The availability of this product is due to the financial support of the National Department of Agriculture and the AgriSETA. Terms and conditions apply.
**Before we start...**

Dear Learner - This Learner Guide contains all the information to acquire all the knowledge and skills leading to the unit standard:

| Title: Demonstrate a basic understanding of the physiological functioning of the anatomical structures of the plant |
| US No: 116272 | NQF Level: 3 | Credits: 4 |

The full unit standard will be handed to you by your facilitator. Please read the unit standard at your own time. Whilst reading the unit standard, make a note of your questions and aspects that you do not understand, and discuss it with your facilitator.

This unit standard is one of the building blocks in the qualifications listed below. Please mark the qualification you are currently doing:

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<th>Title</th>
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<td>National Certificate in Plant Production</td>
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Please mark the learning program you are enrolled in:

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Your facilitator should explain the above concepts to you.

This Learner Guide contains all the information, and more, as well as the activities that you will be expected to do during the course of your study. Please keep the activities that you have completed and include it in your **Portfolio of Evidence**. Your **PoE** will be required during your final assessment.

**What is assessment all about?**

You will be assessed during the course of your study. This is called **formative assessment**. You will also be assessed on completion of this unit standard. This is called **summative assessment**. Before your assessment, your assessor will discuss the unit standard with you.

Assessment takes place at different intervals of the learning process and includes various activities. Some activities will be done before the commencement of the program whilst others will be done during programme delivery and other after completion of the program.
The assessment experience should be user friendly, transparent and fair. Should you feel that you have been treated unfairly, you have the right to appeal. Please ask your facilitator about the appeals process and make your own notes.

Your activities must be handed in from time to time on request of the facilitator for the following purposes:

♦ The activities that follow are designed to help you gain the skills, knowledge and attitudes that you need in order to become competent in this learning module.

♦ It is important that you complete all the activities, as directed in the learner guide and at the time indicated by the facilitator.

♦ It is important that you ask questions and participate as much as possible in order to play an active role in reaching competence.

♦ When you have completed all the activities hand this in to the assessor who will mark it and guide you in areas where additional learning might be required.

♦ You should not move on to the next step in the assessment process until this step is completed, marked and you have received feedback from the assessor.

♦ Sources of information to complete these activities should be identified by your facilitator.

♦ Please note that all completed activities, tasks and other items on which you were assessed must be kept in good order as it becomes part of your Portfolio of Evidence for final assessment.

Enjoy this learning experience!
How to use this guide …

Throughout this guide, you will come across certain re-occurring “boxes”. These boxes each represent a certain aspect of the learning process, containing information, which would help you with the identification and understanding of these aspects. The following is a list of these boxes and what they represent:

**What does it mean?** Each learning field is characterized by unique terms and definitions – it is important to know and use these terms and definitions correctly. These terms and definitions are highlighted throughout the guide in this manner.

**ACTIVITY**

You will be requested to complete activities, which could be group activities, or individual activities. Please remember to complete the activities, as the facilitator will assess it and these will become part of your portfolio of evidence. Activities, whether group or individual activities, will be described in this box.

**Example**

Examples of certain concepts or principles to help you contextualise them easier, will be shown in this box.

**How am I doing?**

The following box indicates a summary of concepts that we have covered, and offers you an opportunity to ask questions to your facilitator if you are still feeling unsure of the concepts listed.

**My Notes …**

You can use this box to jot down questions you might have, words that you do not understand, instructions given by the facilitator or explanations given by the facilitator or any other remarks that will help you to understand the work better.
What are we going to learn?

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SA Unit Standard
Demonstrate a basic understanding of the physiological functioning of the anatomical structures of the plant

Primary Agriculture  
NQF Level 3  
Unit Standard No:116272

What will I be able to do?

When you have achieved this unit standard, you will be able to:

- The learner will be able to identify and describe pertinent physiological processes of different plant structures.
- Learners will gain specific knowledge and skills in plant anatomy and physiology and will be able to operate in a plant production environment implementing sustainable and economically viable production principles.
- They will be capacitated to gain access to the mainstream agricultural sector, in plant production, impacting directly on the sustainability of the sub-sector. The improvement in production technology will also have a direct impact on the improvement of agricultural productivity of the sector.

Learning Outcomes

At the end of this learning module, you must be able to demonstrate a basic knowledge and understanding of:

- It is assumed that a learner attempting this unit standard will show competence against the following unit standards or equivalent:
- The learner should be able to identify and describe the various parts of the plant.
- The function of the various parts of the plant.
- A learner should realise that the environment plays an important role in the functioning of a plant.
- A learner should be aware that nature plays a role in the anatomical functions of plants.
- A learner should know that all functions and structures of a plant are interrelated.

What do I need to know?

It is expected of the learner attempting this unit standard to demonstrate competence against the unit standard:

- It is assumed that a learner attempting this unit standard will show competence against the following unit standards or equivalent:
- NQF 2: Recognise and identify the basic functions of the ecological environment.
- NQF 2: Demonstrate a basic understanding of the structure and functions of a plant.
Aims and Objectives

Aims
1. Demonstrate an understanding of the structure and basic functioning of a plant cell.
2. Describe the effect of the environmental on the physiology and germination of the seed.
3. Describe the anatomy of the root, stem and leaf in relation to its function in the translocation of water and nutrients.
4. Demonstrate an understanding of the anatomy and physiology of a leaf.
5. Identify and describe the anatomical structures of a flower in relation to fruit and seed development.

Objectives
1. The structure of a plant cell is illustrated and explained.
2. The functions of the different components of a plant cell are described.
3. The role of a plant cell in relation to plant growth is explained.
4. The role of the plant cell in relation to metabolic processes of the plant is described.
5. Describe the effect of the environmental on the physiology and germination of the seed.
6. The effect of certain environmental factors on seed germination is described.
7. The process of imbibition and the rupturing of the seed coat are explained.
8. The role that the environment plays on the activation of endogenous hormones during germination is explained.
9. Describe the anatomy of the root and stem in relation to its function in the translocation of water and nutrients.
10. The basic anatomy of the root is illustrated.
11. The characteristics of the xylem vessels and how it functions in the movement of water up a plant is explained.
12. Transport refers to movement of water and nutrients from the roots upwards.
13. The transport of organic food by the phloem vessels is explained.
14. The role of the cambium in the growth of the vascular bundles is explained.
15. Demonstrate an understanding of the anatomy and physiology of a leaf.
16. The structure of the leaf includes but is not limited to cuticle, mesophyll, stomata and vascular bundles.
17. The basic anatomical structure of a leaf is explained.
18. An understanding of the function of stomata and its role in gaseous exchange and transpiration is demonstrated.
19. The different types of leaf-hairs and their role in transpiration and plant protection are described.
20. Identify and describe the anatomical structures of a flower in relation to fruit and seed development.
21. Anatomical structures of a flower may include but is not limited to sepals, pistils and petals.
22. The structure of a flower in relation to pollination is described and illustrated.
23. The process of pollination and the importance of cross-pollination in relation to agricultural systems are explained.
24. Pollination refers to, but is not limited to the transfer of pollen to the stigma by insects.
25. The process of fertilisation of the ovule and the development of the fruit is explained.
26. The development of seeds is described.
Session 1

Plant cell structure and function

After completing this session, you should be able to:
SO 1: Demonstrate an understanding of the structure and basic functioning of a plant cell.

In this session we explore the following concepts:

- Plant cell structure and function
- Plant cell organelles and their functions
- Cell duplication and plant growth

1.1 Plant cell structure and function

Plants are made up of single cells that are organised in complexes of cells called tissues that make up organs. The cells are not just aggregated in a group but are connected and coordinated.

The tissues in plant organs are made up of microscopic units known as plant cells. All plants such as pine trees, tomatoes and even maize all look different from one another, but they are made of similar cells and tissues.

Plant cells are microscopic sized structures that contain various smaller organs known as organelles that enable growth processes to occur.

Cells may vary in size, shape, structure and function. Some cells are relatively simple in the way the internal organelles are organised whilst others are more complex. Cells may perform various functions or may be specialised in their function. Cells with the same function are usually grouped together in tissues like the epidermis, ground tissue and transport tissue which are the main tissue types of all plant organs.

The plant cell consists of a rigid, non-living cell wall and the living protoplast. The cell wall consists mainly of a network of cellulose impregnated with water and pectin. The protoplast consists of the cytoplasm and nucleus. The cytoplasm is bounded by the plasma membrane and consists of the ground plasma or ‘cellular soup’ containing membrane-bound organelles (plastids, mitochondria), systems of membrane (endoplasmic reticulum and dictiosomes) and non-membranous structures (ribosomes and microtubules). The protoplasts of adjacent cells are connected by plasma filaments, called plasmodesmata that pass through the cell wall.
The cell requires various storage organs for waste, oils, etc.

The cell needs an organelle to trap light, to produce food and to metabolise the food which provides energy for growth.

The cell furthermore needs a system which links different organelles together but also links the cell to other cells for transport of vital chemicals.

Finally, the cell needs an organising structure which will control the various processes occurring in the cell.

In the following section we discuss the most important cell organelles, their basic structure and their functions.

Figure 1.1 – A diagram of a two-dimensional section of a plant cell showing the internal organisation of cell organelles.

Please complete Activity 1:
Individual Activity
Draw a diagram of a cross section of a plant cell providing the identity of organelles.

My Notes ...

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1.2 **Plant cell organelles and their functions**

The figure provided in the previous section shows the basic construction of a plant cell.

- **Protoplasm**

Within the membrane is the protoplasm. The protoplasm is basically the ground substance or living material of the cell. This protoplasm includes the complex colloidal organisation of substances making up a cell's nucleus, cytoplasm, plastids and mitochondria.

The most obvious structure in the cell is probably the nucleus. The nucleus consists of chromatic network (chromosomes), a nucleolus and a nuclear membrane containing nuclear pores.

- **Nucleus**

The nucleus, enclosed in a double membrane, controls all the cell functions by specifying the proteins to be produced. It also stores and passes on genetic information to future generations of cells during cell division. DNA responsible for storage and transfer of this genetic information is found in the chromosomes. The chromosomes are enclosed in the nucleus. The information stored and transferred determines what the plant will look like, as well as which characteristics will be expressed.

- **Chloroplast**

The chloroplast is a plastid in which photosynthesis takes place. The chloroplast is enclosed in a double membrane and contains chlorophyll. These are disc-shaped and about 4 to 6 micrometres in diameter. They are found mostly in the cells of leaves and young stems where they can orientate themselves towards light.

A cell could contain 40 to 50 chloroplasts, which equates roughly to about 500,000 in each sq mm of leaf surface. The chloroplast's inner structure is made up of a ground substance called stroma, containing a network of interconnected discs called lamellae. These lamellae are stacked like saucers onto one another and called grana. Chlorophyll molecules (the molecules responsible for trapping light photosynthesis) are contained in the lamellae. Chlorophyll can only be formed in the presence of light. When green plants are kept in the dark for long periods, the chlorophyll breaks down, the grana become disorganised and the plants turn yellow.

- **Adenosine triphosphate**

The light energy, trapped by the chlorophyll, is converted to compounds called adenosine triphosphate (ATP) that drives a series of chemical reactions that take place in the grana and stroma and the end product is starch. The starch is
converted into sugars that can be transported to other parts of the plant where energy is required or where it is stored.

**Mitochondron**

The starch and sugars, made during photosynthesis, is metabolised by the plant through a process called aerobic respiration. This process occurs in the organelle called the mitochondrion. Mitochondria have two membranes, the inner and the outer. The outer serves as an outer boundary of the organelle. The inner membrane contains many proteins with important functions, including those that allow molecules to enter into, or exit from the mitochondrion.

The internal aqueous phase of mitochondria is known as the matrix. It is here where the enzymes occur that catalyse a series of reactions known as the Krebs’ cycle or tricarboxylic acid cycle during respiration.

**Endoplasmic reticulum**

A prominent structure in the cell, clear in the figure above, is an irregular three-dimensional network of spaces, enclosed by a membrane. This structure is called the endoplasmic reticulum (ER). The ER is the site where most cell membrane components as well as materials that are exported from the cell, are produced.

When the ER is covered in ribosomes, it is known as rough ER and when ribosomes are absent, it is known as smooth ER.

**Ribosomes**

Ribosomes are factories for protein synthesis. It is here where the so called messenger RNA is translated into amino acid sequence (protein building blocks). It is obvious that these organelles must be closely associated with the ER as this is the site for synthesis of cell constituents.

**Golgi bodies or Dictiosomes**

The Golgi bodies or dictiosomes are miniature cellular inclusions in the cytoplasm. It is made up of a series of smooth, stacked membranous sacs. The function of the Golgi body is secretion. Each golgi body has two poles, one adjacent to the endoplasmic reticulum where new membrane sacs are formed and the opposite pole where small vesicles, containing the secretion, are formed. The golgi bodies in one cell are interconnected and is referred to as the golgi apparatus of the cell. Golgi bodies are involved in cell wall formation and secretion of different substances. It is obvious that the Golgi apparatus and ER are closely linked.

**Vacuoles**

Vacuoles are membrane bound cavities (sacks) filled with cell sap which is made up mostly of water, containing various dissolved sugars, salts and other chemicals. These could include pigments that provide the colour of flowers.
Please complete Activity 2:
**Individual activity**
In an essay, discuss the function of plant cells within plant tissues and structures.

Please complete Activity 3:
**Individual activity:**
Define the function the plant cell organelles.

### 1.3 Cell duplication and plant growth

The plants grow by means of cells duplicating and enlarging. The process of cell division is known as mitosis which is the normal way that cells multiply. This process keeps going on during plant growth..

Meiosis is another type of cell division that only takes place during sexual reproduction (formation of pollen and the embryo sac) and will be dealt in session 5.

Mitosis is summarised below:

The lengths of chromatin threads containing the DNA, begin to twist and coil, becoming more compacted (chromosomes). Each chromosome consists of two identical halves know as chromatids which are attached to one another at different positions, from the end to more or less in the middle. This gives some of the chromosome an X-like appearance.

During mitosis the chromosomes align across the cell’s middle. The nuclear membrane begins to disintegrate and the two halves of the chromosome are pulled apart, separating at the connection point. They are then pulled in opposite directions.
towards the ends. A new nuclear membrane forms around each new set of chromosomes and the chromosomes then uncoil and unravel. At the same time the rest of the cell also divides in a process known as cytokinesis. The cell as a whole eventually splits in two by means of a new cell wall built across the middle of the parent cell from vesicles produced by the golgi bodies. The end product of meiosis is therefore the formation of two daughter cells with the same number of chromosomes ad the mother cell from which they were formed the daughter cells may divide again before maturing or may enlarge to become part of a specific tissue.

Please complete Activity 4:
Activity to be conducted in pairs
Explain how plant cells are involved in plant growth.

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My Notes ...

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Session 2

Seeds and their germination

After completing this session, you should be able to:
SO 2: Describe the effect of the environmental on the physiology and germination of the seed.

In this session we explore the following concepts:
- Seed Structure
- Seed Viability
- Seed Dormancy
- Germination Inhibitors Present in the seed

2.1 Seed Structure

The seed is covered in a seed coat that will aid the absorption of water when the seed is about to germinate.

A seed develops from the ovule and consists of three parts:

1. The seed coat on the outside, derived from the integuments of the ovule and covers the other parts
2. The embryo developing from the fertilised egg cell of the ovule and also consisting of three parts, the radicle, the cotyledon(s) and the pumule
3. The endosperm developing from the fertilised central cell of the embryo sac in the ovule. In some seeds the endosperm is absorbed by the cotyledons before the seed ripens as in **endospermous** seeds like the bean seed and in others like the castor bean, the embryo is embedded in the endosperm which is absorbed by the cotyledons during germination. These seeds are **endospermous** seeds.

In almost all seeds, the opening through which the pollen tube entered the ovule remains as a small opening (the micropyle) in the seed coat. Close to this a stalk is attached which attaches the seed to the placenta on the inside of the fruit wall. When the seed is removed, a small scar (the hilum) remains.

The fertilised egg cell is known as the **zygote**. After a few cell divisions the embryo consists of a small, spherical, undifferentiated mass of cells. Soon thereafter an indentation is formed on the one side and the bulges on either side of the indentation form the cotyledons, while the plumule (apical bud) later develops in the indentation. The radicle develops the opposite side of the indentation and usually points in the direction of the micropyle.

In gymnosperms, several cotyledons may be present. In the flowering plants (angiosperms) two groups of plants are found. The one group has one cotyledon in the seed and these plants are known as the **monocotyledons** plants (or monocots). In the other group two cotyledons are present and these plants are known as **dicotyledons** plants (or dicots).

The cotyledons are the first leaves of the embryo and functionally the areas where absorption and storage of nutrients occur, drawing nutrients from the endosperm. The cotyledons may function as primary photosynthetic organs just after germination but usually before the first true leaves have developed.

The seed is the product of sexual reproduction. Sexual reproduction by means of plant seeds normally involves two gametes (sexual cells), one male and one female.

In nature most plant species reproduce by means of seed. Seeds are produced inside fruits and when the seeds are mature, the fruit ripens and the seed go into a ‘resting’ phase.
Seed germination

The term germination refers to the process through which the seed embryo resumes growth after dormancy. Germination will not take place unless the seed is placed in a favourable environment. The primary conditions of a favourable environment include adequate water, and oxygen as well as suitable temperature. Some seeds may require light to start germination like many grass seeds, Other seeds will not germinate if exposed to light. Seeds of some plant species however, will germinate best after exposure to extreme temperatures; extremely low or extremely warm temperatures for breaking their dormancy.

During the germination process water diffuses through the seed coat into the embryo (of which the moisture content dropped below 10% during the period of dormancy). The seed then swells to the point where the swelling is so large that the seed coat may rupture. With the absorption of oxygen by the seed, metabolic processes resume and energy is made available for growth. The foodstuffs stored in the endosperm or in the cotyledons are broken down by enzymes into simpler substances, which are transported to the areas of growth.

The radicle (embryonic root) is the first portion of the embryo to break through the seed coat to form the primary root. The primary root then develops root hairs which absorbs water and also attach the embryo to soil particles. The hypocotyl (embryonic stem) then lengthens, bringing the plumule and often the cotyledon or cotyledons above the surface of the soil. If the cotyledons are brought into light, they develop chlorophyll and carry out photosynthesis until the true foliage leaves develop from the plumule. In many plants, especially members of the grass family, the cotyledons never appear above the surface of the soil and photosynthesis does not occur until true leaves develop; the plant meanwhile survives on food stored in the seed. A seedling refers to the plant during the period of time from germination up to the point where the plant is completely independent of reserves that are stored in the seed.

2.2 Seed Viability

Seed viability refers the seed being capable of growing into a healthy plant. Some seeds are viable for only a few days after falling from the parent plant. Other seeds remain viable for many years such as those from the Oriental lotus, which have been claimed to germinate 3,000 years after dispersal. All plant species has its specific period of viability; seeds sown after the period of optimum viability may produce weak plants or may not germinate. This is important when you grow crops from seed. The seed distributor will normally indicate the date after which the seed is no longer expected to be viable on the packaging.
2.3 Seed Dormancy

The lack of viability of seed can be confused with seed dormancy. Many seeds need “resting period” after liberation from the fruit before they are able to germinate to form new plants.

The seeds complete their maturation process in the ripe fruit on the mother tree and in some seeds during this resting period or dormancy period. In some plants, chemical changes take place during the dormancy period that makes the seed ready for germination. Some seeds have extremely tough seed coats that must either soften or decay before water and oxygen can enter the seed to take part in the growth of the embryo (or before the growing embryo is capable of bursting through the seed coat).

2.4 Germination Inhibitors present in the seed

Seeds of many plant species contain chemicals in the developing seeds. These chemicals inhibit the ‘awakening’ of the embryos. They keep the embryos dormant. This is to ensure that the seed will germinate only if environmental conditions are ideally for the seed to germinate. The two best known compounds are abscisic acid and Phenolic compounds.

- **Abscisic Acid**

  This chemical causes the embryo to remain dormant. The chemical is produced in the late summer and early autumn, leaving the seed to become dormant. This means that even if they are dispersed in autumn, they cannot sprout. During the colder winter months enzymes contained in the seeds degrade the abscisic acid so that by spring the abscisic acid is gone and the seed germinates.

  It is possible to stimulate the seeds to germinate earlier; by placing the seed in moist soil and a fridge for about four weeks (a process called **stratification**). This is usually sufficient time to degrade the abscisic acid. The plant seeds are then placed in a warm greenhouse. The seeds assume winter is over, spring has arrived and they begin to sprout.

- **Phenolic Compounds**

  Plants that live in extreme dry environments (desert) have a different problem: a lack of water. These plants use a more potent chemical called phenolic compound, which keep their seeds dormant until the environmental conditions are ideal for germination. Deserts typically have very long dry seasons and a short wet season accompanied by flash floods and so on.
This phenolic compound is water soluble. It will only leach from the seed after it have rained, allowing the seed to germinate. It is therefore a protecting mechanism to ensure that the seed will remain dormant until there is enough water available to allow proper germination.

Please complete Activity 5.
**Individual activity**
Write an essay, discussing the process of imbibitions and the rupturing of the seed coat.

Please complete Activity 6.
**Individual activity**
Develop a presentation on:
- The role that the environment plays on the activation of endogenous hormones during germination.
- The potential influence that the environment may have on seed germination.
Use examples relevant to the crops grown at your place of work to highlight the process.

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In general, roots have a basic structure consisting of a main root from which lateral roots develop. These lateral roots spread out over a large area, not only seeking for water, but also serves as an anchor to keep the plant standing in the soil. All roots grow by means of an apical meristem situated in the root tip where new cells are formed by cell division (mitosis). A few millimeters behind the growing point where the epidermis cells start to mature, they form hair-like outgrowths that are called root hairs. Root hairs are therefore not a kind of root, but simply outgrowths of the epidermal cells to enlarge their surface area in contact with the soil. Their function is
to absorb water and minerals from the soil. Root hairs usually have a very short lifespan and are continuously replaced by new root hairs as the root elongates.

### 3.2 Geotropism (Gravitropism) – The term geotropism no longer used

When a seed germinates, the young root turns downwards, regardless of the way in which the seed is planted. This phenomenon is known as positive gravitropism. It allows a plant to anchor itself in the soil.

The young stem again, always turns upwards, a process known as negatively gravitropism.

The positive geotropism of roots can be influenced though, if there is more water present near the surface of the soil than at greater depths. In this case, roots tend to grow towards the source of water. This response is known as hydrotropism.

### 3.3 The role and function of roots and its relation to its environment

We now know that the function of tap roots, main roots and lateral roots are to anchor the plant in an upright position in soil. The lateral roots spread out from the stem, covering as large an area as possible. The larger the area that is covered, the better the plant is anchored. Attached to the main and lateral roots are root hairs. The root hairs are the main areas on the root where nutrients and water is actively taken up. Any damage to root hairs of a plant results in reduced water and nutrient uptake.

Roots also store nutrients like sweet potato.
A cross section of a root reveals that it has a cylinder-like core, called a vascular core. This vascular core contains xylem and phloem which forms a tube through the plant through which water and nutrients are transported. The root hairs are integrated into the cell system of the root.

In some cases roots are modified to act as a storage organ (such as the taproot of a carrot) for sugars.

### 3.4 Plant stems

The leaf blades are attached to plant stems via the petioles. Stems are divided into segments, which are called internodes. At the end of these internodes the area becomes thicker, called the nodes where the leaves attach to the stem. (One or more leaves may attach at each node.) At the point where the leaf attaches to the stem, the stem bears a lateral bud that is capable of developing into a new shoot.

Stems have the function of carrying the leaves and flowers as well as to transport water and nutrients between roots and leaves. In addition, stems may also have a storage function (see later).
Many herbaceous plants have stems that are not of a woody nature and because of this, these plants are generally small. In the case of cacti the leaves are reduced to needles or spikes. The part we normally see as leaves are actually modified stems (known as cladodes). In the case of potatoes, the stems become a swollen tuber which is used to store food. So, in the case of a potato or sweet potato, the underground part we eat is actually a modified stem rather than a root.

In the case of bulbs, such as onions, the stem of the plant is very short, almost insignificant; therefore the volume of the bulb is made up with modified leaves.

The different plant organs are interlinked through a system of tubes known as the vascular system. This tube system ensures that water, nutrients and food supply can be transported from the source (soil) to the area where it is required (sink).

Water, nutrients and food is transported from the soil (after root uptake), via the vascular system, to the leaves where it is converted into vital sugars; a metabolic process. These sugars are needed by the whole plant to grow, including the roots. In order for the roots to be able to grow, these sugars are transported from the leaves via the vascular system.

### 3.5 The role and function of stems

The stem of vascular plants carries the leaves, buds and flowers. It is usually found above ground, upright and elongated. The stem is highly modified in structure in order to perform a specific function.

Plant stems have two major functions. Firstly, the leaves grow from the stem where it is held in a way that it faces the sun. It also produces and carries buds and flowers. Secondly, the vascular system is upheld to transport water and nutrients from the roots to the leaves where it is converted to sugars which is then transported to the whole plant as well as roots. Some stems are structured to store primarily nutrients or water (e.g. potatoes and cacti).

The potatoes’ tuber is a modified stem with the function of storage of foodstuffs. The large green cladodes of cacti (mistaken as leaves) are modified stems that store water.
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Simplified, a cross section of the stem reveals that a stem is made up of an outer protective layer, supporting structures and the vascular system.

The vascular system is differentiated into 2 distinct types of "veins" and they support the leaves. The two systems are; the phloem through which SUGARS is transported from the leaves (factory) to where they are stored or used (sink or target). Water and mineral Nutrients are transported in the Xylem.

The cambium consists of a ring of reproductive tissue around the stem where callus tissue is produced. Callus tissue is a collection of large, undifferentiated cells. Callus tissue differentiates form Xylem, Phloem and a cambial layer.

Please complete Activity 7:
Individual Activity
Making use of detailed diagrams and describe and discuss the basic structure of a plant root.

Please complete Activity 8:
Group Activity - groups of 2
Develop and present a presentation in which you describe how water and nutrients are transported in plants. Ensure that you cover water uptake from soil and the movement to sinks via roots and stems. The presentation should be 20 minutes long and must include a series of diagrams that illustrate the processes. Allow an additional 10 minutes for questions.
**Concept (SO 3)** | **I understand this concept** | **Questions that I still would like to ask**
--- | --- | ---
The basic anatomy of the root is illustrated. |  | 
The characteristics of the xylem vessels and how it functions in the movement of water up a plant is explained. |  | 
The transport of organic food by the phloem vessels is explained. |  | 
The role of the cambium in the growth of the vascular bundles is explained. |  | 

**My Notes ...**

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After completing this session, you should be able to:
SO 4: Demonstrate an understanding of the anatomy and physiology of a leaf.

In this session we explore the following concepts:
- Plant leaves
- The role and function of plant leaves.

4.1 Plant leaves

The most obvious plant organs visible on the shoot system are the leaves. Plant leaves come in various shapes and sizes. In general, a leaf is made up of a stalk (also called a petiole) through which it is attached to the stem and an expanded, flattened portion, called a blade (lamina).
Leaves of different plants differ to the extent that many of the characteristics used to identify individual plants are based on the features of their leaves.

At a very basic level there are two major types of leaves. These are simple leaves and compound leaves. Simple leaves have single, undivided blades, such as found on peach tree and cucumber plants. Compound leaves have a blade composed of several small leaves (leaflets) such as found on thorn trees and ferns.

4.2 The role and function of plant leaves

One of the most obvious characteristics about leaves is that they are thin and flat. The second most obvious characteristic is that leaves are green. Leaves have these two main characteristics because their primary function is to trap sunlight energy and divert it into a chemical energy that is used for the manufacturing of carbohydrates.

If one were to cut a cross section through a leaf blade and look at it under a microscope, one observes that there are distinct layers, as illustrated below.
The outer layer is a protective layer followed by a layer of cells that produce sugars by trapping sunlight. Below these layers are the leaf veins or vascular system that transports water, minerals and sugar to and from the energy producing cells.

Because the leaf surface is flat and the blade is thin, the process of capturing sunlight is optimised, thereby optimising the photosynthesis process. The leaf is green because it contains a pigment called chlorophyll. Chlorophyll is essential in leaves as this is the pigment responsible for capturing the light energy that is later converted into chemical energy.

Leaf surfaces (especially lower surfaces) are covered in tiny openings, known as stomata. The stomata allow the exchange of gases (oxygen and carbon dioxide) and water vapour, required for transpiration.

The stoma consists of two guard cells and a stoma opening (or pore). By changing the size and shape of the guard cell, the size of the pores are opened or closed. In this way the exchange of gas into and out of the leaf can be regulated.

Plant leaf hairs play important physiological and ecological roles in the plant leaf. Leaf hairs are involved in protecting the leaf from stress, including UV damage, drought tolerance and reduction of radiation, heat and tapping of toxins.

The process of trapping sunlight energy and turning it into chemical energy is known as photosynthesis. During the process of photosynthesis the light energy is captured via the chlorophyll No!, the cells then use carbon dioxide (atmospheric gas) and water (from soil) to produce carbohydrates or sugars and oxygen (atmospheric gas).
The photosynthetic process can be summarised as:

Carbon Dioxide (taken up from atmosphere) + Water (from the soil) + Chlorophyll (in the leaf) and Sunlight (from the sun) = Oxygen (set free into atmosphere) + Sugar (transported to other plant parts for use or storage). Many succulent plants uses crassulacean acid metabolism (CAM), where the CO₂ is taken in during the night and assimilated during the day. In this way the plant reduce water loss by keeping the stomata closed during the heat of the day.

Please complete Activity 9.
**Activity to be conducted in pairs**
Discuss the structure and anatomy of plant leaves using the illustrations provided as reference. Discuss the structure in relation to the physiological processes of transpiration, photosynthesis and respiration.

<table>
<thead>
<tr>
<th>Concept (SO 4)</th>
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<th>Questions that I still would like to ask</th>
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<tr>
<td>The basic anatomical structure of a leaf is explained.</td>
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<tr>
<td>An understanding of the function of stomata and its role in gaseous exchange and transpiration is demonstrated.</td>
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<tr>
<td>The different types of leaf-hairs and their role in transpiration and plant protection is described.</td>
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</table>
Session 5  

Flowers and their relation to fruit

After completing this session, you should be able to:
SO 5: Identify and describe the anatomical structures of a flower in relation to fruit and seed development.

In this session we explore the following concepts:

- Flowers, fruit and seeds
- Fruits
- The role and function of fruit, flowers and seed.
- Pollination
- Fertilisation

5.1 Flowers, fruit and seeds

Flowers are the sexual reproductive organs of plants from which seed and fruit develops.

Every flower develops from a bud and consists of a modified stem, the floral axis or receptacle. The floral axis bears one to four types of specialised appendages, or modified leaves, usually arranged in whorls in the more advanced flowers and spirally arranged in the more primitive ones. In a typical flower the outermost whorl, the calyx, consists of a number of sepals that protect the flower bud before it blooms. The next whorl on the floral receptacle, the corolla, is composed of a number of petals. The next whorl, the androecium or male reproductive parts, consists of a number of stamens that produce pollen necessary for reproduction. Two whorls of stamens may be present. The next, or innermost, whorl of the flower, called the gynaeecium, consists of several carpels, frequently fused to form a pistil, consisting of a stigma, style and ovary. Each carpel contains at least one placenta to which is attached ovules or potential seeds. The calyx and corolla are collectively known as the perianth. Flowers can also contain nectar glands situated on the bases of flower parts or modified flower parts. They produce nectar that aid in attracting pollinators.
Flowers can be borne singly or in inflorescences. (An axis or modified shoot bearing many flowers) as shown below.

### 5.2 Fruits

A fruit can be described as the product of the ovary in a flower after fertilisation of the ovules and seed development, together with all the other persistent flower parts,. Commonly the word “fruit” is often restricted to succulent, edible fruits of plants such as melons, tomatoes, apples etc... Fruit is normally produced after ovules are fertilised. The maturation of the ovary leads to the fruit developing. The ovules within fertilised ovaries develop into seeds. The major function of the fruit is to protect the developing seeds and to help with seed dispersal.
Typically, the fruit is simply the matured ovary, as in the pea pod; but in apples it includes the ovary and receptacle (other fused floral parts); in strawberries it is an aggregation of small individual fruits, called achenes, on a fleshy receptacle; and in pineapples it is a development of an entire inflorescence, or cluster of fruits or inflorescence referring to the whole inflorescence (The inflorescence axis and all flower parts) that became succulent and is seen as a single fruit.

There are a number of different types of fruit. These include:

- Pome fruit – Apples and Pears
- Drupe (stone fruit) – Peaches, apricots, plums
- Berries – tomatoes, citrus
- Pepo – cucumber, melon

Fruit can be classified by several characteristics; the most significant being the number of ovaries. A simple fruit is a single ovary developed from the pistil of a single flower.

Collective fruit developed from many ovaries attached to a single receptacle of the same flower like a strawberry

A multiple (collective) fruit is formed from the merged ovaries of an entire inflorescence like a pineapple

5.3 The role and function of fruit, flowers and seed

The role of flowers, seed and fruit are mutual each represents a stage in the sexual reproduction of the plant.

The primary purpose of the flower is to carry the reproductive organs of the plant. In many cases the male and female reproductive structures are found within a single flower (apples and pears) and every flower can potentially form a fruit.

There are however plants in which the sexes are separate and the pistils and stamens are found on different plants (pistachio nuts), or merely on separate flowers on the same plant (cucurbits and maize) where only the female flowers can form fruit. This is of course an important aspect for the grower.

Where male and female flowers are found on separate plants, the grower needs to establish both male and female plants. In a pistachio orchard, for instance, the male and female trees are established at a specific ratio (number of male to female plants). Also the male plants have to be well positioned to ensure the pollen will reach the female plants.
Where the male and female flower occurs on the same plant, such spacing is not as important.

Plants are classified as **monoecious** when separate male and female flowers are borne on the same plant. **Dioecious** plants are those where male and female flowers are borne on separate plants. Bisexual or hermaphrodite flowers having both stamens and pistils, are borne on the same **bisexual** plant.

### 5.4 Pollination

Pollination is the process where pollen is transferred from the stamen (male structure of a flower) to the stigma of the pistil (female structure of a flower).

- **Self-pollination** occurs when both “sexes” are found in one flower, thus, pollen is transferred from the stamen to the stigma in the same flower or different flowers of the same plant.

- **Cross-pollination** occurs where pollen is transferred from one flower on one plant to another flower on another plant of the same species.

Self-pollination normally occurs in the so-called pioneering plants which can colonise an area very rapidly. Such plants often become weed problems for mankind. The importance of self-pollination is that a single plant can produce offspring. The drawback is that the offspring tend to be genetically very similar; there is not much opportunity for diversity, thus a lower potential for it to cope with altering environmental conditions.

Cross-pollination produces more diverse offspring enabling it to cope with predation, competition and changing environment. Cross-pollinating plants also tend to produce better-quality seeds. Cross-pollinating plants have developed mechanisms to prevent self-pollination from occurring and systems that ensure their pollen is carried to distant plants.

Wind plays a crucial role as a pollen carrier for cross-pollination in certain plant species like maize, poplers, willows and pine trees. This is because wind scatters the pollen indiscriminately over wide areas. Plants, dependant on wind to spread pollen, generally produce an open flower and large volumes of pollen.

Apart from the wind, bees, insects, birds, and bats are also good pollen distributors. These are however more discriminating pollen carriers because they tend to fly from flower to flower of the same species. Over time many plants have developed a strong relationship with specific carriers. Honeybees are probably the most important cross-pollinators of flowers; therefore hives are placed in orchards. Where animal pollen carriers are required, plants tend to develop specific scents and colours in order to attract pollinators.

**Hand pollination** is often used in the agriculture framework to ensure cross-pollination in some crops. Hand pollination is when the pollen is collected from
specific plants and then placed on the flowers of other plants of the same crop. Hand pollination is extensively used in breeding of new cultivars.

Once the flower has been pollinated, it undergoes several changes during a complex developmental phase. The pollen grows down the style of the flower where it will eventually fertilise and ovary. This ovary will then develop into an individual seed. The rest of the structure of the flower will develop into what we see as the fruit.

A fruit (e.g. peach) also play its role in the dispersion of the seed as it is sent to a market from where it is carried to another site. A fruit may also have a protective function; ensuring that the seed are protected from the environment until such time as they are fully developed and able to germinate and to develop into a new plant.

5.5 Fertilisation

The first step in plant fertilisation occurs when the stamen lands on the stigma in the flower. Once this has occurred and environmental conditions are favourable, the pollen will germinate and form a pollen tube. During the process, the pollen tube grows down the style towards the ovary. The pollen tube contains two sperm cells.

In most plant species the pollen tube enters the ovule through a small opening known as the micropyle. The one sperm cell contained in the pollen tube unites with the egg cell in the embryo sac of the ovule and forms zygote. The zygote develops into the embryo.

In flowering plants the other sperm nucleus unites with two polar nuclei of the central cell of the embryo sac and forms an endosperm nucleus. This endosperm nucleus later produces the endosperm tissue around the embryo in the seed.

The tissue surrounding the embryo sac, composing the main part of the ovule at this stage, is later partly digested during the development of the embryo and endosperm tissue.

Surrounding the seed is a hard, tough seed coat; the outer part of the seed is the seed coat and develops from the integument(s) of the ovule. The micropyle through which the pollen tube entered the ovule tends to remain as a small opening in the
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seed coat and is situated close to the point of attachment of the funicle to the seed. The other end of the funicle is attached to the placenta on the inside of the fruit wall. When the seed is removed, a small scar, called the hilum, marks the former attachment of the funicle to the seed.

Please complete Activity 10.
Activity to be completed by groups of 2
Develop a presentation in which you discuss the purpose of flowers, their structure, pollination and seed development and the link to fruit development.

<table>
<thead>
<tr>
<th>Concept (SO 5)</th>
<th>I understand this concept</th>
<th>Questions that I still would like to ask</th>
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<tbody>
<tr>
<td>The structure of a flower in relation to pollination is described and illustrated.</td>
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<tr>
<td>The process of pollination and the importance of cross-pollination in relation to agricultural systems is explained.</td>
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<tr>
<td>The process of fertilization of the ovule and the development of the fruit is explained.</td>
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<tr>
<td>The development of seeds is described.</td>
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My Notes ...

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Am I ready for my test?

- Check your plan carefully to make sure that you **prepare in good time**.
- You have to be found **competent** by a qualified **assessor** to be declared competent.
- Inform the assessor if you have any **special needs** or requirements before the agreed date for the test to be completed. You might, for example, require an interpreter to translate the questions to your mother tongue, or you might need to take this test orally.
- Use this worksheet to help you prepare for the test. These are **examples of possible questions** that might appear in the test. All the information you need was taught in the classroom and can be found in the learner guide that you received.

1. **I am sure** of this and understand it well
2. **I am unsure** of this and need to ask the Facilitator or Assessor to explain what it means

<table>
<thead>
<tr>
<th>Questions</th>
<th>1. I am sure</th>
<th>2. I am unsure</th>
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<tbody>
<tr>
<td>1. What is a plant cell and what is its role in relation to plant growth?</td>
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<tr>
<td>2. What are the two major metabolic processes that occur in plant cells?</td>
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<td>3. What are the main environmental factors that may influence germination?</td>
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<td>4. What is a plant root and its main function?</td>
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<td>5. What is the function of plant leaves?</td>
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<td>6. What is the function of flowers?</td>
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<td>7. What is the function of stems?</td>
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</table>
Demonstrate a basic understanding of the physiological functioning of the anatomical structures of the plant

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Checklist for practical assessment …

Use the checklist below to help you prepare for the part of the practical assessment when you are observed on the attitudes and attributes that you need to have to be found competent for this learning module.

<table>
<thead>
<tr>
<th>Observations</th>
<th>Answer Yes or No</th>
<th>Motivate your Answer (Give examples, reasons, etc.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Can you identify problems and deficiencies correctly?</td>
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<tr>
<td>Are you able to work well in a team?</td>
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<tr>
<td>Do you work in an organised and systematic way while performing all tasks and tests?</td>
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<tr>
<td>Are you able to collect the correct and appropriate information and / or samples as per the instructions and procedures that you were taught?</td>
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<tr>
<td>Are you able to communicate your knowledge orally and in writing, in such a way that you show what knowledge you have gained?</td>
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<tr>
<td>Can you base your tasks and answers on scientific knowledge that you have learnt?</td>
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<td>Are you able to show and perform the tasks required correctly?</td>
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<tr>
<td>Are you able to link the knowledge, skills and attitudes that you have learnt in this module of learning to specific duties in your job or in the community where you live?</td>
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</tbody>
</table>

♦ The assessor will complete a checklist that gives details of the points that are checked and assessed by the assessor.  
♦ The assessor will write commentary and feedback on that checklist. They will discuss all commentary and feedback with you.  
♦ You will be asked to give your own feedback and to sign this document.  
♦ It will be placed together with this completed guide in a file as part of you portfolio of evidence.  
♦ The assessor will give you feedback on the test and guide you if there are areas in which you still need further development.
Paperwork to be done ...

Please assist the assessor by filling in this form and then sign as instructed.

<table>
<thead>
<tr>
<th>Learner Information Form</th>
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</thead>
<tbody>
<tr>
<td>Unit Standard</td>
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Users are free to produce and adapt this material to the maximum benefit of the learner.

No user is allowed to sell this material whatsoever.
Acknowledgements

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  Didacsa Design SA (Pty) Ltd

- Layout:
  Ms A du Plessis
SOUTH AFRICAN QUALIFICATIONS AUTHORITY

REGISTERED UNIT STANDARD:

Demonstrate a basic understanding of the physiological functioning of the anatomical structures of the plant

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<th>SAQA US ID</th>
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<td>116272</td>
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PURPOSE OF THE UNIT STANDARD

The learner will be able to identify and describe the physiological processes of the different anatomical structures of the plant.

Learners will gain specific knowledge and skills in plant anatomy and physiology and will be able to operate in a plant production environment implementing sustainable and economically viable production principles.

They will be capacitated to gain access to the mainstream agricultural sector, in plant production, impacting directly on the sustainability of the sub-sector. The improvement in production technology will also have a direct impact on the improvement of agricultural productivity of the sector.

LEARNING ASSUMED TO BE IN PLACE AND RECOGNITION OF PRIOR LEARNING

It is assumed that a learner attempting this unit standard will show competence against the following unit standards or equivalent:

- NQF 2: Recognise and identify the basic functions of the ecological environment.
- NQF 2: Demonstrate a basic understanding of the structure and functions of a plant.

UNIT STANDARD RANGE

Whilst range statements have been defined generically to include as wide a set of alternatives as possible, all range statements should be interpreted within the specific context of application.

Range statements are neither comprehensive nor necessarily appropriate to all contexts. Alternatives must however be comparable in scope and complexity. These are only as a general guide to scope and complexity of what is required.
Specific Outcomes and Assessment Criteria:

**SPECIFIC OUTCOME 1**
Demonstrate an understanding of the structure and basic functioning of a plant cell.

**OUTCOME RANGE**
The structure of a plant cell refers to but is not limited to the cell wall, nucleus, cytoplasm, mitochondria and plastids.

**ASSESSMENT CRITERIA**

**ASSESSMENT CRITERION 1**
The structure of a plant cell is illustrated and explained.

**ASSESSMENT CRITERION 2**
The functions of the different components of a plant cell are described.

**ASSESSMENT CRITERION 3**
The role of a plant cell in relation to plant growth is explained.

**ASSESSMENT CRITERION 4**
The role of the plant cell in relation to metabolic processes of the plant is described.

**SPECIFIC OUTCOME 2**
Describe the effect of the environmental on the physiology and germination of the seed.

**OUTCOME RANGE**
The environment may include but is not limited to water, temperature and light. Germination refers to the development of the seed after emerging from the seed coat.

**ASSESSMENT CRITERIA**

**ASSESSMENT CRITERION 1**
The effect certain environmental factors have on seed germination is described.

**ASSESSMENT CRITERION 2**
The process of imbibitions and the rupturing of the seed coat is explained.

**ASSESSMENT CRITERION 3**
The role that the environment plays on the activation of endogenous hormones during germination is explained.

**SPECIFIC OUTCOME 3**
Describe the anatomy of the root and stem in relation to its function in the translocation of water and nutrients.

**OUTCOME RANGE**
The anatomy refers to the different microscopic parts of the root and stem. Anatomical structures refers to: a) root and root hairs, root cap, root cells, vascular bundles; b) stem - vascular bundles (consisting of xylem, phloem and cambium), Translocation refers to the movement of water and nutrients to the entire plant.
ASSESSMENT CRITERIA

ASSESSMENT CRITERION 1
The basic anatomy of the root is illustrated.

ASSESSMENT CRITERION 2
The characteristics of the xylem vessels and how it functions in the movement of water up a plant is explained.

ASSESSMENT CRITERION RANGE
Transport refers to movement of water and nutrients from the roots up.

ASSESSMENT CRITERION 3
The transport of organic food by the phloem vessels is explained.

ASSESSMENT CRITERION 4
The role of the cambium in the growth of the vascular bundles is explained.

SPECIFIC OUTCOME 4
Demonstrate an understanding of the anatomy and physiology of a leaf.

OUTCOME RANGE
The structure of the leaf includes but is not limited to cuticle, mesophyll, stomata and vascular bundles.

ASSESSMENT CRITERIA

ASSESSMENT CRITERION 1
The basic anatomical structure of a leaf is explained.

ASSESSMENT CRITERION 2
An understanding of the function of stomata and its role in gaseous exchange and transpiration is demonstrated.

ASSESSMENT CRITERION 3
The different types of leaf-hairs and their role in transpiration and plant protection is described.

ASSESSMENT CRITERION RANGE
Plant protection by leaf-hairs refers to specialised cells, which act to reduce transpiration or exude chemicals to protect against insects.

SPECIFIC OUTCOME 5
Identify and describe the anatomical structures of a flower in relation to fruit and seed development.

OUTCOME RANGE
Anatomical structures of a flower may include but is not limited to sepals, pistils and petals.

ASSESSMENT CRITERIA

ASSESSMENT CRITERION 1
The structure of a flower in relation to pollination is described and illustrated.

ASSESSMENT CRITERION 2
The process of pollination and the importance of cross-pollination in relation to agricultural systems is explained.

**ASSESSMENT CRITERION RANGE**
Pollination refers to but is not limited to the transfer of pollen to the stigma by insects.

**ASSESSMENT CRITERION 3**
The process of fertilization of the ovule and the development of the fruit is explained.

**ASSESSMENT CRITERION 4**
The development of seeds is described.

**UNIT STANDARD ACCREDITATION AND MODERATION OPTIONS**
The assessment of qualifying learners against this standard should meet the requirements of established assessment principles.

It will be necessary to develop assessment activities and tools, which are appropriate to the contexts in which the qualifying learners are working. These activities and tools may include an appropriate combination of self-assessment and peer assessment, formative and summative assessment, portfolios and observations etc.

The assessment should ensure that all the specific outcomes; critical cross-field outcomes and essential embedded knowledge are assessed.

The specific outcomes must be assessed through observation of performance. Supporting evidence should be used to prove competence of specific outcomes only when they are not clearly seen in the actual performance.

Essential embedded knowledge must be assessed in its own right, through oral or written evidence and cannot be assessed only by being observed.

The specific outcomes and essential embedded knowledge must be assessed in relation to each other. If a qualifying learner is able to explain the essential embedded knowledge but is unable to perform the specific outcomes, they should not be assessed as competent. Similarly, if a qualifying learner is able to perform the specific outcomes but is unable to explain or justify their performance in terms of the essential embedded knowledge, then they should not be assessed as competent.

Evidence of the specified critical cross-field outcomes should be found both in performance and in the essential embedded knowledge.

Performance of specific outcomes must actively affirm target groups of qualifying learners, not unfairly discriminate against them. Qualifying learners should be able to justify their performance in terms of these values.

- Anyone assessing a learner against this unit standard must be registered as an assessor with the relevant ETQA.
- Any institution offering learning that will enable achievement of this unit standard or assessing this unit standard must be accredited as a provider with the relevant ETQA.
- Moderation of assessment will be overseen by the relevant ETQA according to the moderation guidelines in the relevant qualification and the agreed ETQA procedures.

**UNIT STANDARD ESSENTIAL EMBEDDED KNOWLEDGE**
It is assumed that a learner attempting this unit standard will show competence against the following unit standards or equivalent:

- The learner should be able to identify and describe the various parts of the plant.
- The function of the various parts of the plant.
A learner should realise that the environment plays an important role in the functioning of a plant.
A learner should be aware that nature plays a role in the anatomical functions of plants.
A learner should know that all functions and structured of a plant are interrelated.

**UNIT STANDARD DEVELOPMENTAL OUTCOME**
N/A

**UNIT STANDARD LINKAGES**
N/A

**Critical Cross-field Outcomes (CCFO):**

**UNIT STANDARD CCFO IDENTIFYING**
Problem Solving: Relates to all outcomes.

**UNIT STANDARD CCFO WORKING**
Teamwork: Relates to all outcomes.

**UNIT STANDARD CCFO ORGANIZING**
Self-Management: Relates to all outcomes.

**UNIT STANDARD CCFO COLLECTING**
Interpreting Information: Relates to all outcomes.

**UNIT STANDARD CCFO COMMUNICATING**
Communication: Relates to all outcomes.

**UNIT STANDARD CCFO SCIENCE**
Use Science and Technology: Relates to all outcomes.

**UNIT STANDARD CCFO DEMONSTRATING**
The world as a set of related systems: Relates to all outcomes.

**UNIT STANDARD CCFO CONTRIBUTING**
Self-development: Relates to all outcomes.

**UNIT STANDARD ASSESSOR CRITERIA**
N/A

**UNIT STANDARD NOTES**
N/A

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