsh worksheets are written and checked by Tutor Meets Tutee tutors for WJEC A level Biology students.

Mark this worksheet with the BioWelsh mark scheme **BW-A2-OptionB-W1** (MS).

Acknowledgements

Image 1.1: Micrographs: Berkshire Community College Bioscience Image Library, CC0 (Wikimedia Commons, 'Connective Tissue Hyaline Cartilage (40958873155)', 'Connective Tissue Elastic Cartilage (41855666711)', 'Connective Tissue Fibrocartilage (27988651538)'). Cropped and placed side by side; letters added.

Image 7.1: Photo: Berkshire Community College Bioscience Image Library, CC0 (Wikimedia Commons, 'Muscle Tissue Skeletal Muscle Fibers (40153601630)'). Cropped; letters and label lines added.

Image 7.2: Electron micrograph: Louisa Howard, Dartmouth College, public domain (Wikimedia Commons, 'Human skeletal muscle tissue 1 - TEM'). Cropped.

Image 12.1: Engravings: Henry Vandyke Carter, Gray's Anatomy (1918), public domain (Wikimedia Commons, 'Gray89' and 'Gray94'). Placed side by side; letters added.

Image 12.2: X-ray: unknown author, public domain (Wikimedia Commons, 'Scoliosis X-ray'). Cropped.

Image 13.2: X-ray: Mikael Häggström, CC0 (Wikimedia Commons, 'Severe (Tönnis grade 3) osteoarthritis of the hip').

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