

**EVALUATING
ACADEMIC READINESS
FOR APPRENTICESHIP TRAINING**
Revised for
ACCESS TO APPRENTICESHIP

**SCIENCE SKILLS
BASIC CELL STRUCTURE**

**AN ACADEMIC SKILLS MANUAL
for
The Horticulture Trades**

This trade group includes the following trades:

Arborist, and
Horticulturist

*Workplace Support Services Branch
Ontario Ministry of Training, Colleges and Universities*

Revised 2011

In preparing these Academic Skills Manuals we have used passages, diagrams and questions similar to those an apprentice might find in a text, guide or trade manual.

This trade related material is not intended to instruct you in your trade. It is used only to demonstrate how understanding an academic skill will help you find and use the information you need.

SCIENCE SKILLS

BASIC CELL STRUCTURE

*An academic skill required for the study of the
Horticulture Trades*

INTRODUCTION

A maple tree growing in a yard is alive, while a piece of spruce lumber sitting in a pile is not. The tree and the board are both made up of cells. What is the difference between the living tree and the non-living board? The most noticeable difference is that the cells of the tree are still actively carrying out processes such as respiration and photosynthesis- processes that are necessary to keep the tree alive. The spruce board was once part of a living organism, so it retains some of the characteristics of living things. However, the dead cells of the wood are no longer carrying out the functions necessary for life.

The basic structural unit of plants (and of all living organisms) is the cell. The organization of a plant cell determines how the plant interacts with its environment. This skills manual looks at a plant cell and identifies some of the different structures found in it. It also looks at the differences between a living plant and wood from non-living plant. The following topics are included:

- ◆ Properties of living plants
- ◆ Cell theory
- ◆ Structure of a plant cell

PROPERTIES OF LIVING PLANTS

Living plants are composed of **carbon-based** organic molecules. Atoms of the elements carbon, oxygen, hydrogen and nitrogen make up 99% of living plant matter. These atoms combine to form the complex carbon-based molecules that a plant uses to grow.

The general characteristics of living plants include these properties:

- ◆ A plant is made up of highly organized units called *cells* that work together for the good of the plant.
- ◆ A plant uses the sun's energy to produce sugars in a process called *photosynthesis*.
- ◆ A plant breaks down these sugars to obtain energy needed for growth through the process of *respiration*. In respiration, the plant takes in oxygen and uses it to release energy from the stored food. The end products of respiration are carbon dioxide and water.
- ◆ A plant *responds to* changes in its *environment*.
- ◆ A plant can *reproduce* itself, producing offspring that resemble the parent plant or plants.
- ◆ A plant grows throughout its life. Eventually it will *die*.

Let's look at these characteristics in more detail.

Cells

A living plant is highly organized. The basic unit of plant structure is the cell. The cell is organized into many different parts. The different parts of the cell have separate functions but all work together for the benefit of the whole organism.

***Photosynthesis** is the process in which the leaves of a plant capture the energy in light-waves from the sun and make the energy available to the plant in the form of plant sugars. When the plant absorbs energy from the outside environment, it converts it to a form that it can use for its own needs. During photosynthesis:*

- ◆ The plant takes in carbon dioxide from the atmosphere and releases oxygen.
- ◆ The plant also absorbs water and minerals from the soil to use during this process.
- ◆ The sugars (or carbohydrates) produced are used to form cell components such as cell walls and storage areas containing starch.

***Respiration** is the process by which the plant takes in oxygen and releases carbon dioxide and water. The energy stored in plant food is released by the process of cellular respiration.*

- ◆ While photosynthesis uses carbon dioxide and releases oxygen, respiration works in the opposite way – the plant takes in oxygen and releases carbon dioxide.
- ◆ During respiration, the plant breaks down stored sugars, releasing energy in the process.
- ◆ The energy is used to synthesize needed plant components such as proteins, cell walls and membranes.
- ◆ This energy is also used by the cell nucleus and during reproduction.

*A plant can respond to its **environment**.*

- ◆ In the autumn, the leaves of deciduous trees such as maple, oak and poplar change colour and fall to the ground. The tree enters a resting state for the winter.
- ◆ As the climate warms up in the spring, sap stored in the roots moves back up to the buds and the leaves open up to begin the process of photosynthesis again.
- ◆ Coniferous trees usually keep their needles all year, but their responses slow down during the winter.
- ◆ This pattern can be seen in the yearly growth rings when the trunk of a tree is examined.

*The plant uses energy to **reproduce**. Most plants produce seeds that develop and then fall to the ground.*

- ◆ The seeds have the potential to develop into new plants that are similar to the parent plants.
- ◆ Plants can also reproduce by producing bulbs, tubers, suckers and runners.

A living plant eventually **dies**. Once it dies, it can no longer use energy to maintain its distinct living form.

- ◆ The organic (carbon-based) molecules that make up the plant lose their ability to function together as organized units.
- ◆ They are broken down into humus by microorganisms that thrive in moist conditions and become part of the soil.

When a tree is cut down, it can no longer maintain communication and organization between the different parts of its structure. It stops functioning as a living organism, and eventually dies.

- ◆ A board is made of the same molecules as a tree but it is not alive.
- ◆ It retains many of the structural qualities that the living tree had, but:
 - it can no longer use outside energy to organize its parts,
 - it can no longer grow,
 - it can no longer actively respond to its environment,
 - it can no longer reproduce.

CELL THEORY

Just as the atom is the basic building block of all matter, the cell is the basic building block of all living objects. The central role of the cell is identified in the cell theory. *The **cell theory** states that all living things are composed of cells and all cells arise from other cells.*

- ◆ Most cells have a regular cycle of growth, division and death.
- ◆ Movement and activity occur inside a cell.
- ◆ Cells contain DNA, complex molecules that contain genetic information used to direct the functions of the organism.
- ◆ This genetic material can replicate itself, so when a cell divides in two, the genetic material is passed on to both new cells.

The number of cells in a living organism varies tremendously. Less complex organisms such as bacteria are composed of only one cell, while more complex organisms such as humans are made of about 100 trillion cells.

STRUCTURE OF A PLANT CELL

All living organisms are made of cells, which come in a variety of shapes and sizes. Although all cells have the same basic structure, animal and plant cells differ in some respects. All cells contain an outside cell **membrane** that can help control what goes into and out of the cell. Plant cells also have a rigid **cell wall** outside the cell membrane. This wall gives plants the strength to stand up. Animals usually have skeletons to support themselves.

Cytoplasm

Both plant and animal cells contain a jelly-like material inside the cell membrane called **cytoplasm**, which consists of water, food, minerals and enzymes. Floating in the cytoplasm are many specialized **organelles** that carry out special tasks.

The control centre of the cell is called the **nucleus**. The DNA in the nucleus contains the genetic information that directs the activities of the cell. This genetic material is passed on to both cells whenever an original cell divides into two cells. It is also passed on in the reproductive seeds a plant produces.

Below is a diagram of a typical plant cell:

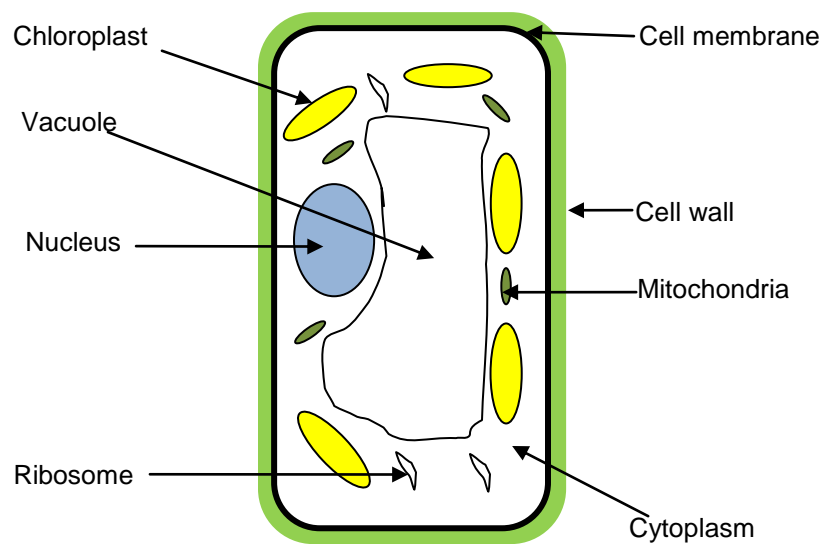


FIGURE 1: Structure of a Plant Cell

Organelles

Chloroplasts: A plant cell contains a special organelle called a **chloroplast** that can use the energy from the sun to create food through the process of photosynthesis. The chloroplast contains a special molecule called **chlorophyll** that can capture the energy in sunlight.

- ◆ The cell uses this food to get the energy it needs to maintain itself.

Mitochondria: The food is converted into energy in the **mitochondria** through the process of respiration.

- ◆ The cell uses this energy, along with molecules of plant food, water and minerals, to produce new plant components.

Ribosomes: An organelle called a **ribosome** produces protein substances for the plant.

- ◆ Proteins help direct the complex functions of the cell.

Vacuole: The plant cell has a large storage area called a **vacuole**.

- ◆ Because it is filled with watery cell sap, the vacuole helps a plant maintain its shape.

Specialized Cells

Distinctive cells are arranged in groups called tissues. Specialized cell tissues move water from the roots to the leaves. Other types of cells transport food molecules throughout the cell, especially from the leaves to the roots.

Xylem cells are the water-conducting cells in plants. They are very long compared to the cell in the diagram. They have hollow, cylindrical centres which form tubes running in the direction of the stem or trunk.

- ◆ These tubes transport water and minerals absorbed by the roots from the soil to the rest of the plant.

Phloem cells transport food throughout the plant. Most of the food is produced in the leaves.

- ◆ Food is moved through the stem or trunk to the roots and any other parts of the plant that need food energy, such as the tips of actively growing cells.

Woody Plants

Annuals grow and die in one season. They produce numerous seeds that overwinter and sprout the next spring. Most perennial plants have a soft stem that dies back after a season of growth. Their roots and crown stay alive over the winter, storing food during this dormant stage. In the spring, they start to regrow a new stem and leaves. They also produce seeds

Woody plants have a rigid stem called a trunk that does not die back but continues to harden and grow throughout the tree or shrub's life. Many woody deciduous trees and shrubs drop their leaves in the fall and grow new leaves in the spring. Coniferous trees keep their leaves, which are also called needles, over the winter. They shed their leaves throughout the year.

The growing part of a woody plant such as a tree is a ring of cells called the **cambium** that completely surrounds the tree near the outside of the trunk. The cambium produces xylem and phloem cells as it divides.

- ◆ On the outside near the bark, the cambium produces the phloem cells that carry stored sap from the roots to the rest of the plant to be used for growth in the spring and then back to the roots for storage in the fall.
- ◆ On the inside, the cambium produces the xylem cells that carry water from the ground to the leaves.

In a tree, only the xylem near the cambium is alive. This living xylem is called sapwood.

- ◆ The xylem towards the centre of the tree dies as the tree grows.
- ◆ As the xylem cells die, they become filled with a hard substance called lignum.
- ◆ It is lignum that gives wood its characteristic hardness.
- ◆ The inside of a tree that contains the dead cells is called heartwood.

CONCLUSION

Plants are formed from cells that are organized to carry out the necessary functions of survival, growth and reproduction. The cell is itself highly organized. It consists of a rigid cell wall, a membrane that controls what moves in and out of the cell and a liquid cytoplasm. Inside the cytoplasm are specialized organelles.

Chloroplasts contain a molecule called chlorophyll that can capture the energy from sunlight. Inside the chloroplast, the chlorophyll, along with carbon dioxide and water, makes plant food in the form of sugars. Mitochondria use the plant food, along with oxygen, to release energy, water and carbon dioxide. The energy is used to build needed plant structures.

The nucleus contains the genetic instructions that direct the functions of the cell. These instructions are reproduced each time a plant cell divides. They are also passed on through the seeds to the next generation of plants.

Special types of cells called phloem and xylem carry food and water throughout the plant. In a woody plant, dead xylem cells form a rigid trunk that enable a tree to reach upwards in search of sunlight.

The parts of the cell are made from molecules obtained from water, air and soil components. A living plant organizes these molecules into the cell structures needed by the plant to function, grow and reproduce. Coordination within the plant cell and between the cells that make up the different parts of a plant is necessary for the plant to stay alive. This coordination allows each plant to function as a unified organism.

Answer the following questions by putting the correct word in the blank spaces. Answers are on the next page.

phloem	cells	xylem	chloroplast	carbon	cytoplasm	protein
water	membrane	food	photosynthesis	oxygen	nucleus	

1. Living organisms are made of organic molecules that contain the element _____ .
2. A plant captures the sun's energy in a process called _____ .
3. Photosynthesis takes place inside a special cell structure called a _____ .
4. During photosynthesis, a plant takes in carbon dioxide and releases _____ .
5. Cell theory states that all living organisms are composed of _____ .
6. The control centre of the cell is the _____ .
7. The _____ contains the organelles that carry out specialized cell functions.
8. The cell _____ helps control what moves in and out of the cell.
9. Ribosome produces plant _____ .
10. Xylem cells carry _____ and minerals absorbed by the roots to the rest of the tree.
11. The centre of a tree contains dead _____ cells called lignum that gives wood its hardness.
12. Phloem cells transport _____ from the leaves to the rest of the plant.

ANSWER PAGE

1. carbon
2. photosynthesis
3. chloroplast
4. oxygen
5. cells
6. nucleus
7. cytoplasm
8. membrane
9. protein
10. water
11. xylem
12. food