

## The trees in my neighbourhood

### Module 3 Trees and stress

#### Summary of module 3

Students discover the influence of the environment on tree development, and the diseases that can affect it. After identifying different stresses and establishing their relationship with tree physiology, students head outdoors to diagnose trees along the street. In a discussion session, they debate the question of whether the diseased trees should be cut down, treated or left on their own.

#### Cross-curricular competencies

- CCC1 - Use information
- CCC3 - Exercise critical judgment
- CCC9 - Communicate appropriately

#### Subject area competencies

- SAC1 - Seek answers or solutions to scientific or technological problems: define a problem, choose an investigation or design scenario, carry out the procedure, conduct an experiment, analyze the results or solution
- SAC2 - Make the most of knowledge of science and technology: understand how technical objects work, understand natural phenomena
- SAC3 - Communicate in the languages used in science and technology: participate in exchanging scientific and technological information, divulge scientific or technological knowledge or results, interpret and produce scientific and technological messages

#### Objectives

- Identify the relationships between the environment and tree growth
- Learn to diagnose the state of health of trees

#### Contents

- Diversity of life: habitat, physical and behavioural adaptation
- Life-sustaining processes: photosynthesis and respiration
- General characteristics of the Earth: water
- Geological and geophysical phenomena: water cycle

#### Classroom organization

- As a group, individually and in teams of 2 or 3 students
- Duration: one class session of 45 minutes, one session of 60 minutes outdoors and one class session of 30 minutes

### Sequence of activities for Module 3

- **Activity 1: *Trees under influence* – 45 minutes – in class**  
From ten illustrations, students learn to identify the stresses to which a tree can be subjected and find out about the phenomenon of tree decay. They fill out the **Experiment 1 worksheet** to consolidate their knowledge of the signs of environmental influences on the tree.
- **Activity 2: *The tree in its environment* – 60 minutes – outdoors**  
Students head outdoors to diagnose trees along the street. They note their observations on the **Experiment 2 worksheet** and consolidate what they have learned.
- **Activity 3: *The value of a tree* – 30 minutes – in class**  
After identifying diseased or damaged trees, students debate the fate of the diseased trees they observed (cut them down, treat them or do nothing).



### Summary

From ten illustrations, students learn to identify the stresses to which a tree can be subjected and find out about the phenomenon of tree decay. They fill out the **Experiment 1 worksheet** to consolidate their knowledge of the signs of environmental influences on the tree.

### Classroom organization

45 minutes in class – individually and as a group

### Material required

Worksheet title	Contents	Quantity/User
Visual aids 1 to 10	Illustrations of stressed trees	1 series - teacher
Concepts	Influence of the environment on trees and stress	1 teacher
Answer key 1	Answers to Experiment 1 worksheet	1 teacher
Experiment 1	Questionnaire on tree stress	1 per student

### Step-by-step procedures

- Remind students that while trees have an impact on the environment, the contrary is equally true. Introduce the concept of stress (see the **Concept worksheet** and the **Answer key 1 worksheet**). Distribute the **Experiment 1 worksheet** and answer **question 1**.
- Review the main principles of tree physiology (photosynthesis, evapotranspiration, respiration) using the **Concept worksheet**.
- Answer **question 2** of the **Experiment 1 worksheet**.
- Explain that stresses cause tree dieback, and define this phenomenon. Answer **question 3**.
- A tree weakened by a stress is more vulnerable to diseases. Explain that trees also have cavities (decay), although this is caused by fungi and not by bacteria, as is the case in humans. Explain that a tree defends itself by producing antifungal substances and a specialized scar tissue called callus tissue. Complete **questions 4 and 5** with the students.
- Introduce the concept of an entry point for decay: an injury or structural defect, a weak point through which fungi can penetrate the wood. Answer **question 6**.
- Present the ten illustrations of trees that have been subjected to a stress (**Visual aid worksheets 1 to 10**). Ask students whether these trees seem healthy and whether they observe signs that something is wrong. Start a debate on the possible sources of stresses and on which aspect of tree physiology or morphology these stresses can have an impact. For each image, fill out the chart in **question 7** of the **Experiment 1 worksheet**.
- In conclusion, summarize the concepts covered during the activity.

### Summary

Students head outdoors to diagnose trees along the street. They note their observations on the **Experiment 2 worksheet** and consolidate what they have learned.

### Classroom organization

60 minutes outdoors – in teams of 2 or 3 students

### Material required

Worksheet title	Contents	Quantity/User
Visual aids 1 to 10	Illustrations of stressed trees	1 series - teacher
Concepts	Influence of the environment on trees and stress	1 teacher
Answer key 2	Answers to Experiment 2 worksheet	1 teacher
Tool	Identification key (see Module 1)	1 teacher and 1 per team
Experiment 2	Observations of the stress of trees along the street	1 per team

### Preparation

45 minutes – prepare the route students will follow. Choose primarily trees showing signs of stress. Number the trees to be identified and observed (a dozen) by placing a numbered card at the base of each. Identify the genus and the stresses of each tree and note the answers.

### Step-by-step procedures

- Outdoors, divide the class into teams and explain the route to follow.
- Review the concept of tree stress by presenting the 10 **visual aid worksheets**. Distribute the **Experiment 2 worksheet** and the **Tool worksheet**.
- Ask students to identify the genus as well as apparent stresses of each trees, and to note this beside the appropriate tree number on their worksheets. Ask students to specify whether it is a mild or major stress.
- At the end of the activity, collect the worksheets and announce that the class will debate the fate of the diseased trees they observed (cut them down, treat them or not intervene) – Activity 3.

### Summary

Students use the observations and data collected in Activities 1 and 2. They calculate the average diameter of trees, and then evaluate the quantity of carbon stored. By comparing the results obtained at the two locations studied, they realize the impact of trees on different environmental factors.

### Classroom organization

30 to 75 minutes in class – in teams of 4 or 5 students + 15-minute homework assignment

### Material required

Worksheet title	Contents	Quantity/User
Concepts	Influence of the environment	1 teacher
Answer key 2	Answers to Experiment 2 worksheet	1 teacher
Experiment 2	Observations of the stress of trees along the street - completed worksheet	1 per team

### Step-by-step procedures

- Divide the class up into the same teams and distribute the Experiment 2 worksheets they filled out in Activity 2. Summarize what transpired during Activity 2 outdoors.
- Assess the progress of each team and provide the correct answers, reviewing the strategy to be used. Review the concepts related to the consequences of each stress.
- Ask each team to sum up their ideas on the fate of the diseased trees they observed (cut them down, treat them or do nothing).
- Start a group discussion on the various answers and ask students to justify their views:  
>> *What grounds justify your choice?*
- In conclusion, talk about the value of trees (financial value, legacy, etc.) and the importance for arboriculturists (specialists of trees), landscape architects and others of diagnosing the state of health of trees.

**Image 1:** Tree with **dried and discoloured leaves** (observable sign) caused by **drought** (stress factor)





**Image 2:** Tree with fewer **leaves, some yellowed** (observable sign) caused by **atmospheric or urban pollution** (de-icing salt, carbon dioxide, dust, etc.) (stress factor)



**Images 3A and 3B:** Trees presenting **carpophores** (observable sign) caused by decay (stress factor)





**Image 4:** Tree with visible signs of damages (observable sign) caused by **wildlife**, in this case by a woodpecker (stress factor)



**Image 5:** Tree with **chewed leaves** (observable sign) caused by **insects** (stress factor)



**Image 6:** Trees with **chlorosis**, more or less pronounced discoloration of the leaves, due to a lack of chlorophyll necessary for photosynthesis (observable sign) caused by an **alkaline or toxic soil**, in which nutrients are not available to the plant (stress factor). Chlorophyll is the pigment that which gives leaves their green color.





**Image 7:** Tree with **leaves mottled with black or yellow spots** (observable sign) caused by a **disease** (stress factor).



This picture: Tar spot of maple

More information:

<http://www2.ville.montreal.qc.ca/jardin2/voirRavageurEN.do?idMaladie=49>

**Image 8:** Trees with broken branches (observable sign) caused by caused by **ice** or **lightning** (stress factor).





**Image 9:** Tree with a **gash in the wood** (observable sign) caused by a **mechanical injury** (stress factor)





**Image 10:** Tree with an **incomplete crown and/or leaning trunk** (observable sign) caused by **lack of space or light** (stress factor)



## The influence of the environment on trees

Different factors exert a stress on tree growth, sometimes hindering its development. Examples include sunscald, water stress, frost, atmospheric pollution, diseases and injuries.

Stresses disturb physiological processes in the tree, such as photosynthesis, respiration, evapotranspiration and absorption. They can lead to **dieback** of the tree, a process that weakens branches and stunts leaves, ultimately resulting in the death of the tree.

As dieback progresses, the tree is more sensitive to diseases, in particular to fungi that cause decay. Using enzymes, these microorganisms attack the wood and little by little dig a hole in the trunk, which we call **decay**. Often the most visible part of the fungus is its fruit, the **carpophore**. In response to an infection, the tree produces antifungal compounds. The compartmentalization of certain of its anatomical parts blocks the progression of the fungus. The entry point of a decay-causing fungus is usually an injury or a structural defect, a weak point through which fungi can penetrate the wood. The tree defends itself by producing a specialized scar tissue called **callus tissue**.

For landscape architects, it is very important to diagnose diseased trees before creating a plantation design. A tree surgeon or forest engineer is called in to identify which trees are diseased or damaged. A list is also made of those trees that have a structural defect such as a forked stem following an insect attack on the terminal bud, since they are more likely to break. This presents a danger for users and can constitute an entry point for a decay-causing fungus.

It is also important to consider the positive aspects of a tree, such as its heritage and ecological value. By evaluating the impact related to the state of health of the tree, to its value and to the project, a decision is made to treat or to cut down the tree.

## Some definitions

### Photosynthesis

This is the process through which plants use light to manufacture their food and produce energy reserves. This phenomenon relies on a complex molecule, chlorophyll. This pigment, which gives plants their green color, is mainly found in their leaves. Chlorophyll captures light energy and uses it to form carbohydrates from water and carbon dioxide. Photosynthesis also produces oxygen, which is released into the atmosphere.

### Respiration

All living beings (plants, animals and microorganisms) breathe. Respiration makes it possible to obtain energy from carbohydrates. This energy is necessary for living beings to grow, move and ensure all their vital functions. In plants, respiration is the inverse reaction

to photosynthesis. Plants consume oxygen (oxidation of sugars) and release water and carbon dioxide (CO<sub>2</sub>).

### **Evapotranspiration**

This is the phenomenon by which plants perspire (transpiration by evaporation). In this way, plants lose water as it evaporates into the air. The warmer the ambient temperature, the more this phenomenon accelerates. In trees, evapotranspiration occurs mainly from the leaves.

To learn more, visit the [Trees Inside Out](#) virtual exhibit

Last name, First name \_\_\_\_\_

**1. Define what stress is for trees.**

Stress is an environmental factor that prevents proper tree development.

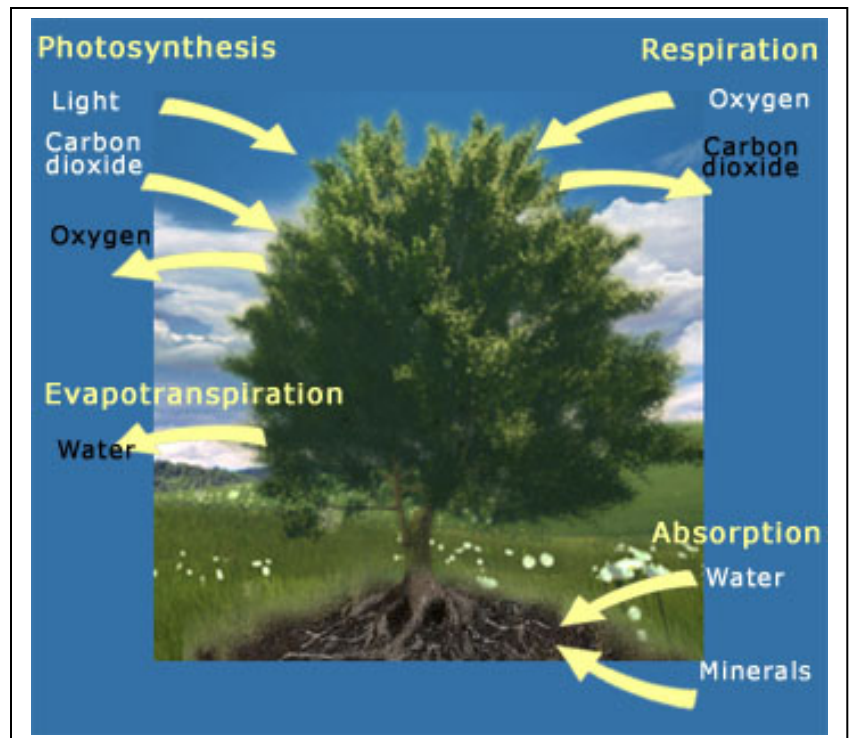
**2. Using the diagram below, name the elements that each of these mechanisms requires, in order to be able to contribute to tree growth**

Photosynthesis: oxygen, carbon dioxide, water, light

Respiration: oxygen, carbon dioxide

Absorption: water, mineral salts

Evapotranspiration: water

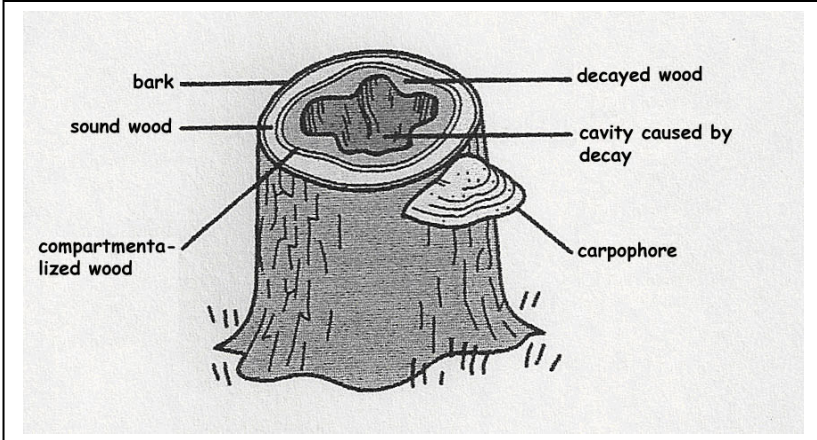


**3. Define dieback:**

Dieback is a weakening of a tree's branches and stunting of its leaves, caused by one or several stresses which may result in the death of the tree.



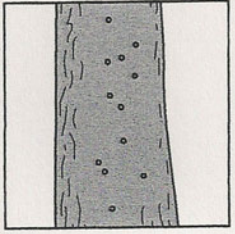
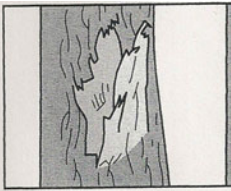

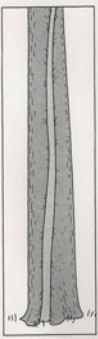
4. Complete the following diagram



5. What do we call the tissue a tree produces in response to decay?

The tissue produced in response to decay is called callus tissue.

6. Draw arrows to connect the decay entry points to their cause:

 <p>Holes</p>	<input type="checkbox"/> Axe
 <p>Mechanical injury</p>	<input type="checkbox"/> Birds
 <p>Forked stem</p>	<input type="checkbox"/> Frost
 <p>Frost crack</p>	<input type="checkbox"/> Destruction of the terminal bud

7. For each image presented to you, fill in the following chart, choosing from the list of possible answers:

Image n°	Signs observable on the tree	Stress	Consequences
1	<u>Dried and discoloured leaves or needles</u>	Drought	<u>The tree lacked water.</u>
2	Fewer leaves, some yellowed.	<u>Atmospheric or urban pollution</u>	The leaves are covered with dust, which prevents the tree from absorbing CO <sub>2</sub> .
3	Carpophore	<u>Decay</u>	<u>Decay destroys the wood.</u>
4	<u>Damaged trunk</u>	Animals	Wounds may be an entry point for diseases.
5	Chewed leaves	<u>Insects</u>	<u>The tree has fewer leaf surface to carry out photosynthesis.</u>
6	<u>Discoloured leaves along the veins</u>	Alkaline or toxic soil	Roots are not able to absorb nutritive elements - chlorophyll is not produced.
7	<u>Spots on leaves (mottled leaves)</u>	Diseases	<u>The leaves may fall prematurely, the tree may be weak, and it may have problems to produce new leaves.</u>
8	Broken branches, incomplete crown broken trunk	<u>Ice or lightning</u>	Wounds may be an entry point for diseases. The tree a structural problems. The tree may die.
9	<u>Gash in the wood</u>	Mechanical injury	<u>The wound is an entry point for decay.</u>
10	Incomplete crown, leaning trunk	<u>Lack of space or light</u>	The tree experiences growth problems.

Last names, First names \_\_\_\_\_

Using the chart below as a guide, note the stress(es) that can be observed on each tree (if any are present), after having identified its genus:

Signs observable on the tree	Stress
Dried and discoloured leaves	Drought
Large leaves, some yellowed	Atmospheric pollution
Carpophore	Decay
Damaged trunk	Animals
Chewed leaves	Insects
Discoloured leaves along the veins	Alkaline or toxic soil
Spots on the leaves	Disease
Broken branches, incomplete crown, broken trunk	Ice or lightning
Gash in the wood	Mechanical injury
Incomplete crown, leaning trunk	Lack of space

Number	Genus	Observable stress(es)
4	Birches	Caterpillars

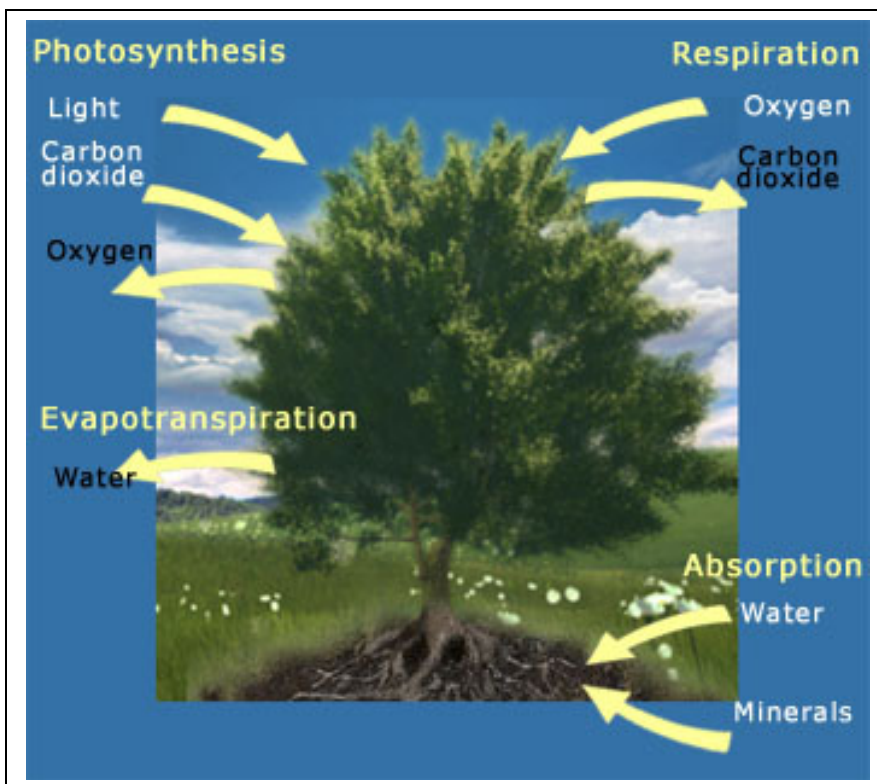
Last name, First name \_\_\_\_\_

1. Define what stress is for trees:

\_\_\_\_\_

2. Using the diagram below name the elements that each of these mechanisms requires in order to be able to contribute to tree growth

Photosynthesis:



Respiration:

Absorption:

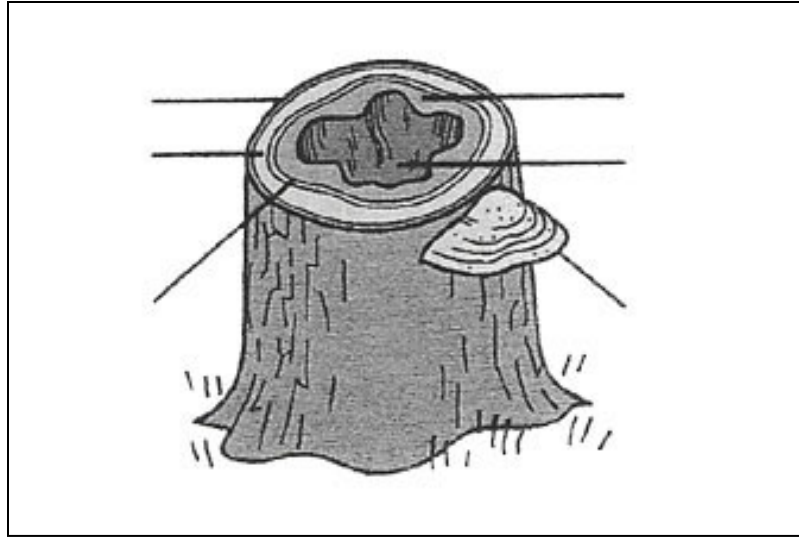
Evapotranspiration:

3. Define dieback:

\_\_\_\_\_



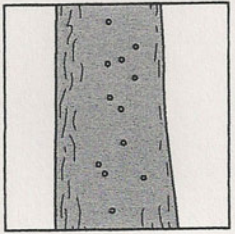


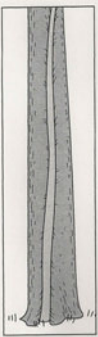
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3	Carpophore		
4		Animals	Wounds may be an entry point for diseases.
5	Chewed leaves		
6		Alkaline or toxic soil	Roots are not able to absorb nutritive elements - chlorophyll is not produced.
7		Diseases	
8	Broken branches, incomplete crown broken trunk		Wounds may be an entry point for diseases. The tree a structural problems. The tree may die.
9		Mechanical injury	
10	Incomplete crown, leaning trunk		The tree experiences growth problems.



Last names, First names \_\_\_\_\_

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Discoloured leaves along the veins	Alkaline or toxic soil
Spots on the leaves	Disease
Broken branches, incomplete crown, broken trunk	Ice or lightning
Gash in the wood	Mechanical injury
Incomplete crown, leaning trunk	Lack of space

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