Tree trunks - general facts and information

The structure of a tree trunk

1. The outer bark protects the tree from extreme temperatures, bad weather, insects and fungi.
2. The phloem (bast) is also called the inner bark. It conveys the food-bearing sap developed in the leaves down to the various parts of the tree.
3. The cambium is a thin layer of cells, which produce phloem on one side and xylem (sapwood) on the other.
4. Sapwood is the living wood in the tree through which the raw sap rises from the roots to the leaves.
5. The heartwood consists of old cells. This is the dead part of the tree that nevertheless provides structural strength.
6. The pith is the central core of the tree (missing in many species).

In areas where there are pronounced seasons, tree form new cells, arranged in concentric circles called annual rings or annual growth rings. These annual rings show the amount of wood produced during one growing season. Rings are made up of a light and a dark band. At first, the cambium produces numerous large cells with thin walls that form the springwood (earlywood). If you look at a cross section of a tree, this is the light-coloured band. The function of springwood is to help the transport of water to the buds. Then, towards the end of the summer, growth slows down. The cells manufactured at this time of year are small, with thick walls. They form the summerwood (latewood) which appears as a darker band on the tree cross section. This wood is primarily for support and strength.

The darker wood is not formed in winter, as some people believe, because the cambium is completely inactive in the winter.

The following year, a new two-part ring is added. The older rings are closest to the centre of the tree. The tree grows in diameter because it manufactures new cells around its circumference, not because the old cells get larger.

The old annual rings form the heartwood of inactive cells: this is the dead part of the tree. The live portion includes only the most recent rings. Depending on the tree’s age and species, this portion is 1.5 to 7.5 cm wide. The dead wood is the largest part of the tree. Often, it takes on a darker colour.

Rings are narrower in years of low rainfall.

The three main things we can tell from tree rings are

- age of the tree
- clues to the growth of the tree and factors affecting it e.g. reaction wood, fungal attack, where branches grew (knots), site conditions
- past weather patterns, particularly rainfall.
**Bark facts**

- The bark is essential for protecting the tree against animals, fungi, disease, and from drying out.
- For most trees, when the bark is damaged, it allows a way for fungi and disease to get into the tree, affecting the health of the tree. Tree sap will ooze out of the cut and harden in an attempt to seal the damaged area. However, if the bark is stripped off all around the tree, most species of tree will die.
- Cork oak trees can survive the outer bark being stripped halfway around the trunk as it will regenerate.
- The Wellingtonia, or giant redwood, has spongy, fibrous bark that can be up to 30cm thick. It’s fireproof - protecting the tree from forest fires.
- The bark of many young trees is fairly smooth – it develops cracks as it grows older.
- The horizontal dashes seen in birch bark are called lenticels. They are pores that allow gases from the air to reach the wood beneath. All plants take in gases through their stems / trunks as well as their leaves. You may notice that birch bark peels off naturally. When the lenticels become blocked with algae or pollution, fresh bark is grown beneath, allowing the old bark to peel away, cleaning the trunk.

**Trunk facts**

- The centre of the trunk is called heartwood. It is very strong and enables the tree to grow tall, supporting the weight and spread of branches. This gives the tree an advantage as it gains good access to sunlight, shading out the ground plants below.
- Each year the girth of a tree increases, a new ring grows just under the bark, and this is necessary to support the extra height and spread of longer / new branches.
- The trunk also houses the transport network of the tree. There are two different types of tubes running up the length of the trunk - phloem that carry food-bearing sap, and xylem that carry the water and minerals from the roots up to the leaves.
- A mature oak tree can absorb 50 gallons of water in a day - that’s the equivalent of 227 litres, or 689 cans of lemonade! On a hot day it can be more than this.
- The tallest tree in the world (and therefore the longest trunk) is called 'Hyperion' - a coastal redwood 115.5m high.
- The type of tree with the largest trunk (the greatest volume of wood) is called 'General Sherman' - a giant redwood or wellingtonia.
Trunk explorer

1. Bark that feels

<table>
<thead>
<tr>
<th>Texture</th>
<th>Name of tree</th>
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</thead>
<tbody>
<tr>
<td>Smooth</td>
<td></td>
</tr>
<tr>
<td>Rough</td>
<td></td>
</tr>
<tr>
<td>Silky</td>
<td></td>
</tr>
<tr>
<td>Prickly</td>
<td></td>
</tr>
</tbody>
</table>

2. Bark patterns

- dashes
- spotty
- diagonal stripes
- jigsaw

3. Find bark that matches these colours

4. Damaged bark low down on the trunk - circle which animals may have caused the damage

5. Damaged bark high up on the trunk - circle which animals may have caused the damage

6. Sticky oozing sap
   (the tree is trying to protect itself because it has been damaged)

7. Peeling bark
   (the tree is cleaning itself where the bark's pores have been blocked by algae or pollution)
8. Things growing on the bark

- green furry moss
- feathery lichens
- fungi

9. Signs of things living in the trunk

- round woodpecker hole
- larger hollow for an owl
- loose bark where bats can roost

10. A trunk you can reach your arms around

11. A trunk that needs more than 3 people to reach around it

12. A trunk that smells good!
Bark casts and bark books
*recording diversity through clay and plasticine imprints and rubbings*

These activities will give your students the opportunity to make careful observations of the bark as well as learn to use bark to classify and identify trees. Winter is an excellent time of year to do this activity as the barks of many trees are very prominent at this time of year.

**Bark casts**

*Materials*
- modelling clay
- plaster-of-Paris
- base board
- 42cm card strip stapled into a ring about 2 inches high
- tree ID guides with bark patterns shown for different species

*Method*
1. Prepare by flattening out a stick of modelling clay or plasticine so that it forms a rectangle about half an inch thick.
2. Press the flattened clay hard into the bark of a tree. (Make sure that students push on the back of the clay as hard as they can.)
3. Carefully peel the clay off the bark.
4. Place the card collar over the clay and push down - this will stop the plaster of Paris from oozing out.
5. Mix plaster-of-Paris and pour into the bowl. Let it set. When hard remove clay or plasticine.

*Questions*
- Have students group the casts according to similarities and explain why they grouped them the way they did. See if the students can identify individual species from their bark cast patterns.
- Discuss with students the importance of making careful observations. You may want to have the students paint the casts to make them look like the bark. Be sure that they try to paint their casts match the bark of the tree - not just paint it brown.

**Bark books**

Provide the group with a selection of papers and crayons. Demonstrate how to take a rubbing and give them time to experiment and discover how to achieve a good print.
Invite them to collect rubbings of a variety of trees to make into a bark book back at school. Remind them to record the name of each tree.
Story of a tree’s life
examining tree rings to tell the story of how a tree grows

Dendrochronology is the dating of past events (such as climatic changes) through the study of tree ring growth. A tree’s growth can be affected by rainfall, sunlight levels, wind, temperature, soil properties, snow accumulation and competition from other trees.

Look for a tree stump or fallen trunk and examine the rings. What can you find out about the tree’s life?

Each year a tree grows a new ring just beneath the bark. Each ring is made up of two bands:
• a light band (the quick growth of spring)
• a darker band (the slower growth of late summer)

Not every annual ring is the same:
• In warmer, wetter years, trees grow well so the ring will be thicker
• In colder, drier years, trees do not grow so well so the ring will be thinner.

• If the rings are narrow on one side of a tree with wide rings on the other, the tree was either crowded on the side of the tree where the rings are narrow or exposed to the wind.
• The side with wider rings shows the tree had more space to grow or was sheltered from strong winds.
Ancients of the wood
(using tree girth to calculate the age of trees)

Foresters measure a tree’s girth, or circumference in order to calculate its approximate age, the volume of timber in the tree and even how much carbon is stored in the wood.

Find an oak, Scots pine, yew or horse chestnut tree to measure

Method 1

1. How many of your hand spans does it take to go around the trunk?

   [Hand spans]

2. Using a ruler, measure how wide your hand span is.

   [cms]

3. Using your hand span measurements, estimate how big the girth of the tree is.

   [ ] × [ ] = [ ]

In Europe, Britain, Canada and Australia tree trunk girth is measured at a fixed height of 1.3m above the ground - a point called Breast Height.
Method 2

4. Using a tape measure, measure the girth of the tree at breast height.

5. Does this measurement differ from your hand span estimate?

6. Can you think of any reasons why?

You can use the girth of a tree to work out its approximate age. Different types of tree grow at different rates. The table below shows the average growth rate of a selection of trees, how much the girth increases each year.

You can find out the age of the tree by dividing the girth by the growth rate.

<table>
<thead>
<tr>
<th>Type of tree</th>
<th>Average trunk growth rate (girth) per year (cms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sycamore</td>
<td>2.5</td>
</tr>
<tr>
<td>English Oak</td>
<td>1.5</td>
</tr>
<tr>
<td>Cedar of Lebanon, London Plane, Douglas Fir</td>
<td>7</td>
</tr>
<tr>
<td>Scots Pine, Horse Chestnut, Common Lime</td>
<td>1</td>
</tr>
<tr>
<td>Yew</td>
<td>0.7</td>
</tr>
</tbody>
</table>

7. Using the table work out the girth of a 100-year old Cedar of Lebanon tree.

8. Using the table work out how old a Common Lime with a girth of 135cm would be. Is it older or younger than a Sycamore with a girth of 315cm?

9. Now use the table to work out the age of your tree.
**Sun seekers**  
*(measuring tree height in a variety of ways)*

There are several different ways to measure the approximate height of a tree.  
Try each of the methods for the same tree and see if you arrive at similar answers.  
Look for a tree that stands separate from the rest as you will need the space around it to help you measure.

**Resources**
- Calculator
- Tape measure
- Ruler or fairly straight stick
- Clinometer

**Method 1**  
Working as a group, estimate the height of your tree as follows.

(a) First measure the height of one person.  
(b) Get that person to stand straight against the tree while the rest of the group stands at a distance and estimates how many “heights” of that person make up the tree height.  
(c) To calculate the height of the tree, multiply the height of the person (a) by the number of person heights it takes to make the height of the tree (b).
Method 2
1. Working in pairs, have your partner stand at the base of the tree while you back away from the tree, holding a ruler or stick in front of you in a vertical position. Keep your arm straight.
2. Stop when the tree and the ruler or stick appear to be the same size. (Close one eye to help you line it up.)
3. Turn your wrist so that the ruler looks level to the ground and is in a horizontal position, keeping your arm straight.
4. Now get your partner walk to the spot that you see as the top of the ruler. Be sure the base of the ruler is kept at the base of the tree.
5. Finally measure the distance between your partner and the tree - this is the tree’s height.
Method 3: Using a clinometer

Making a simple clinometer

You will need:

- A square piece of card
- A drinking straw
- A length of string
- Sellotape
- A weight (such as a washer or nut)

1. Fold the card to form a triangle.

Since the paper was square, an isosceles triangle will be formed – 2 sides of equal length, a 90 degree angle and two 45 degree angles.

2. Tape the drinking straw along the long edge of the triangle. The straw will be used as a sight.

3. At the upper end of the long fold attach the string. Tie the weight to the other end of the string, making it long enough so that the weight dangles a few inches below the corner of the triangle (see diagram). Held as shown in the diagram, the student will look up through the straw.

Using your clinometer (in pairs)

1. One student looks up the straw to sight the top of the tree, while the other student guides and tells them when the string is hanging straight down (i.e. when the string is vertical or parallel to the edge of the card).

2. When the student sighting through the clinometer can see the top of the tree with the string hanging straight down they are as far away from the tree as the tree is high. They can now simply measure the distance from where they are to the base of the tree (Remember to add on the height from the student’s eyes to the ground!)

Using your three answers work out the average height of the tree.
Carbon calculator
(using girth to calculate how much carbon a tree stores)

Activity: Use a calculator, a tape measure and a nearby tree to measure how much carbon is stored inside.

Trees take in carbon dioxide from the atmosphere and store it as carbon in their trunk, roots and leaves. They can help us to reduce climate change.

Follow the steps below to calculate the amount of carbon stored in a tree.

Approximately half of the dry weight of a tree is carbon. Therefore to work out how much carbon your tree is storing, we must first work out its dry weight.

You can also work out how much carbon dioxide was absorbed from the atmosphere to create that carbon store.

1. To calculate dry weight first of all you must use the tape measure to measure the circumference of the tree. Give the tree a big hug! The circumference is the distance all the way around the trunk at about chest height.

2. When you've measured the circumference look at the table below to convert this to dry weight. Use the nearest value in the table to the one you have calculated.

<table>
<thead>
<tr>
<th>Circumference (cm)</th>
<th>Dry weight (kg)</th>
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<tbody>
<tr>
<td>50</td>
<td>106</td>
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<tr>
<td>100</td>
<td>668</td>
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<tr>
<td>150</td>
<td>1,964</td>
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<tr>
<td>200</td>
<td>4,221</td>
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<tr>
<td>225</td>
<td>5,771</td>
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<tr>
<td>250</td>
<td>7,641</td>
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<tr>
<td>275</td>
<td>9,842</td>
</tr>
<tr>
<td>300</td>
<td>12,410</td>
</tr>
<tr>
<td>325</td>
<td>15,350</td>
</tr>
<tr>
<td>350</td>
<td>18,700</td>
</tr>
<tr>
<td>400</td>
<td>26,674</td>
</tr>
</tbody>
</table>

3. Because half of the dry weight of the tree is carbon, you then need to divide your answer for the dry weight by 2. This tells you how much carbon is stored in the tree.

One step further...

4. You can calculate how much carbon dioxide was absorbed to create this carbon store by multiplying your figure for carbon by 3.67.

Example
The circumference of a tree is 150cm. Looking at the table this means its dry weight is about 1964kg. Dividing this by 2 tells us that the tree is storing 982kg of carbon. Multiplying this figure by 3.67 tells us that the tree has absorbed 3604kg of carbon dioxide throughout its lifetime.
Growing Green Activity Pack – The trunk

**Tree cubes**
*(measuring weight and exploring density)*

*You will need to ask for the set of tree cubes when you book*

1. Using the set of weighing scales, weigh each wooden cube and write your answer in the table below.

<table>
<thead>
<tr>
<th>Tree cube</th>
<th>Weight (grams)</th>
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<tbody>
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</tbody>
</table>

As all the cubes are the same size, we can compare their weights.

* • Which is the heaviest wood?*
* • Which is the lightest wood?*

2. Below is a table that shows the *density* of wood from different trees. The density of each cube depends on the amount of air spaces its wood contains.

The more air spaces the wood contains the lighter and less dense it is. The weight of the wood increases as density increases.

<table>
<thead>
<tr>
<th>Tree cube</th>
<th>Density (Kg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oak</td>
<td>725</td>
</tr>
<tr>
<td>Yew</td>
<td>675</td>
</tr>
<tr>
<td>Scots Pine</td>
<td>510</td>
</tr>
<tr>
<td>Ash</td>
<td>530</td>
</tr>
<tr>
<td>Holm oak</td>
<td>770</td>
</tr>
<tr>
<td>Sitka spruce</td>
<td>440</td>
</tr>
<tr>
<td>Douglas Fir</td>
<td>430</td>
</tr>
<tr>
<td>Beech</td>
<td>725</td>
</tr>
</tbody>
</table>

* • Which tree has the densest wood?*
* • Which wood cube contains the most air?*
* • Which wood cube contains the least air?*

3. Wood that contains less air tends to be stronger than wood that contains lots of air. Using this information can you rank the cubes from weakest to strongest?