The photomicrographs in Fig. 2.3 and Fig. 2.4 have the same magnification.

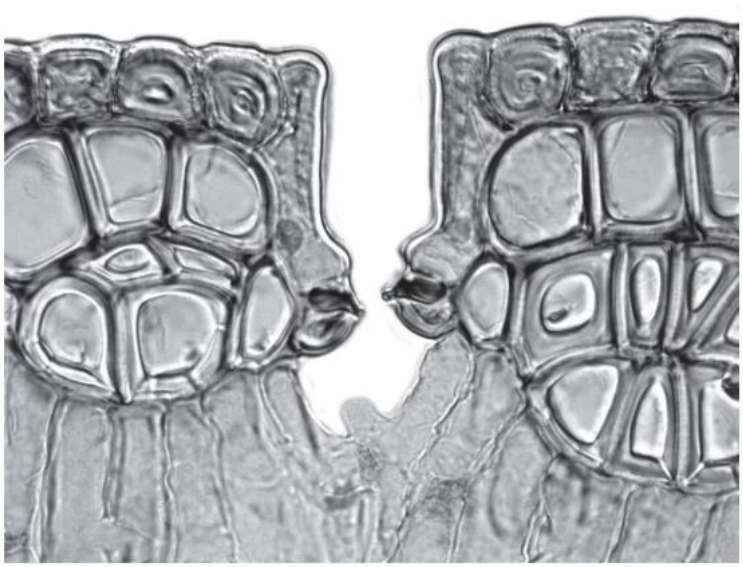

Fig. 2.3

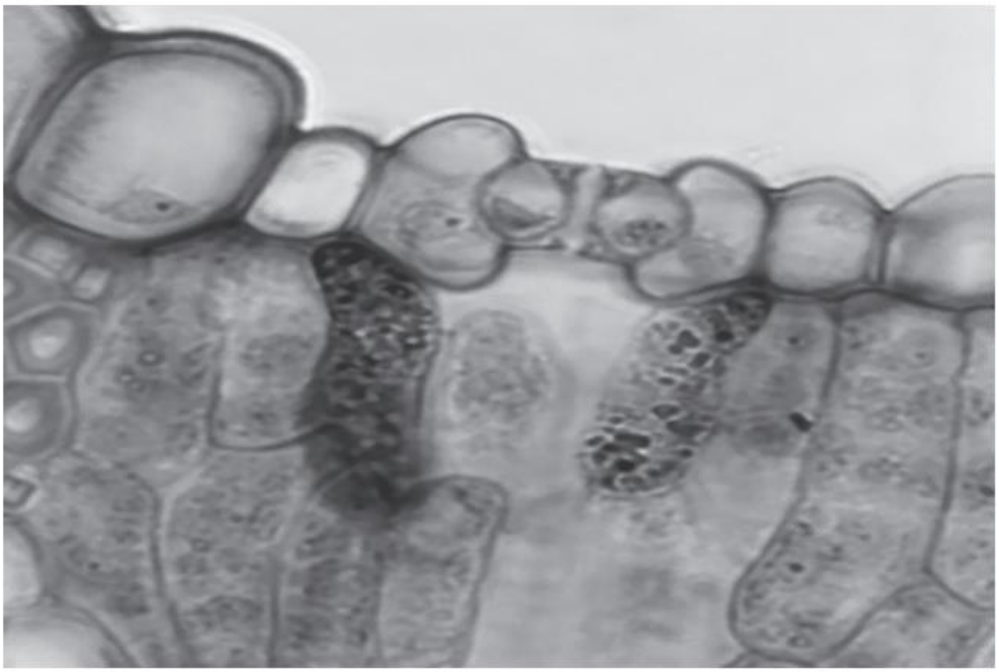

Fig. 2.4

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Identify **three** observable differences between the leaf section shown in Fig. 2.3 and the leaf section shown in Fig. 2.4.

Record these **three** observable differences in Table 2.1.

feature	**Fig. 2.3.**	**Fig. 2.4.**
location of, guard cells / stomata	sunken	on surface ;
epidermal cell walls	have thickenings	no thickenings ;
size of epidermal cells	cells all similar size	cells vary in size ;
cuticle	thick / present	thin / absent ;
AVP ;		

Fig. 2.1 is a photomicrograph of a stained transverse section of a leaf from a different type of plant.

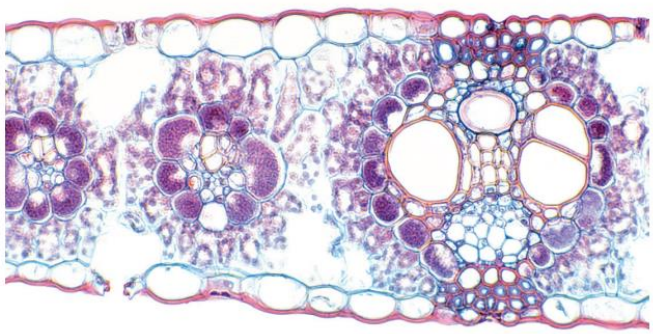

Fig. 2.1

(b) Identify **three** observable differences between the leaf on **K1** and the leaf shown in Fig. 2.1.

Record these **three** observable differences in an appropriate table.

2(b)(i) 1 organises comparison into 3 columns; **4**

*any **three differences** from*:

feature	**K1**	**Fig. 2.1**
number of vascular bundles	one vascular bundle	more vascular bundles ;
size of vascular bundles	small	large ;
size of xylem vessels	smaller	larger ;
epidermal layer	thinner	thicker ;
trichomes	present	absent ;

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1 only observable differences <u>and</u> more than one observable difference ; 2, 3, 4 three correct differences: *any **three** from:*	**4**

feature	L1	Fig. 2.2
trichomes	present	absent ;
shape of vascular bundle	round	crescent ;
number of vascular bundles	more	less ;
palisade tissue	thicker	thinner ;
AVP ;		

(b) Fig. 2.2 is a photomicrograph of a stained transverse section through a different stem from **L1**.

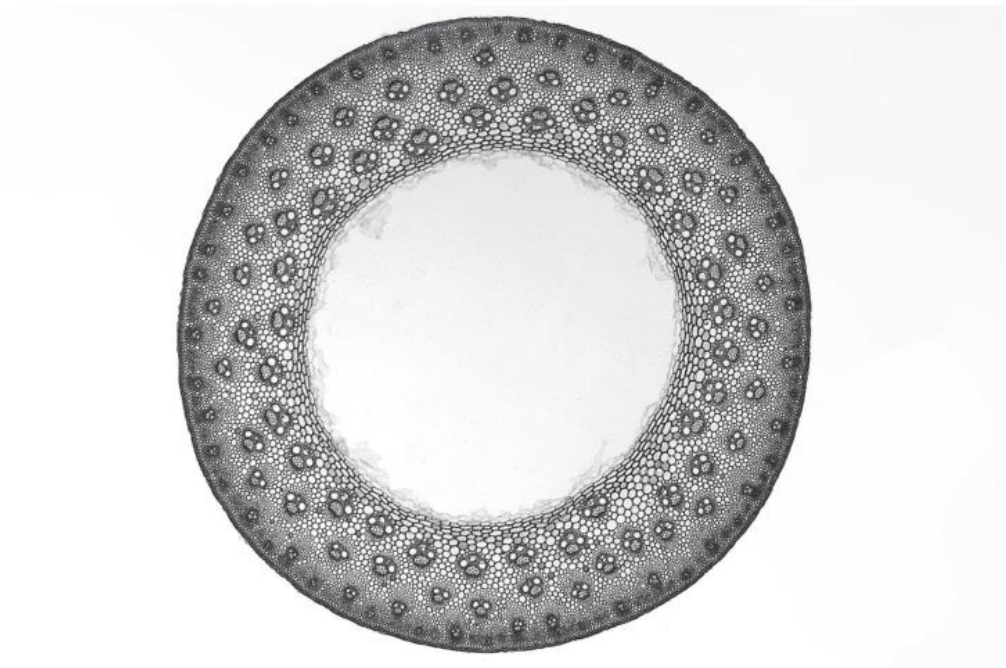

Fig. 2.2

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Identify **three** observable differences, other than colour, between the stem section in Fig. 2.2 and the stem section on **L1**.

1 only observable differences ;
2, 3, 4 three correct differences:

*any **three** from.:*

feature	Fig. 2.2.	M1
number of vascular bundles	more	less ;
trichomes	absent	present ;
shape of stem	round	wavy ;
number of tissue layers	less	more ;
AVP ;		

4

(b) Fig. 2.2 is a photomicrograph of a stained transverse section through a different stem from **N1**.

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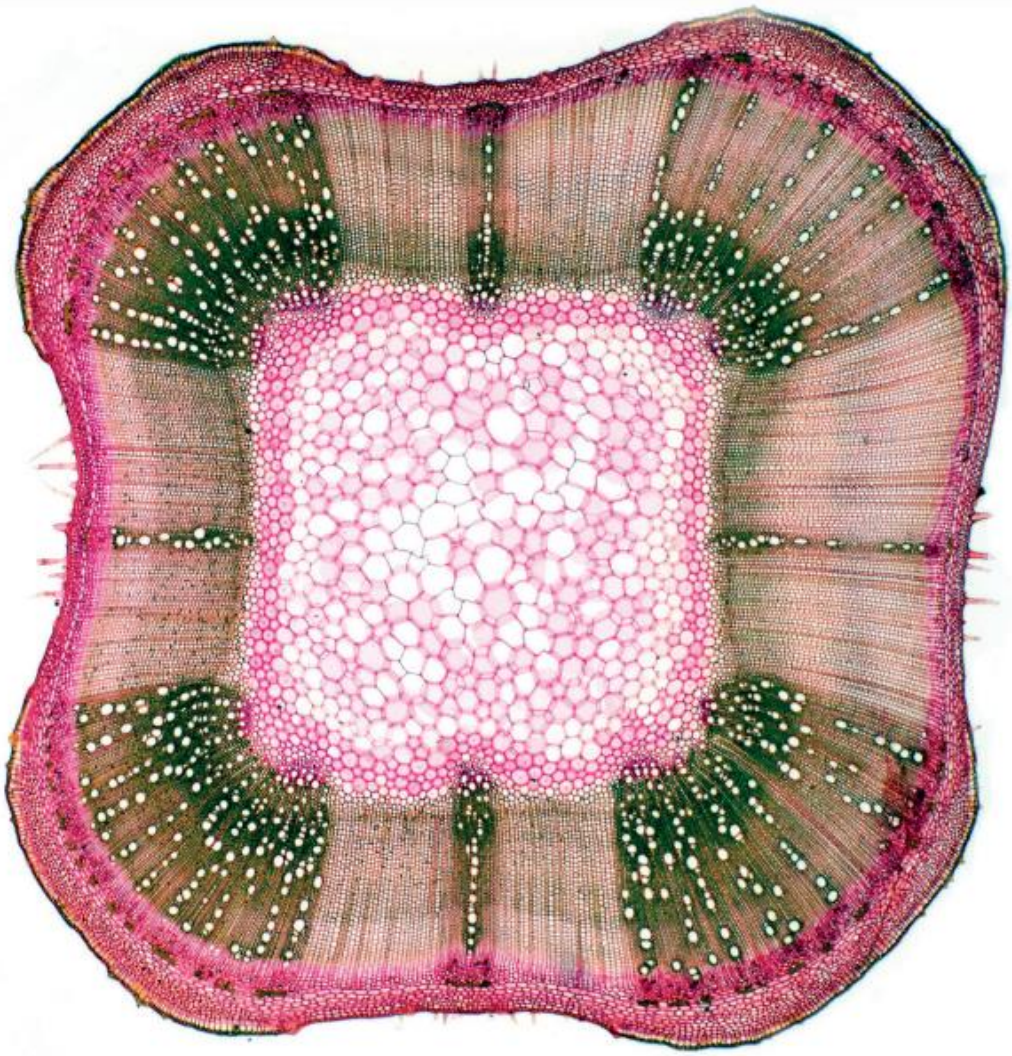

The section on **N1** and the section in Fig. 2.2 have some similar structures.

One example of a similar structure is shown in Table 2.1.

Identify **three** more observable structures that are similar on the section on **N1** and the section in Fig. 2.2 and describe how each observable structure is similar.

Record and describe these **three** observable similarities in Table 2.1.

Table 2.1

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similar structure	how the structures are similar
xylem	xylem vessel elements present in distinct lines in the vascular bundles

[4]

1 states only observable structures that are similar ; 2, 3 and 4 three correct similarities: *any **three** from*:	**4**

similar structure	how the structures are similar
shape of stem	both stems are square ;
size of vascular bundles	both have vascular bundles that are large and small ;
number of vascular bundles	4 or 8 vascular bundles in total ;
position of vascular bundles	one vascular bundle in each corner ;

(b) Fig. 2.2 is a photomicrograph of a stained transverse section of a different leaf.

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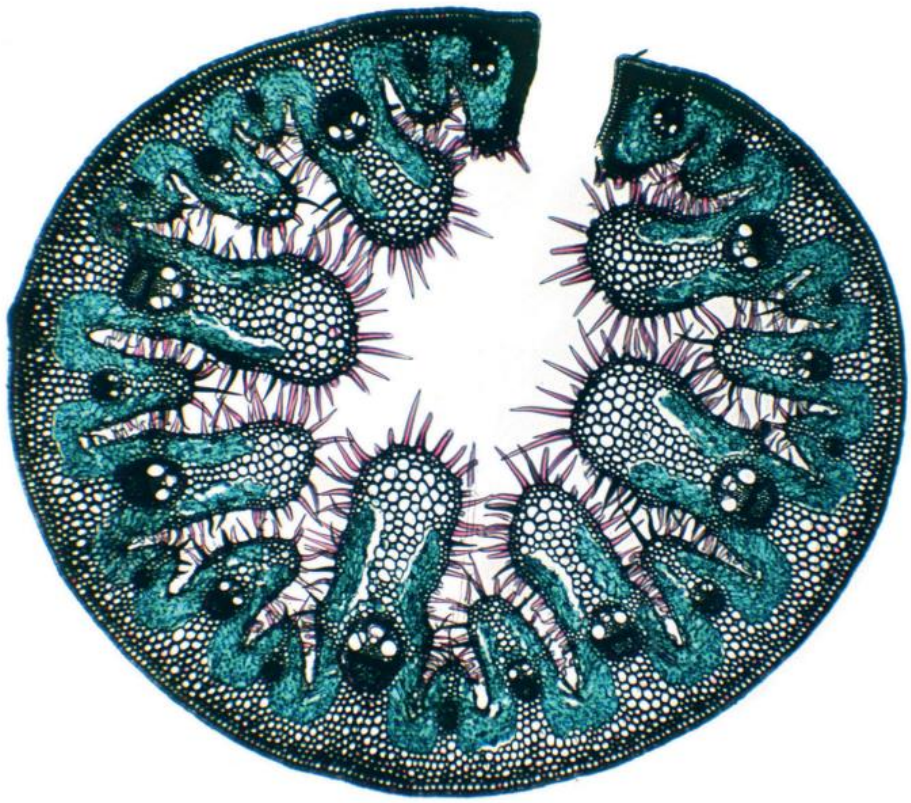

(i) Identify **three** observable **differences**, other than colour, between the leaf section in Fig. 2.2 and the leaf section on **J1**.

Record these three observable differences in Table 2.1.

only observable differences ; *any **three** from e.g.:*	**4**

feature	Fig. 2.2	J1
trichomes	present	absent ;
large central cells	absent	present ;
shape	curved	straight ;
cuticle	thick	thin ;

(b) Fig. 2.2 shows a photomicrograph of a transverse section through a different root.

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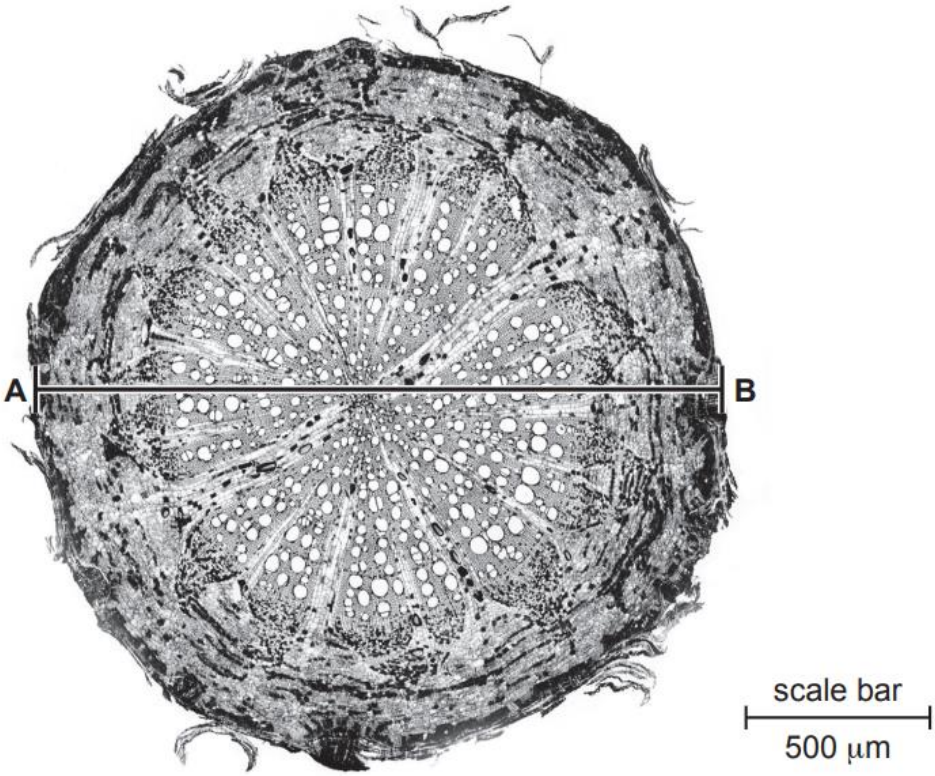

(i) Identify **three** observable differences, other than colour, between the root section on **K1** and the root section in Fig. 2.2.

Record these observable differences in Table 2.1.

Table 2.1

(ii) Line **A**–**B** represents the diameter of the root in Fig. 2.2.

Use the scale bar on Fig. 2.2 to calculate the **actual diameter** of the root.

Show your working.

Include the unit in your answer.

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(iii) Use your value from **(b)(ii)** to calculate the magnification of Fig. 2.2.

Give your answer to **two** significant figures.

magnification = × .....
[1]

three correct differences ; *any **three** from e.g.:*	**3**

feature	K1	Fig. 2.2
shape outline	wavy	circular ;
number of xylem vessels	fewer	more ;
relative size of vascular tissue	small	large ;
cortex	wider	narrower ;

Question	Answer	Marks
2(b)(ii)	1 correct measurement of scale bar **and** line **A**–**B and** units ; 2 measurement of line **A**–**B** multiplied by 500 **and** divided by measurement of scale bar ; 3 correct answer **and** units ;	**3**
2(b)(iii)	correct answer recorded to two significant figures ;	**1**

(b) Fig. 2.1 is a photomicrograph of a stained transverse section through a different plant and a different organ.

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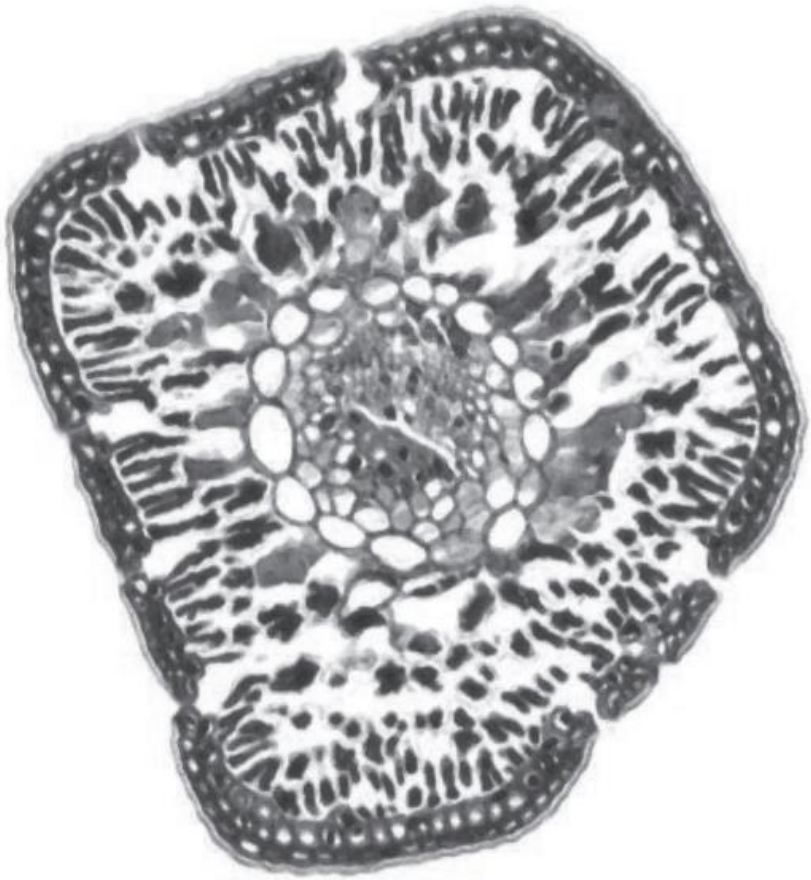

Fig. 2.1

(i) Identify **three** observable **differences**, other than colour, between the section on **L1** and the section in Fig. 2.1.

Record the **three** observable **differences** in Table 2.1.

(ii) Describe **one** observable **similarity** between the vascular bundle on **L1** and the vascular bundle in Fig. 2.1, other than that they both contain xylem and phloem.

.....

.....

..... [1]

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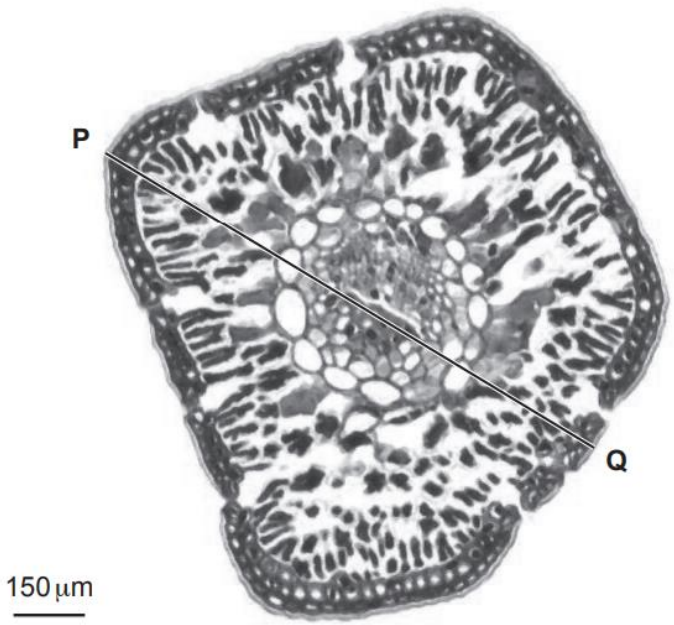
(c) Fig. 2.2 is the same photomicrograph as that shown in Fig. 2.1 with the line **P–Q** added.



Use the scale bar to calculate the actual length of line **P–Q**.

Show your working and use appropriate units.

actual length of **P–Q** = ... [4]

uses only observable differences ;

*any **three** from* :

feature	L1	Fig. 2.1
overall shape	circular	angular ;
trichomes	present	absent ;
palisade mesophyll	absent	present ;
stomata	absent	present ;

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)	vascular bundle in centre ;	**1**
	1 correct measurement of scale bar **and** line P – Q ; 2 shows length of scale bar divided by 150 ; 3 shows length of line P – Q divided by answer to mp 2 ; 4 correct answer **and** appropriate units ;	**4**

(b) Fig. 2.2 is a photomicrograph of a stained transverse section of a stem from a different plant species to the stem on **N1**.

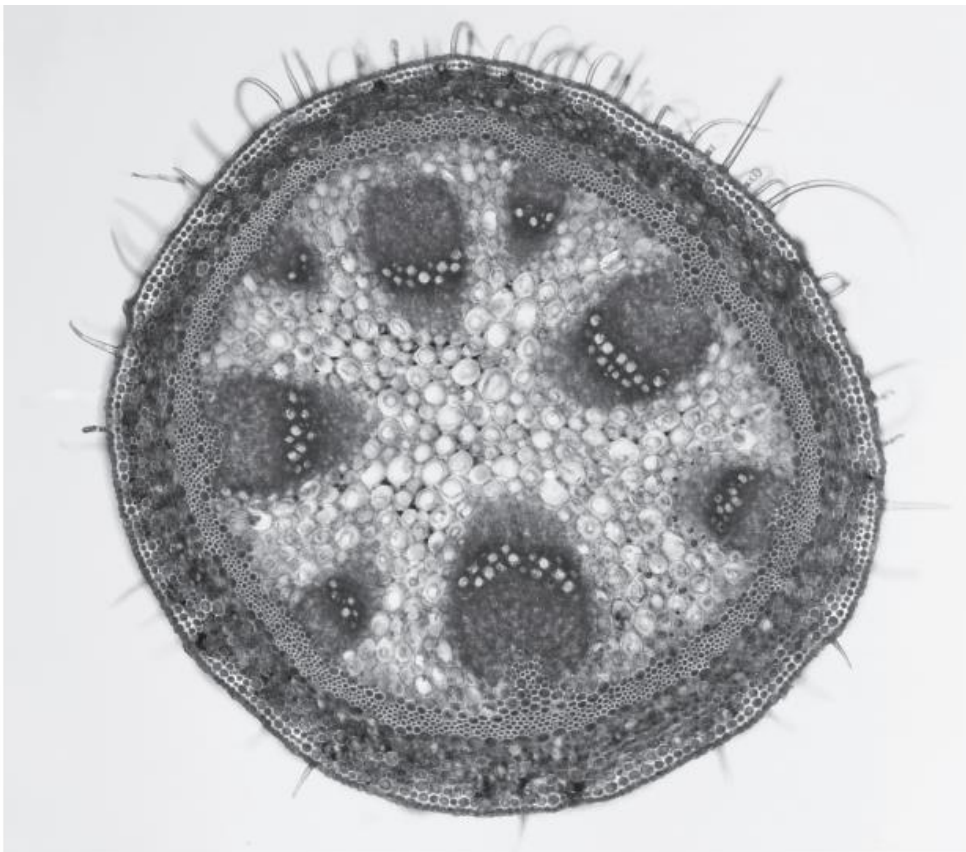

Fig. 2.2

Identify **three** observable **differences**, other than colour, between the stem in **N1** and the stem in Fig. 2.2.

Record these three observable differences in Table 2.1.

(c) Fig. 2.3 shows a photomicrograph of a stage micrometer scale that is being used to calibrate an eyepiece graticule.

One division, on either the stage micrometer scale or the eyepiece graticule, is the distance between two adjacent lines.

The length of one division on the stage micrometer in Fig. 2.3 is 0.50 mm.

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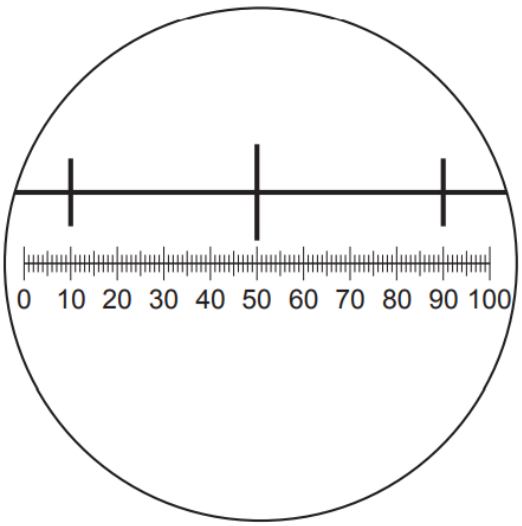

Fig. 2.3

(i) Calculate the actual length of one eyepiece graticule unit shown in Fig. 2.3.

Give your answer in micrometres (μm).

Show your working.

actual length = ... μm [2]

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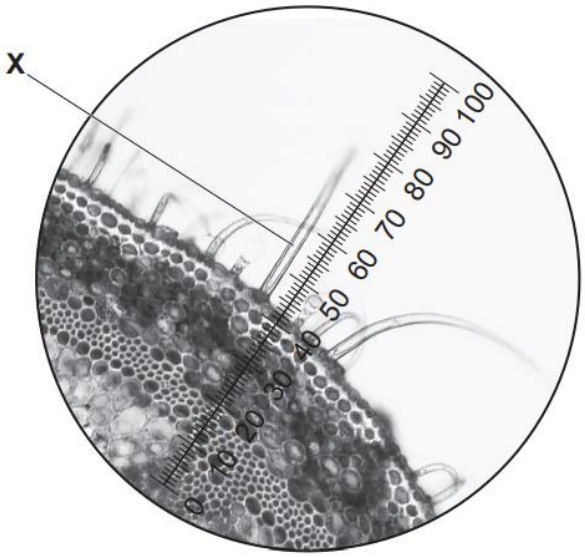
Fig. 2.4 shows a magnified section of the stem shown in Fig. 2.2. This was taken with the same microscope and the same lenses used to take the photomicrograph in Fig. 2.3.



(ii) Use the calibration of the eyepiece graticule unit from **(c)(i)** to calculate the actual length of the trichome labelled **X** in Fig. 2.4.

Show your working.

actual length = ... [2]

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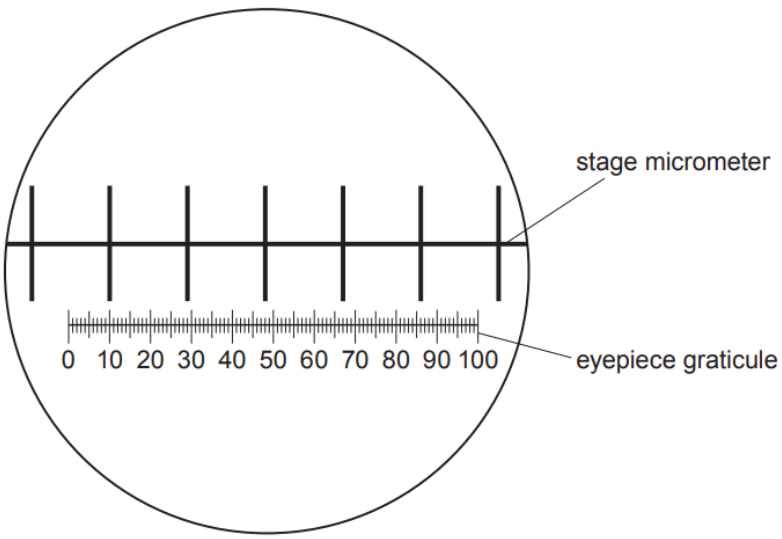
<table>
<tr><td>2(b)</td><td>states only differences ;

*any **three** from*:

<table><tr><th>feature</th><th>N1</th><th>Fig. 2.2</th></tr><tr><td>epidermis</td><td>thinner</td><td>thicker ;</td></tr><tr><td>number of vascular bundles</td><td>more</td><td>fewer ;</td></tr><tr><td>trichomes</td><td>absent</td><td>present ;</td></tr><tr><td>shape</td><td>triangular</td><td>circular ;</td></tr></table></td><td>4</td></tr>
<tr><td>2(c)(i)</td><td>1 shows 0.5 divided by 40 ;
2 states correct answer (12.5) ;</td><td>2</td></tr>
<tr><td>2(c)(ii)</td><td>1 states correct number of eyepiece graticule units within range (41–32) ;
2 multiplies by answer from (c)(i) ;</td><td>2</td></tr>
</table>

(b) Fig. 2.2 shows a photomicrograph of a stage micrometer scale that is being used to calibrate an eyepiece graticule.

The length of one division on this stage micrometer is 1 mm.



(i) Use Fig. 2.2 to calculate the actual length of one eyepiece graticule unit.

Show your working and include appropriate units.

actual length = ... [3]

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Fig. 2.3 shows a photomicrograph of a transverse section through a different leaf. This was taken with the same microscope and the same lenses used to take the photomicrograph in Fig. 2.2.

The eyepiece graticule has been placed across the leaf section to measure its thickness.

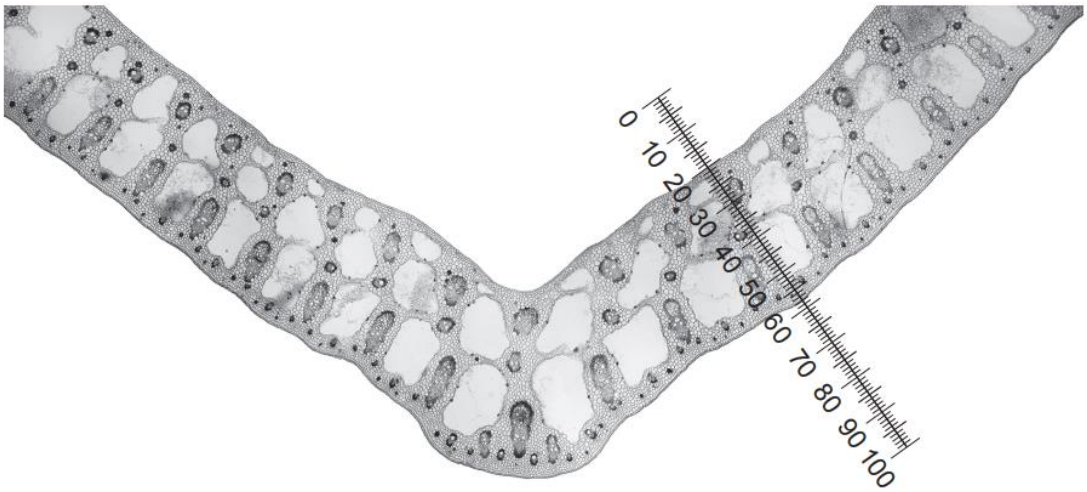

Fig. 2.3

(ii) Use the calibration of the eyepiece graticule from **2(b)(i)** to calculate the actual thickness of the leaf section in Fig. 2.3.

Show your working and write your answer to **two** significant figures.

actual thickness = ... [2]

(iii) The presence of large air spaces in the leaf shown in Fig. 2.3 is one adaptation of the plant for living in water.

Suggest a function of these air spaces.

.....

.....

..... [1]

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(iv) Identify **three** observable differences, other than colour and the presence of air spaces, between the leaf section on **M1** and the leaf section in Fig. 2.3.

Record these observable differences in Table 2.1.

Table 2.1

<table>
<tr><td>2(b)(i)</td><td>1 states correct number of graticule units per 1 mm division (19) ;
2 shows one divided by 19 ;
3 correct answer and units ;</td><td>3</td></tr>
<tr><td>2(b)(ii)</td><td>1 states correct number of graticule units across leaf depth (38) ;
2 correct calculation and answer to two significant figures ;</td><td>2</td></tr>
<tr><td>2(b)(iii)</td><td>suggests a correct function of the large air spaces as being related to gases in the leaf or buoyancy ;</td><td>1</td></tr>
<tr><td>2(b)(iv)</td><td>any three from:
<table>
<tr><th>feature</th><th>M1</th><th>Fig. 2.3</th></tr>
<tr><td>epidermis</td><td>thick</td><td>angular ;</td></tr>
<tr><td>palisade mesophyll</td><td>present</td><td>no distinct palisade mesophyll ;</td></tr>
<tr><td>stomata</td><td>present</td><td>absent ;</td></tr>
<tr><td>vascular bundle</td><td>central in midrib</td><td>no central vascular bundle ;</td></tr>
</table></td><td>3</td></tr>
</table>

(b) Fig. 2.2 shows a photomicrograph of a transverse section through a root. This root is different to the root on slide **P1**. You are **not** expected to be familiar with this root section.

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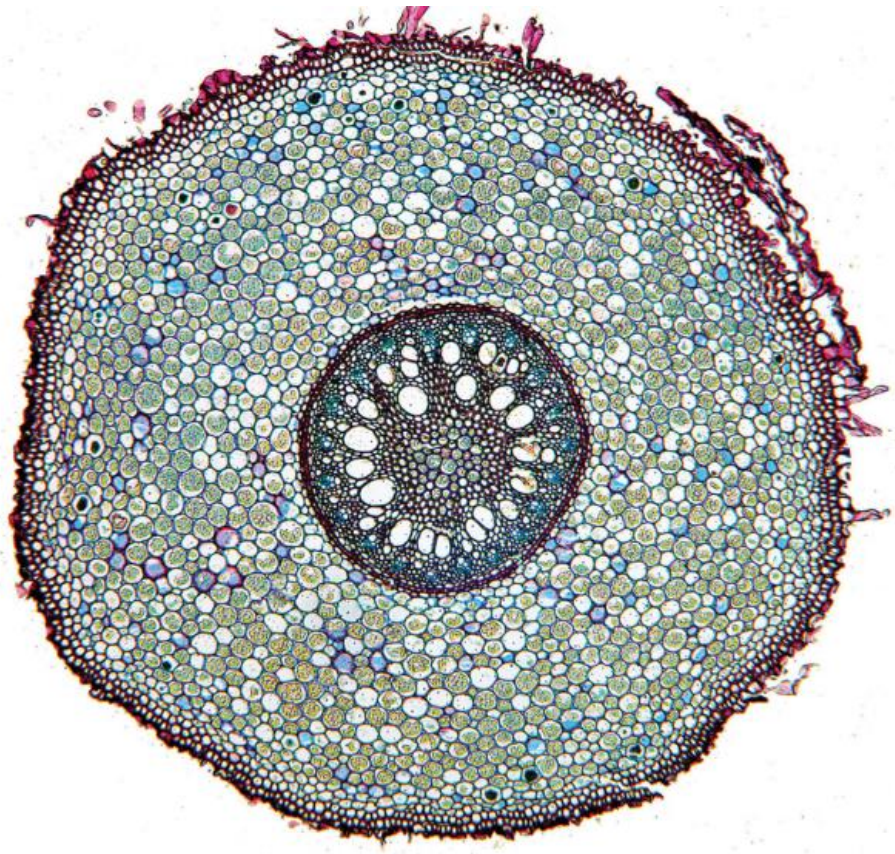

Fig. 2.2

(i) Identify **three** observable differences, other than colour, between the root in Fig. 2.2 and the root on slide **P1**.

Record these **three** observable differences in an appropriate table.

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(ii) Fig. 2.3 is a photomicrograph of the same root section that is shown in Fig. 2.2.

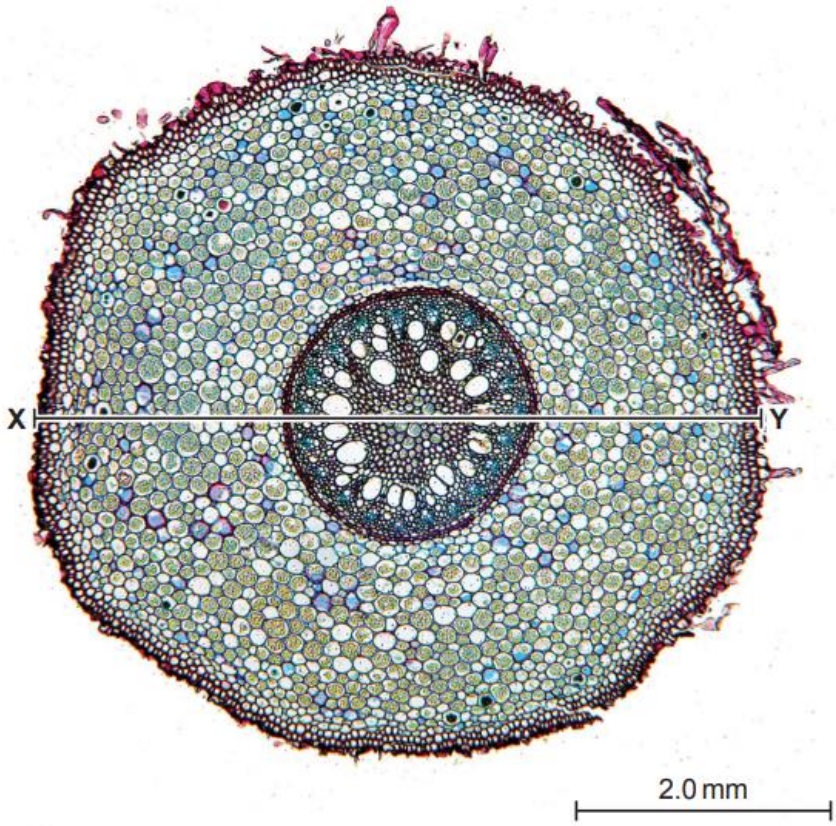

Fig. 2.3

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Use the scale bar on Fig. 2.3 to calculate the magnification of the photomicrograph **and** the actual diameter of the root section identified by the line **X–Y**.

Show your working and use appropriate units.

magnification = × .....

actual diameter = ...

[5]

Question	Answer	Marks
2(b)(i)	organises comparison into two-column table (same feature stated and compared in each row) or three-column table (first column defines feature to be compared) ; *plus any **three** from:* **feature** / **P1** / **Fig. 2.2** position of vascular tissue / towards periphery / in the centre ; size of xylem vessels / smaller / larger ; endodermis / not visible / visible ; width of cortex / narrow / wide ; epidermal layer / less intact / more intact ;	**4**
2(b)(ii)	1 measures length of scale bar <u>and</u> units ; 2 measures length of X–Y <u>and</u> units ; 3 shows length of scale bar divided by 2 ; 4 shows length of X–Y divided by magnification ; 5 correct answer <u>and</u> units ;	**5**

(b) Fig. 2.2 is a scanning electron micrograph of trichomes on the surface of a leaf.

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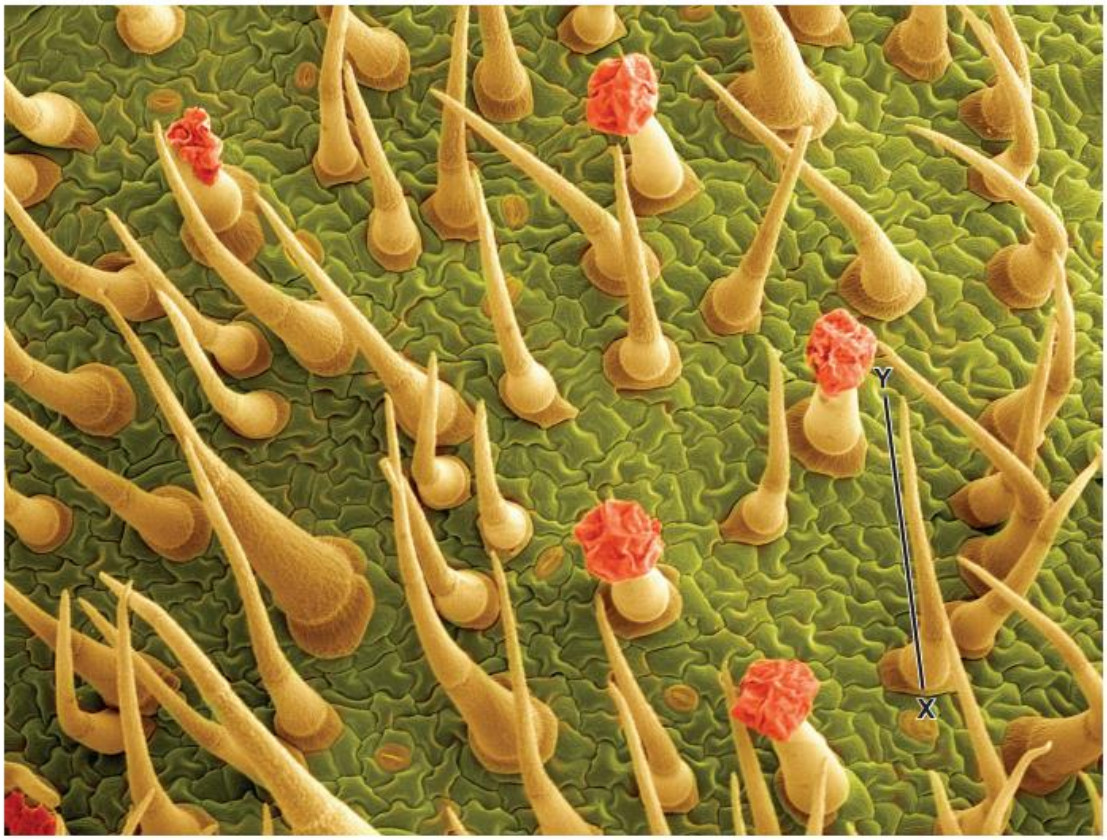

scale bar
100 μm

(i) Use the scale bar and line **X–Y** on Fig. 2.2 to calculate the actual length of one trichome.

Show your working and use appropriate units.

..... [3]

(ii) Add a labelled line to Fig. 2.2 to identify a stoma. [1]

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(iii) Fig. 2.3 is a scanning electron micrograph of trichomes on the leaf of a different plant.

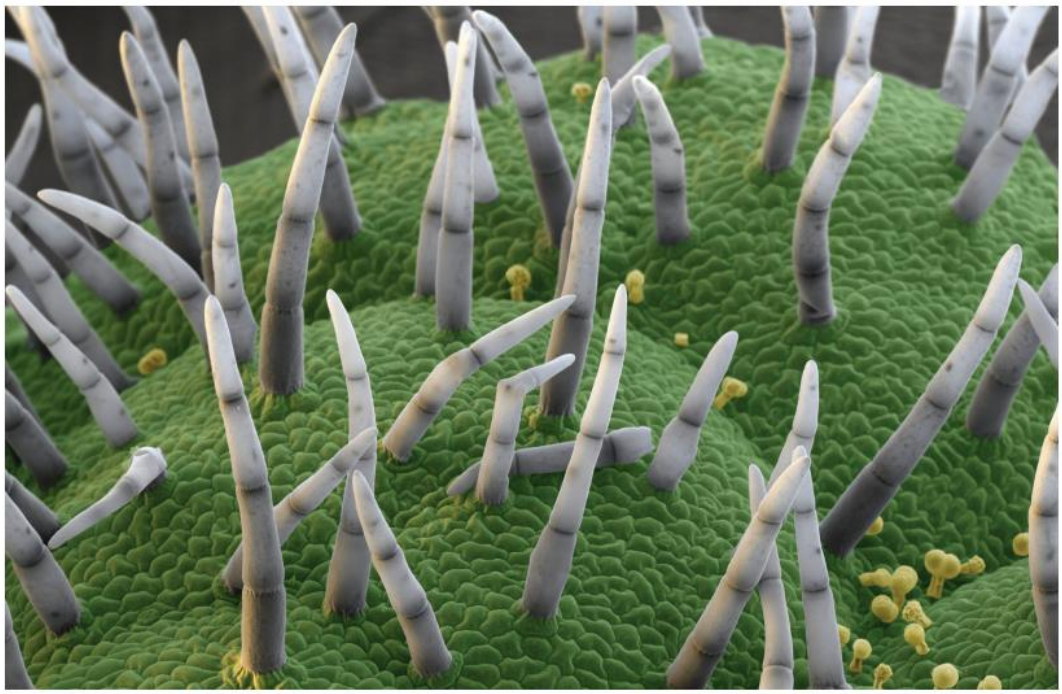

Fig. 2.3

Observe the trichomes in Fig. 2.2 **and** Fig. 2.3.

Identify **one** observable similarity and **two** observable differences, other than size and colour, between the trichomes in Fig. 2.2 and the trichomes in Fig. 2.3.

Record these observations in an appropriate table.

2(a)(ii)	1 minimum size **and** lines continuous, thin and sharp **and** no shading ; 2 draws only four whole vessel elements **and** each touches at least one other ; 3 two lines around each vessel element **and** three lines where vessel elements touch ; 4 vessel elements angular ; 5 label line and label to one vessel element wall ;	**5**
2(b)(i)	1 correct measurement of scale bar and length of trichome (X –Y) ; 2 correct calculation e.g. shows length of scale bar divided by 100 and divided by 0.16 ; 3 correct answer and units ;	**3**

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1 table with headings for Fig. 2.2 **and** Fig. 2.3 **and** table organised to show a similarity and differences ; **4**
2 two correct differences ;;
*any **two** from*:

feature	Fig. 2.2	Fig. 2.3
segments	fewer	more ;
structure at tip of trichome	more / larger	fewer / smaller ;
base of trichome	present	absent ;
width	thin	thick ;

3 similarity: e.g. wider at base than at tip ;

Fig. 2.2 is a photomicrograph of a stained transverse section of a stem from a different type of plant.

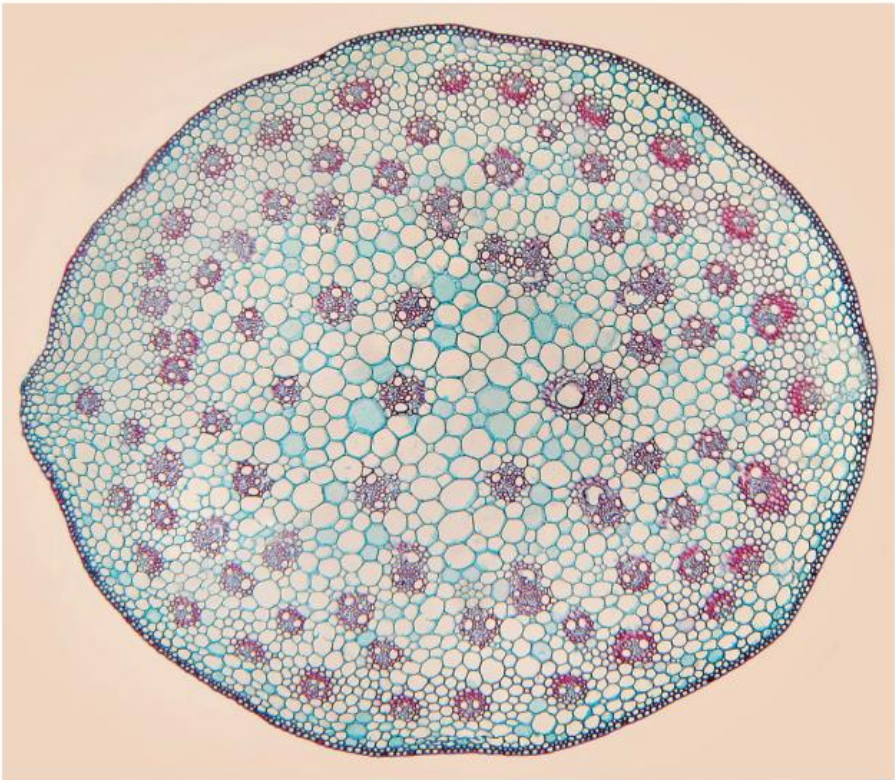

Fig. 2.2

(b) Identify **three** observable differences, other than size and colour, between the stem in Fig. 2.2 and the stem on **K1**.

Record these **three** observable differences in an appropriate table.

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(c) Fig. 2.3 is the same photomicrograph as that in Fig. 2.2.

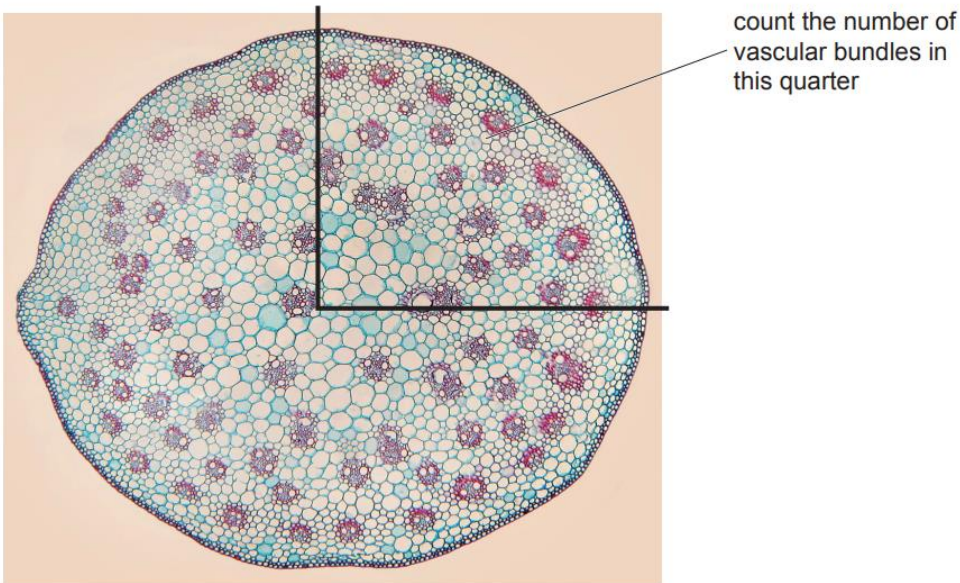

Fig. 2.3

Fig. 2.3 shows many vascular bundles within the photomicrograph. A sampling technique may be used to estimate the number of vascular bundles present in the whole photomicrograph.

(i) The region shown in Fig. 2.3 is one quarter of the stem section.

Count and record the number of vascular bundles in the region shown in Fig. 2.3.

If half or more of a vascular bundle is within the region, count it as a whole vascular bundle.
Do not count any vascular bundle if less than half of the vascular bundle is within the region.

Mark clearly, using a pen (not a pencil), on Fig. 2.3 each of the vascular bundles you have counted.

Estimate the total number of vascular bundles in the whole photomicrograph.

Show your working.

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estimated number of vascular bundles in the whole photomicrograph .....
[4]

(ii) The plant shown in Fig. 2.3 has many vascular bundles.

Suggest why it is an advantage to the plant to have many vascular bundles in its stem.

.....

.....

..... [1]

<table>
<tr><td>2(b)</td><td>1 organises comparison into 2 / 3 columns ;
2 three correct differences ;;;
any three from:
<table>
<tr><th>feature</th><th>K1</th><th>Fig. 2.2</th></tr>
<tr><td>number of vascular bundles</td><td>fewer</td><td>more ;</td></tr>
<tr><td>location of vascular bundles</td><td>in a ring towards periphery</td><td>scattered ;</td></tr>
<tr><td>arrangement of xylem / phloem</td><td>inner xylem / outer phloem</td><td>random ;</td></tr>
<tr><td>pith</td><td>present</td><td>absent ;</td></tr>
<tr><td>trichomes</td><td>present</td><td>absent ;</td></tr>
</table></td><td>4</td></tr>
<tr><td>2(c)(i)</td><td>1 shows counting on photomicrograph ;
2 correct number of vascular bundles counted ;
3 shows number of vascular bundles in quarter multiplied by 4 ;
4 correct answer ;</td><td>4</td></tr>
<tr><td>2(c)(ii)</td><td>1 helps to transport water etc. or helps support stem ;</td><td>`1</td></tr>
</table>

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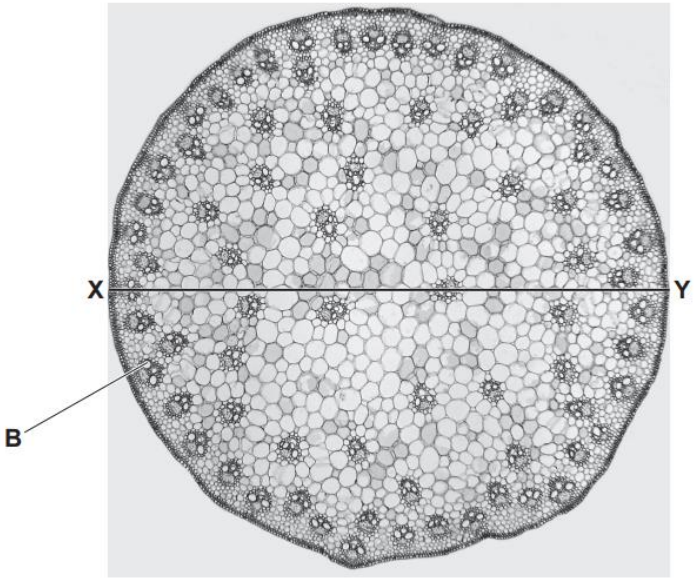
(b) Fig. 2.2 is a photomicrograph of a stained transverse section of a stem from the same plant species as the root on **L1**.



Magnification ×22

Fig. 2.2

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(i) In Fig. 2.2 the line **X–Y** is drawn across the diameter of the root.

Use the magnification and the line **X–Y** to calculate the actual diameter of the root.

Show your working and use appropriate units.

actual diameter = ... [3]

(ii) In Fig. 2.2, the structure labelled **B** forms part of the vascular bundle.

Identify structure **B** and explain how you identified this structure.

structure **B** .....

explanation .....

.....

[1]

(iii) Identify **three** observable **differences**, other than size and colour, between the root on **L1** and the stem in Fig. 2.2.

Record these three observable differences in Table 2.1.

Table 2.1

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<table>
<tr><td>2(b)(i)</td><td>1 correct measurement of X–Y ;
2 shows division by 22 ;
3 appropriate units ;</td><td>3</td></tr>
<tr><td>2(b)(ii)</td><td>1 xylem and reason ;</td><td>1</td></tr>
<tr><td>2(b)(iii)</td><td>1 only observable differences ;
2 three correct differences ;;;
any three e.g.:
<table>
<tr><th>feature</th><th>L1</th><th>Fig. 2.2</th></tr>
<tr><td>vascular bundle distribution</td><td>centre</td><td>scattered ;</td></tr>
<tr><td>root hairs</td><td>present</td><td>absent ;</td></tr>
<tr><td>endodermis</td><td>present</td><td>absent ;</td></tr>
<tr><td>number of vascular bundles</td><td>one</td><td>many ;</td></tr>
</table></td><td>4</td></tr>
</table>

(b) Fig. 2.1 is a photomicrograph of a stained transverse section through a different root.

Observe the photomicrograph in Fig. 2.1 and the section on **N1** to identify differences between them.

Fig. 2.1 has been annotated to describe **one** of these differences. A label line has been used to indicate the feature that is different.

Complete Fig. 2.1 by:

- identifying **and** annotating **three** more differences between the photomicrograph in Fig. 2.1 and the section on **N1**
- using a label line to identify the feature that is different.

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Fig. 2.1 .....

.....

N1 .....

.....

Fig. 2.1 has flattened cells
N1 has rounded cells

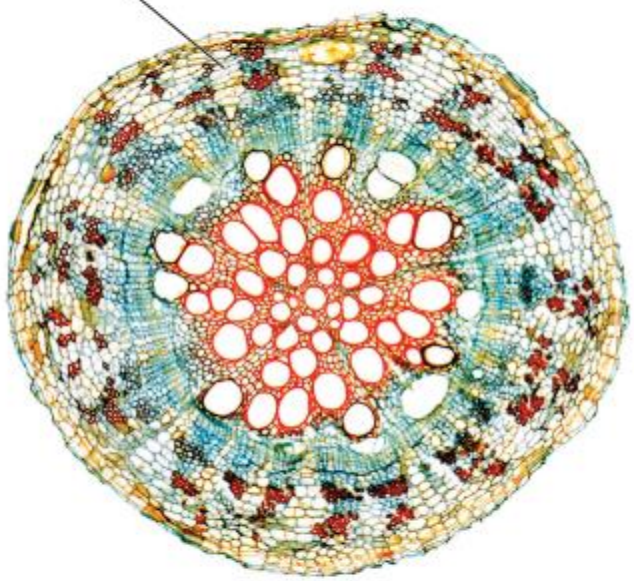

Fig. 2.1 .....

.....

N1 .....

.....

Fig. 2.1 .....

.....

N1 .....

.....

Fig. 2.1

[4]

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(c) Fig 2.2 is the same photomicrograph as that shown in Fig. 2.1.

A black dot has been placed at the centre of the section.

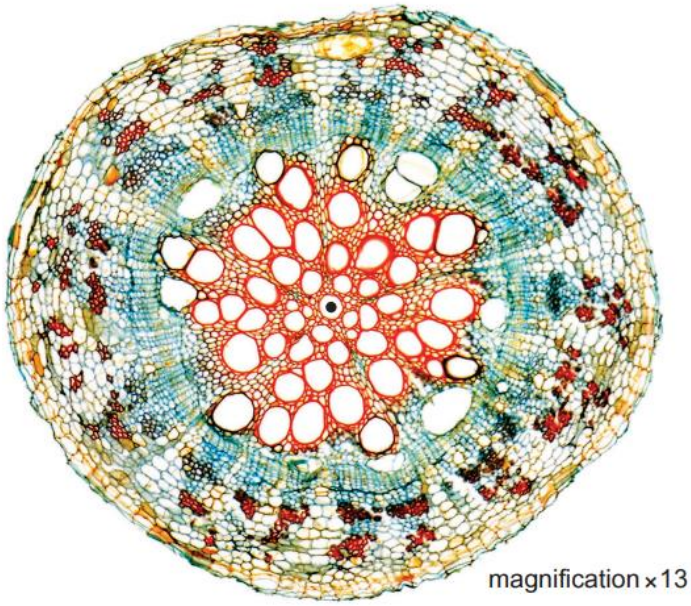

Fig. 2.2

(i) Determine the mean actual diameter of the section in Fig. 2.2.

- draw lines across the diameter of Fig. 2.2
- use your lines to measure the diameter of the section
- calculate the mean actual diameter of the section.

mean actual diameter = ... mm
[3]

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(ii) Calculate the actual area of the section using your answer in **(c)(i)** and the formula: actual area = πr^2, where π = 3.14.

State your answer to the nearest whole number and use appropriate units.

actual area of the section = ...

[3]

<table>
<tr><td>2(b)</td><td>1 records differences using only observable features and uses a label line to identify each feature ;
2 any three differences as annotations from: ;;;
<table>
<tr><th>feature</th><th>Fig. 2.1</th><th>N1</th></tr>
<tr><td>cortex</td><td>smaller</td><td>larger ;</td></tr>
<tr><td>cortex</td><td>cells more compact</td><td>cells less compact ;</td></tr>
<tr><td>xylem vessels</td><td>more spread out from centre</td><td>small area in centre ;</td></tr>
<tr><td>xylem vessels</td><td>scattered</td><td>cross-shape ;</td></tr>
<tr><td>xylem vessels</td><td>more</td><td>less ;</td></tr>
<tr><td>endodermis</td><td>not visible</td><td>visible ;</td></tr>
</table></td><td>4</td></tr>
<tr><td>2(c)(i)</td><td>1 uses at least 2 measurements of the diameter ;
2 uses at least three measurements of the diameter ;
3 (adds measurements <u>and</u> divides by number of measurements) <u>and</u> shows division by 13 ;</td><td>3</td></tr>
<tr><td>2(c)(ii)</td><td>1 shows answer from (c)(i) divided by 2 and squared ;
2 shows multiplication by 3.14 ;
3 whole number <u>and</u> mm^2 ;</td><td>3</td></tr>
</table>

(b) Fig. 2.1 is a photomicrograph of a stained transverse section through a different type of leaf from **J1**.

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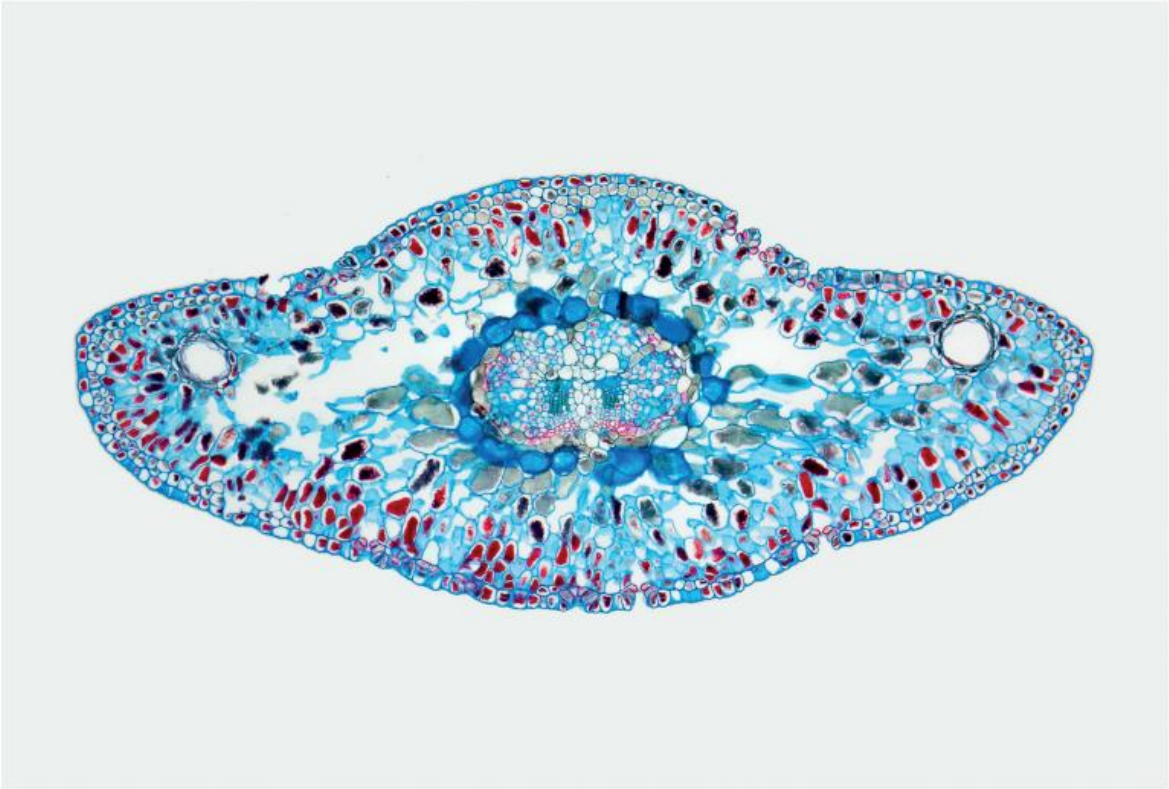

Fig. 2.1

Identify **three** observable **differences** between the leaf section on **J1** and the leaf section in Fig. 2.1.

Record these three observable differences in Table 2.1.

(c) Fig. 2.2 is the same photomicrograph as that in Fig. 2.1, with the line **X–Y** drawn across its width.

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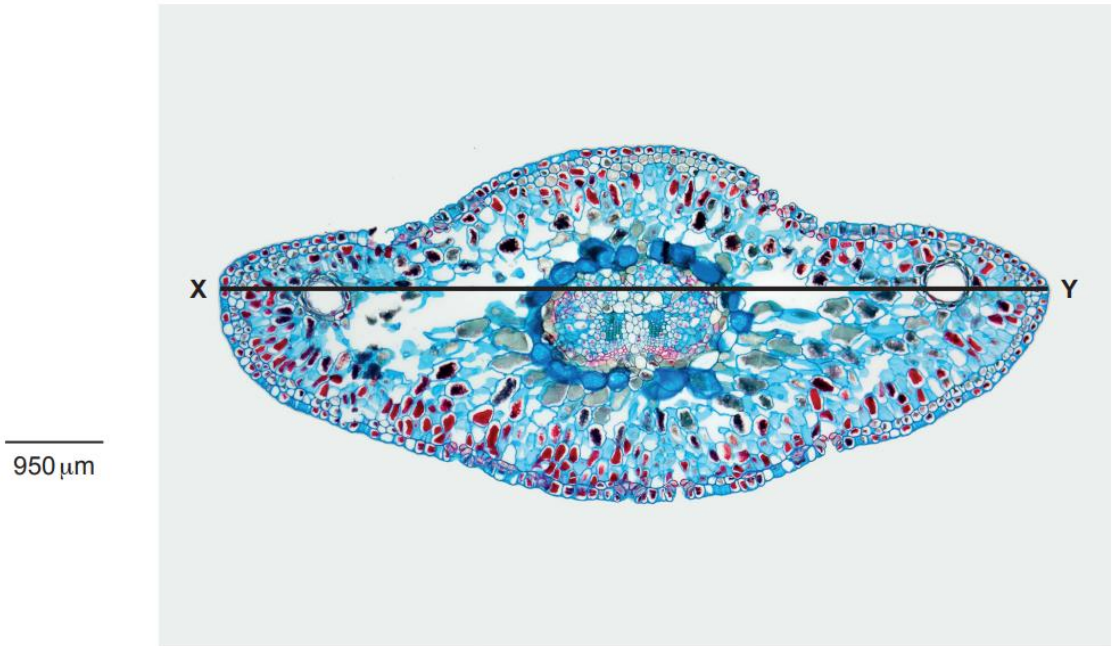

Fig. 2.2

In Fig. 2.2 the line **X–Y** is drawn across the width of the leaf. Use the line **X–Y** and the scale bar to calculate the actual width of the leaf.

Show your working.

actual width of leaf = ... [4]

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Question	Answer	Marks
2(b)	1. three correct differences *any **three** from e.g.:*	3

feature	J1	Fig. 2.1
vascular tissue	smaller in proportion to the whole leaf	larger in proportion to the whole leaf ;
air spaces	more	fewer ;
shape of leaf	triangle	elongated ;
stomata	fewer	more ;

2(c)	1. measures and records the correct length of the scale bar ; 2. shows the length of scale bar divided by 950 ; 3. shows the length of line **X**–**Y** divided by the answer to mp2 ; 4. records the correct width of the leaf <u>and</u> units ;	4

(b) Fig. 2.1 is a photomicrograph of a stained transverse section through a root of a different type of plant.

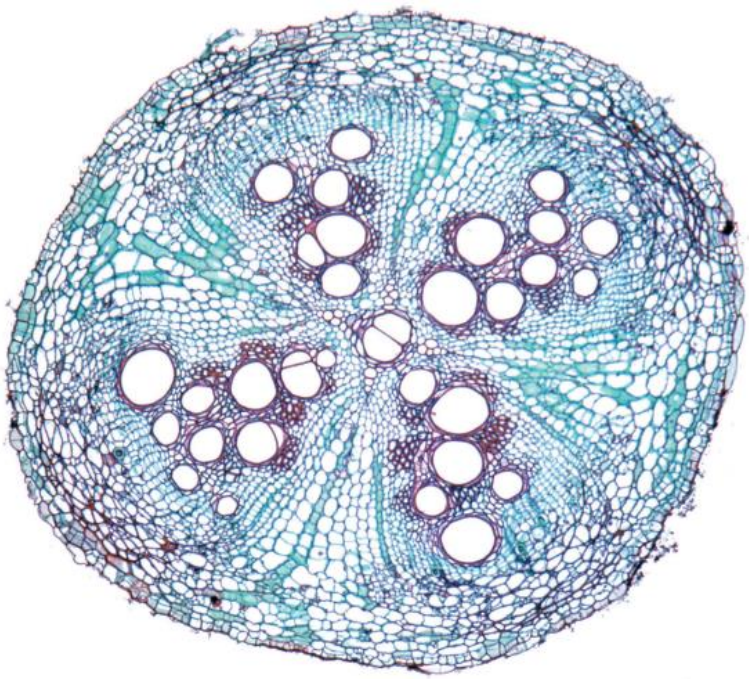

Fig. 2.1

Identify **three** observable differences, other than size and colour, between the root section on **M1** and the root section shown in Fig. 2.1.

Record **three** observable differences in Table 2.1.

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(c) Fig. 2.2 is the same photomicrograph as that in Fig. 2.1, with the line **X–Y** drawn across its width.

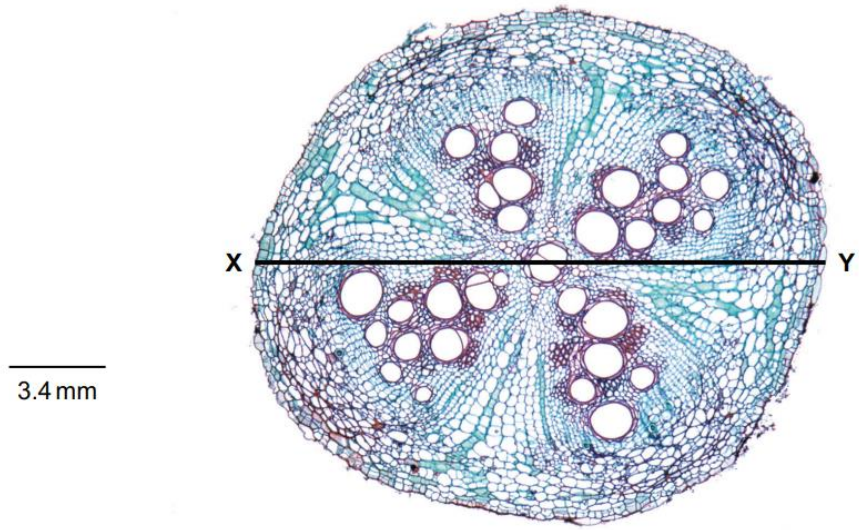

Fig. 2.2

(i) In Fig. 2.2 the line **X–Y** is drawn across the diameter of the root section.

Use the line **X–Y** and the scale bar to calculate the actual diameter of the root section.

Show your working and use appropriate units.

actual diameter of the root section = ... [3]

(ii) Calculate the area of the root section in Fig. 2.2, using the actual diameter from **(c)(i)** and the equation:

$$\text{area} = \pi r^2$$

Show your working and use appropriate units.

area of root section = ... [2]

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(iii) Suggest why the answer to **(c)(ii)** is an estimate of the area of the root section shown in Fig. 2.2 rather than the actual area.

.....

..... [1]

(iv) Suggest how a more accurate estimate of the area of the root section shown in Fig. 2.2 could be made.

.....

..... [1]

	3 label line and label to one cell wall ;	
2(b)	records only differences ; *any **three** correct differences from e.g.:*	**4**

feature	M1	Fig. 2.1.
epidermis	thinner	thicker ;
cortex	wider	narrower ;
endodermis	present	absent ;
central tissue	parenchyma cells	xylem vessels ;

Question	Answer	Marks
2(c)(i)	1 correct measurement of the scale bar and correct measurement of the line **X–Y** ; 2 to find the magnification, shows the length of the scale bar divided by 3.4 and shows the length of the line **X–Y** divided by the figure for the magnification ; 3 correct answer with the appropriate units ;	**3**
2(c)(ii)	shows the diameter of the root divided by 2 ; records the answer to area in μm^2 or mm^2 or cm^2 ;	**2**
2(c)(iii)	the root section is not a true circle /AW ;	**1**
2(c)(iv)	take more measurements of the diameter at different points and calculate the mean ;	**1**

2(b)	*any **three** from:*	**3**

feature	slide J1	Fig. 2.2	
number of vascular bundles	many	few	;
position of vascular bundles	peripheral	central	;
vascular bundles	joined	separate	;
air spaces	absent	present	;
sclereids / AW	absent	present	;
AVP	described	described	;

2(c)(i)	1 records correct length of five air spaces and units ; 2 shows addition of five measurements and division by five ;	**2**
2(c)(ii)	1 shows division by magnification (×48) ; 2 correct numerical answer matched with appropriate units ;	**2**

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