

InsideTrees Module 1: Introduction to Biomaterials and Characteristics of Trees

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Discussion Questions

- How is energy produced? From renewable or nonrenewable resources?
- What are future challenges for continued fossil fuel consumption?
- How has consumer perception changed concerning energy and/or resource production in recent years?
- What are alternative resources for energy and/or materials?



Tesla: <https://www.autoblog.com/tesla/model+s/>



Building: <https://cfpa-e.eu/the-worlds-tallest-and-safest-timber-building/>



Kettle chips:
<https://www.walmart.com/ip/Kettle-Brand-Potato-Chips-Sea-Salt-and-Vinegar-Kettle-Chips-8-5-oz/10818721>

Watch and learn from this U.S. Department of Energy short video on YouTube

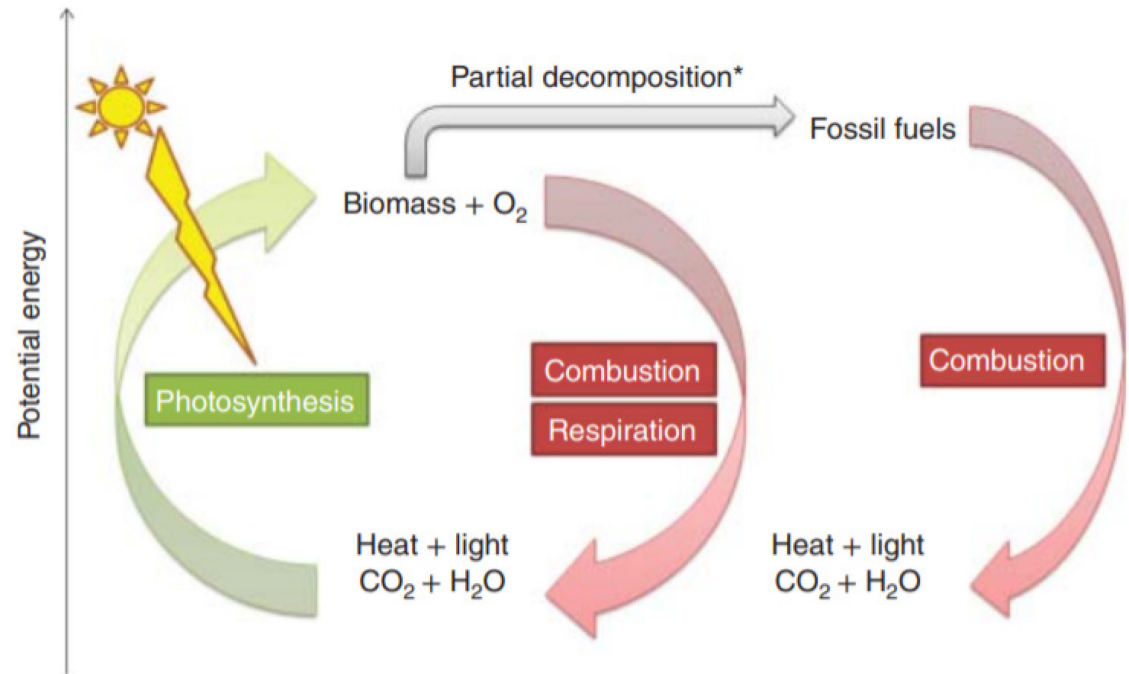


<http://www.youtube.com/watch?v=-ck3FYVNI6s>

Biomass & Fossil Fuels

Define biomass or biomaterials

How are biomaterials more beneficial than fossil fuel derived materials? What are challenges to using biomaterials vs fossil fuels?



Content Introduction: Go through [Biomass Jeopardy](#) game to review definitions

Sustainable Biomaterials: What are they?

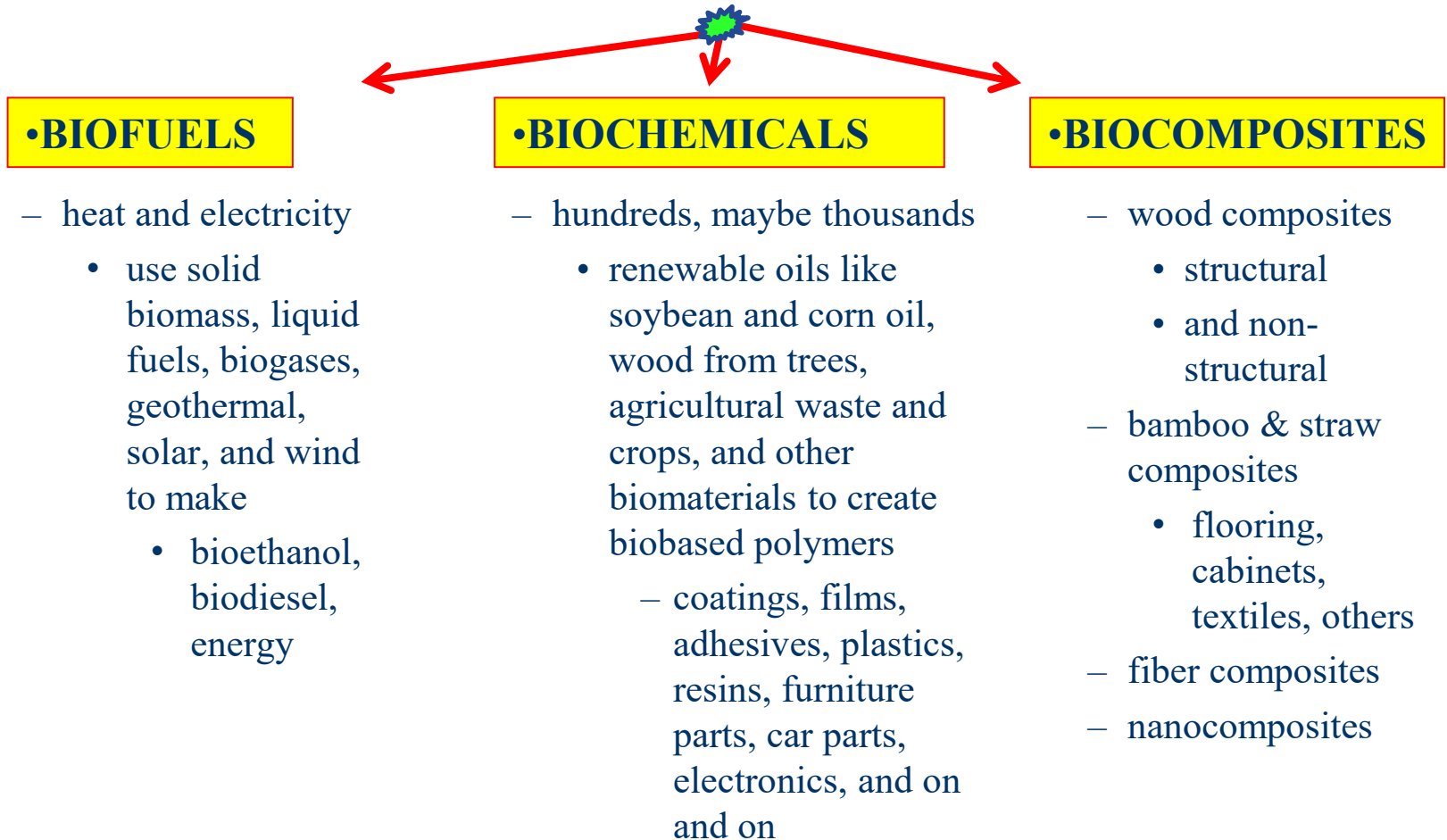
Raw Materials:

- Materials used in manufacturing of products
- Wood, steel, aluminum, concrete, and many others

Biomaterials:

- Natural, renewable materials
- Bamboo, cotton, hemp, **wood**, and others such as waste materials like corn cobs or wheat straw
- Used as biofuels, natural chemicals, and biocomposites
- Made from sustainable practices that promote ecological, human, and economic health and prosperity

How are these materials used?



GROUP ACTIVITY

Biomaterial Investigation

INSTRUCTIONS:

The instructor will divide the class into equal groups of two or three persons per group. The group will have ten minutes to list as many biomaterials that they use in their daily lives. The groups will list the biomaterials on the following slide. Additionally, the students need to list the raw material from which the biomaterial was derived. The groups have open access to additional resources (Internet, etc). The goal of the activity is to come up with as many unique biomaterials as possible within the time allowed.

Example:

Litter Box - Wood Pellets (Trees)



Pellets: [https://media.tractorsupply.com/is/image/TractorSupplyCompany/3195163?\\$456\\$](https://media.tractorsupply.com/is/image/TractorSupplyCompany/3195163?456)

Biomaterials (EXAMPLE of listing sheet for groups)

Group 1

- | <input type="radio"/> Biomaterial | <input type="radio"/> Raw Material |
|-----------------------------------|------------------------------------|
| 1. _____ | 1. _____ |
| 2. _____ | 2. _____ |
| 3. _____ | 3. _____ |
| 4. _____ | 4. _____ |
| 5. _____ | 5. _____ |
| 6. _____ | 6. _____ |
| 7. _____ | 7. _____ |
| 8. _____ | 8. _____ |
| 9. _____ | 9. _____ |
| 10. _____ | 10. _____ |
| 11. _____ | 11. _____ |
| 12. _____ | 12. _____ |
| 13. _____ | 13. _____ |
| 14. _____ | 14. _____ |
| 15. _____ | 15. _____ |

Group 2

- | <input type="radio"/> Biomaterial | <input type="radio"/> Raw Material |
|-----------------------------------|------------------------------------|
| 1. _____ | 1. _____ |
| 2. _____ | 2. _____ |
| 3. _____ | 3. _____ |
| 4. _____ | 4. _____ |
| 5. _____ | 5. _____ |
| 6. _____ | 6. _____ |
| 7. _____ | 7. _____ |
| 8. _____ | 8. _____ |
| 9. _____ | 9. _____ |
| 10. _____ | 10. _____ |
| 11. _____ | 11. _____ |
| 12. _____ | 12. _____ |
| 13. _____ | 13. _____ |
| 14. _____ | 14. _____ |
| 15. _____ | 15. _____ |

REFLECT:

Looking at the lists of biomaterials just created and the associated raw material from which the biomaterials were derived, **what was the most commonly used raw material?**

HINT: It's *inside trees*

REFLECT:

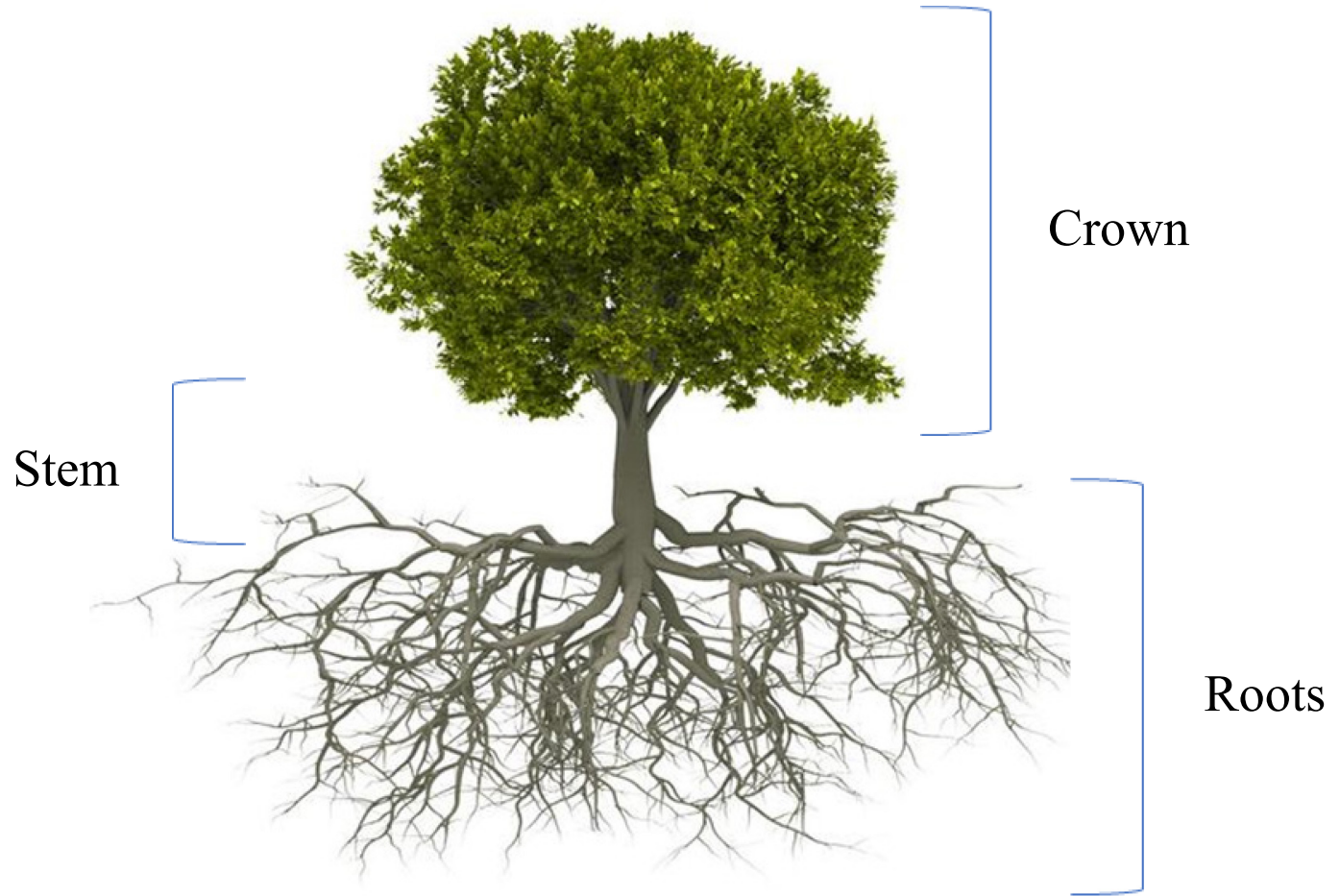
WOOD - WHY?

Trees are a natural, renewable resource and with proper management, forests can provide thousands of products while **also** providing important environmental functions



DISCIPLINARY CONTENT

Characteristics of a Tree



Stem

Crown

Roots



Discussion Question:

What are the main functions of each part of the tree?

Answer: Root System, Crown, and Stem



Root System:

1. **Absorbs and conducts** water and minerals from the surrounding soil to other parts of the tree
2. **Anchors** the aboveground tree stem and crown
3. **Stores** water and minerals during dormant months

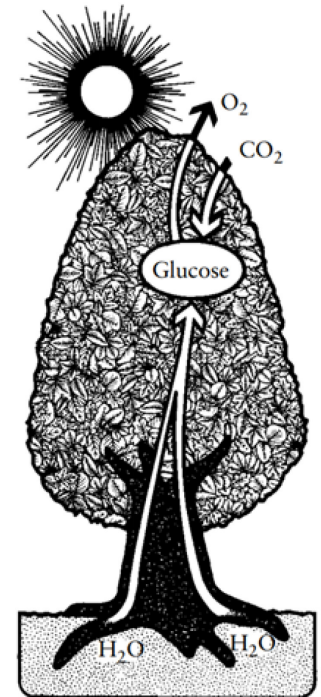
Crown:

Provides energy for the tree through *photosynthesis*

Photosynthesis is “the process by which water and carbon dioxide are combined in the leaves of green plants, employing the energy from the sunlight to form glucose and other simple sugars, with oxygen as a by-product”

Sugar is used to produce new leaves, shoots, and wood, stored for later utilization, and consumed through respiration.

Sugar is transported throughout the tree in the form of sap, which contains various sugars, water, and growth regulators (hormones).





Stem:

- 1. Conducts** water and minerals from the roots to the crown and sugar from the crown to the roots
- 2. Provides mechanical support**
- 3. Protects** the tree from diseases, insects, and fire



Discussion Question:

How are water and nutrients transported throughout the tree?

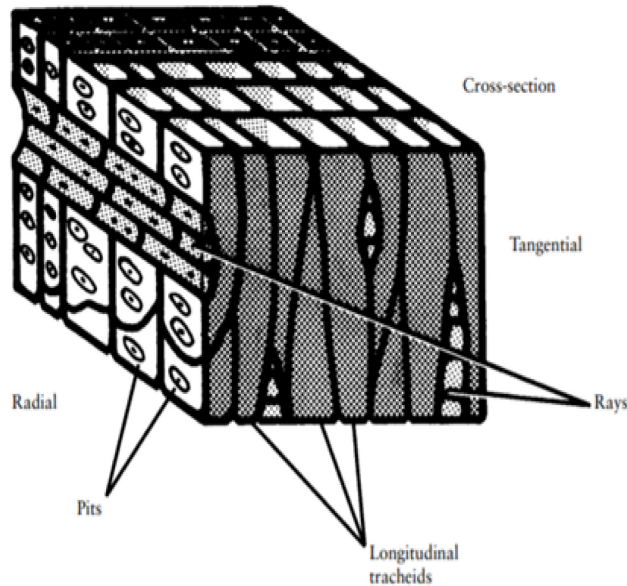


Discussion Question:

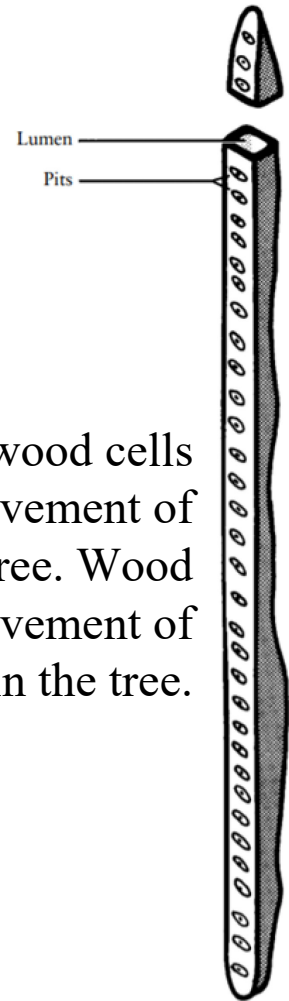
Answer: As sap (sugars, water, hormones, nutrients, and minerals) through **wood and inner bark cells**

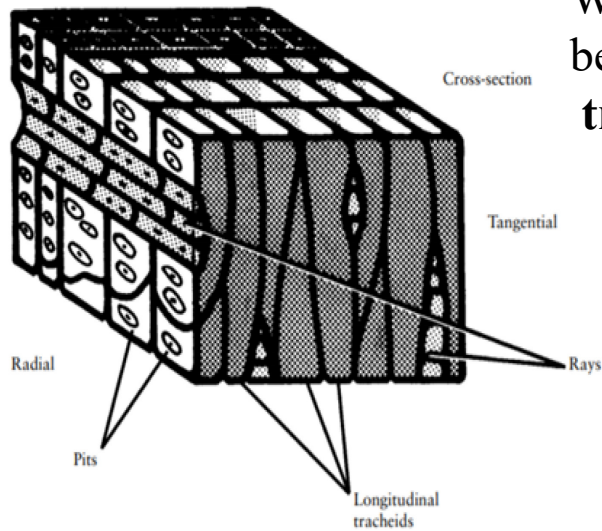
Wood Cells

The majority of wood cells are long, slender tubes composed of a hollow center (lumen), closed at the ends, and perforated with openings known as pits on the sidewalls.

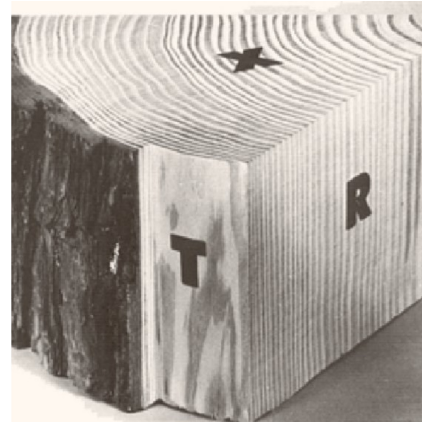


The lumens and pits in the wood cells allow for *vertical* movement of substances throughout the tree. Wood rays allow for *horizontal* movement of substances within the tree.





Wood cells are arranged such that three different surfaces can be identified –
transverse (cross section), **radial**, and **tangential**.

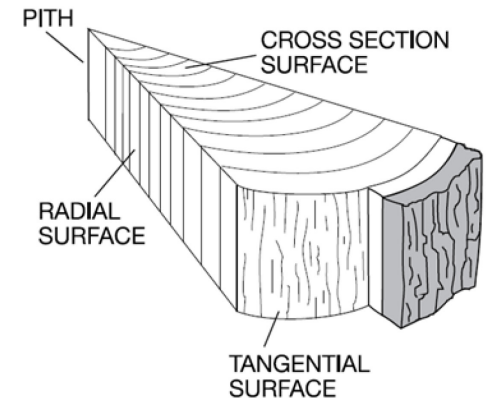


https://www.researchgate.net/figure/Wood-sections-X-cross-section-R-radial-T-tangential-Wolfgang-Gard_fig2_270277437

Transverse (cross section) Surface – X
 formed by cutting a log across the tree stem

Radial Surface – R
 formed by cutting along the grain longitudinally parallel to a radius

Tangential Surface – T
 formed by cutting along the grain perpendicular to a radius, i.e., tangent to the growth rings



<https://tropicalwoods.weebly.com/wood-database.html>

DISCIPLINARY CONTENT

Tree Growth

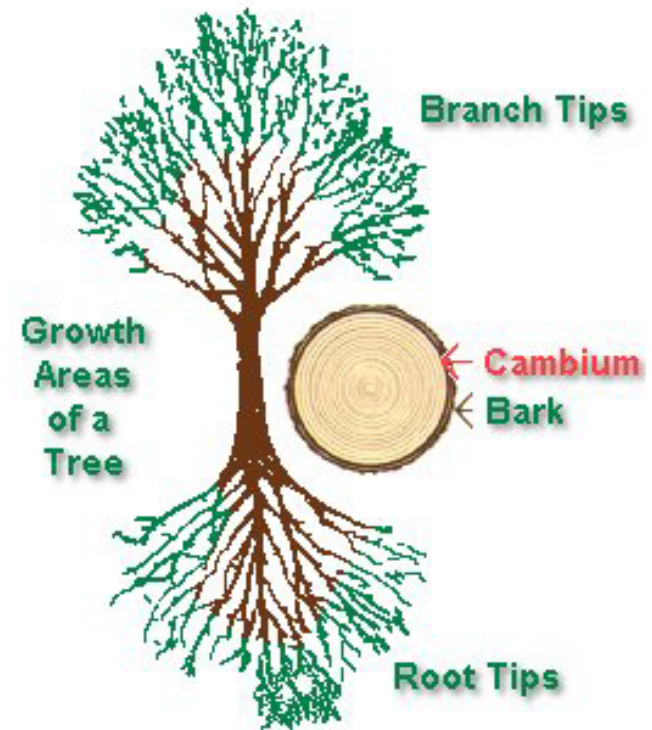
Discussion Question:

How do trees grow?

Answer: through meristematic growth regions

The tree stem and branches grow in diameter as new cells are added by growth regions beneath the bark.

Roots and branches grow in length as new cells are formed by growth regions at branch and root tips.



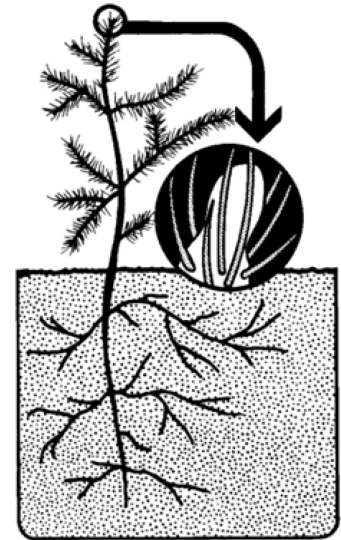
Shmulsky, R., & Jones, P. D. (2019). Forest Products and Wood Science An Introduction: Seventh Edition. John Wiley & Sons Ltd.

Meristematic Regions

Specialized regions in the tree where cells divide repeatedly to form new cells, responsible for tree growth – **Apical Meristem** and **Vascular Cambium**

Apical Meristem –

- meristematic zone at the apex of the main stem, branch, and root tips
- lengthens the stem due to cell formation and elongation
- responsible for tree height growth



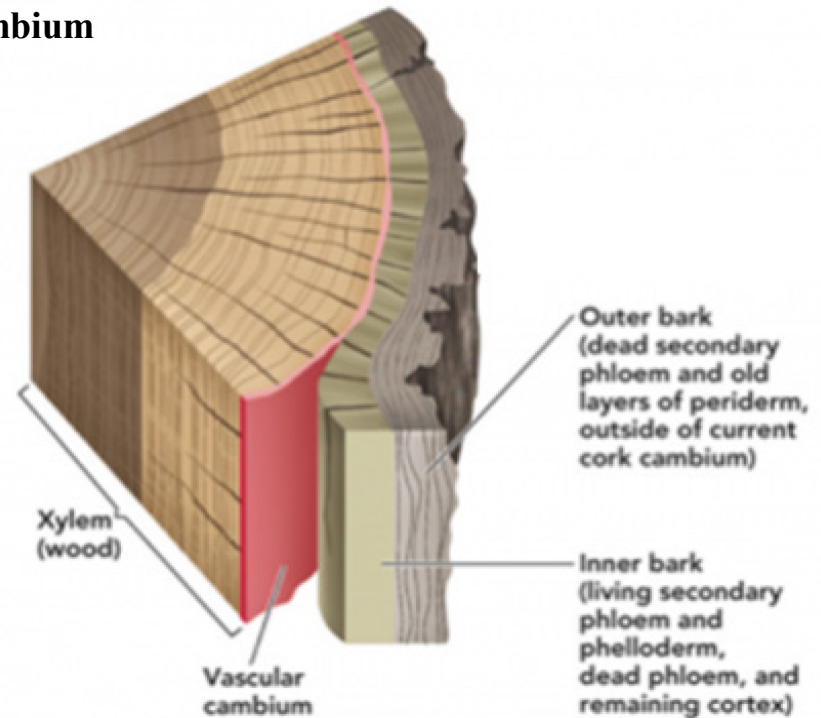
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Meristematic Regions

Specialized regions in the tree where cells divide repeatedly to form new cells, responsible for tree growth – **Apical Meristem** and **Vascular Cambium**

Vascular Cambium –

- growth region that sheaths the entire tree
- produces xylem cells to the inside (wood) and phloem cells to the outer side (inner bark)
- a season of growth results in diameter growth and a new continuous layer of wood for the tree stem



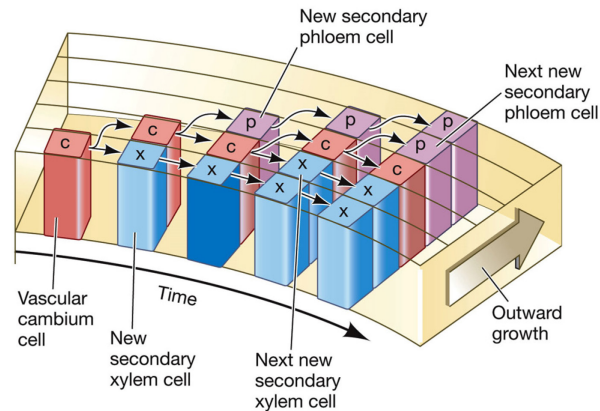
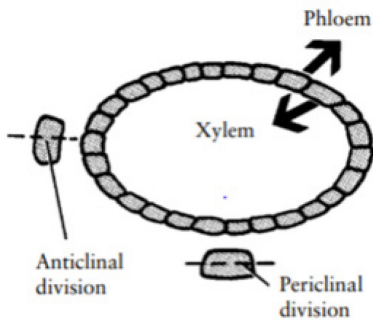
<https://www.plantscience4u.com/2015/06/what-is-bark.html>

Meristematic Regions

Specialized regions in the tree where cells divide repeatedly to form new cells, responsible for tree growth – **Apical Meristem** and **Vascular Cambium**

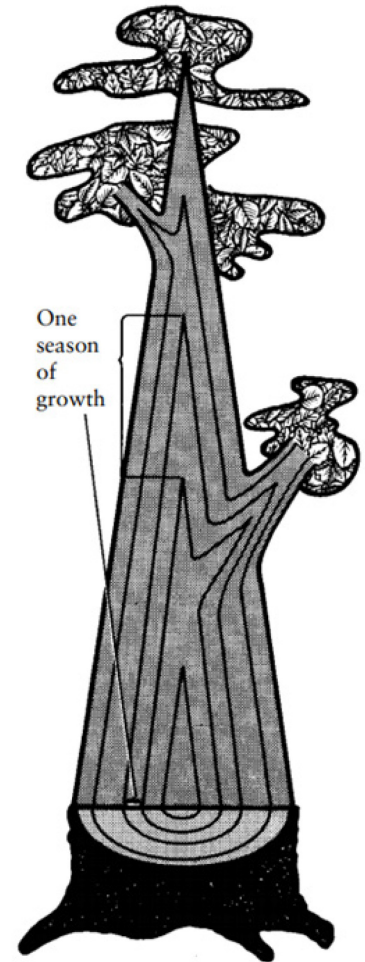
Vascular Cambium –

Responsible for increase in stem diameter (periclinal division) and circumference (anticlinal division)



LIFE 9e, Figure 34.17 (Part 2)

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Shmulsky, R., & Jones, P. D. (2019). Forest Products and Wood Science An Introduction: Seventh Edition. John Wiley & Sons Ltd.

Discussion Question:

If you were to tape a poster on a tree stem, how far up will the poster move as the tree grows?

Discussion Question:

Trick Question! The poster will not move!

Remember that tree height growth only occurs at branch tips due to the apical meristem.

SUMMARY REFLECTIONS

Biomass is an organic renewable energy and product source from agricultural and forest residues, energy crops like trees, and algae. Scientists are finding new, more efficient ways to convert biomass like wood into biofuels and bioproducts that can take the place of conventional fuels and products derived from nonrenewable sources.

Discussion Question:

What are future challenges and opportunities created through the utilization of biomass for energy and products?

SUMMARY REFLECTIONS

Trees and forest products are a natural renewable resource that are widely and increasingly used in our daily lives. In addition, trees play a vital role in regulating our environment by absorbing carbon dioxide.

Wood from trees can be harvested, used, recycled, regrown, and harvested again and again in a never-ending cycle. With proper management of our forests, we can enjoy thousands of products and still have plenty of trees for wildlife habitat, recreation, and aesthetic beauty for today and in the future.

Discussion Question:

What are some examples of environmental and human benefits from using wood from trees and other renewable sources for creation of biomass?