

Scene Six



Friday morning

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Place:

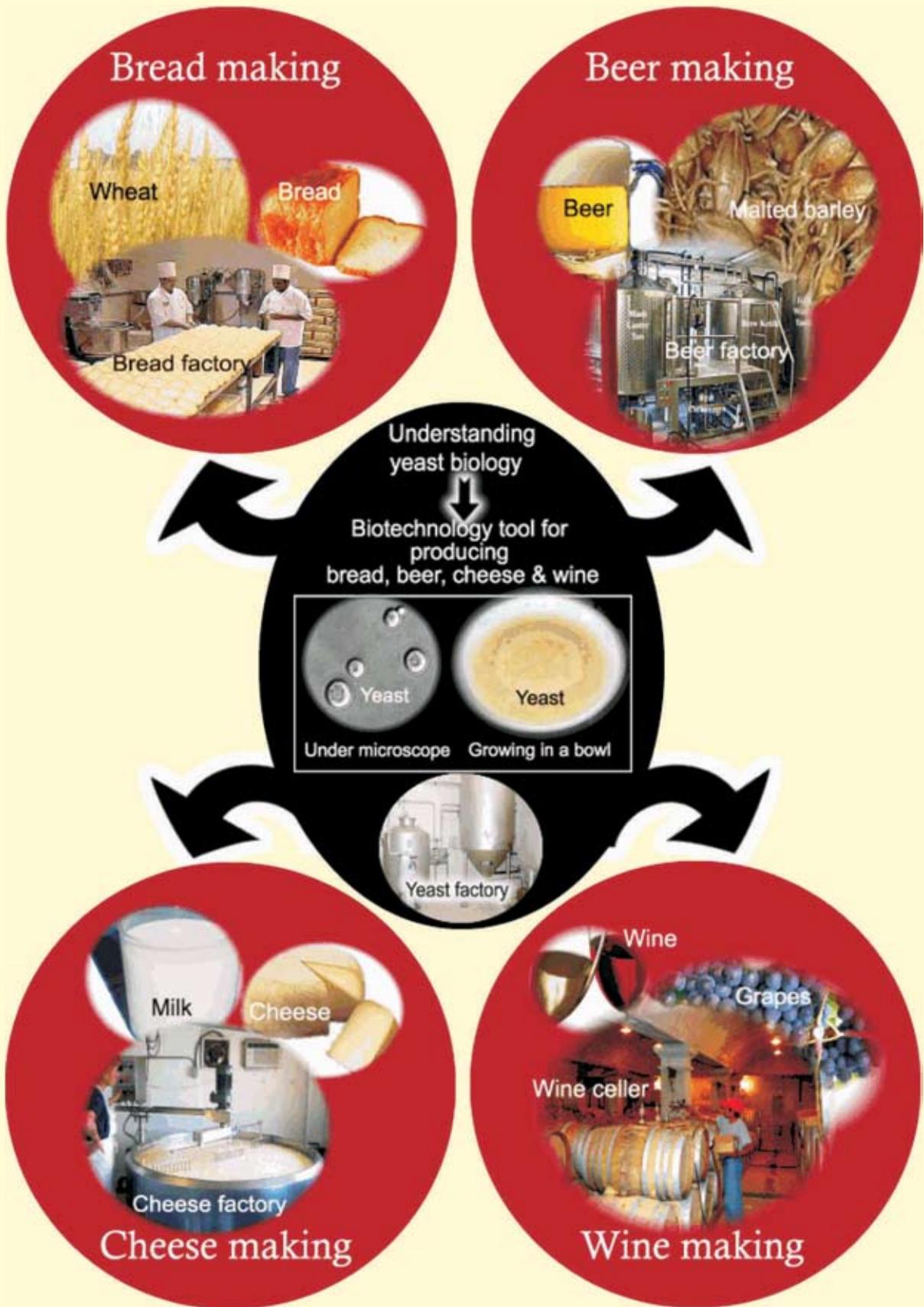
Classroom

Characters:

Students & biology teacher

Situation:

A discussion on biotechnology tools



Simple biotechnology tools

Scene Six:
Friday morning

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A discussion on biotechnology tools

Teacher:

Good morning students. During our last biology class, we discussed "PGR", "conservation" and "gene banks". Today we will discuss "biotechnology". Who can tell me something about biotechnology?



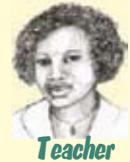
Efia:

Biotechnology uses biological material in order to make, modify or improve plants, animals or micro-organisms for specific uses.



Teacher:

Very good! So can you tell me what biotechnology tools are?



Mandisa:

Biotechnology tools are all the techniques that use biological material to make, modify or improve plants, animals or micro-organisms.



Dhakiya:

So, when we use live yeast to produce something, are we using a biotechnology tool?



Teacher:

Yes, the processes of making beer, bread, wine and cheese using yeast and bacteria are good examples of biotechnology tools. For example, the knowledge of how to use yeast to produce soft bread came from an understanding of how and when yeast reacts. So this knowledge about yeast biology is used as a biotechnology tool. The term "biotechnology" was coined only in 1917 when plant and animal breeding techniques were developed on a large scale.



Gathi:

Are you going to tell us how biotechnology tools can now be used for conservation of PGR?



Teacher:

Yes, that is the focus of our discussion today. The simple biotechnology tools are "cryopreservation", "tissue culture" and "micropropagation".



Dhakiya:

I have heard that biotechnology tools were used to develop a cassava plant that is virus-resistant.



Teacher:

Yes, that is right, Dhakiya. What do you know about virus-resistant cassava?



Dhakiya:

My dad was talking with his friends about it. He said that we can now buy small cassava plants that will not be killed by a virus that normally kills them when they grow into bigger plants.



Teacher:

Do you know the name of the virus, Dhakiya?



Dhakiya:

No, I don't know the name of the virus.



Teacher:

It is called "cassava mosaic virus". The disease is called cassava mosaic disease or CMD. It is caused by a white fly that carries the virus within it.



Pepukayi:

Was this insect-resistant cassava variety made using biotechnology tools?

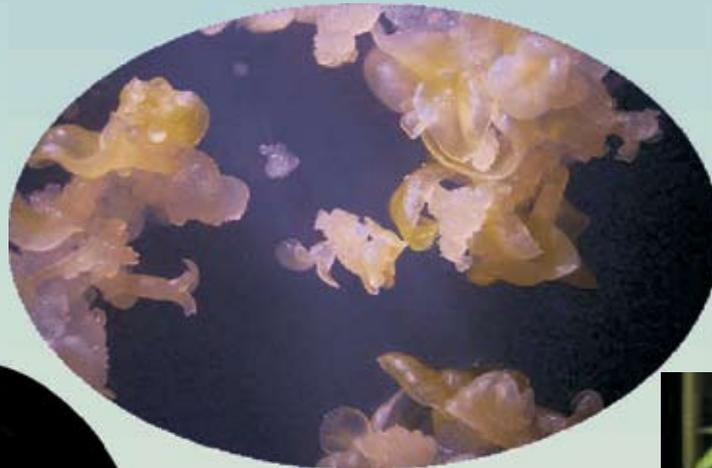
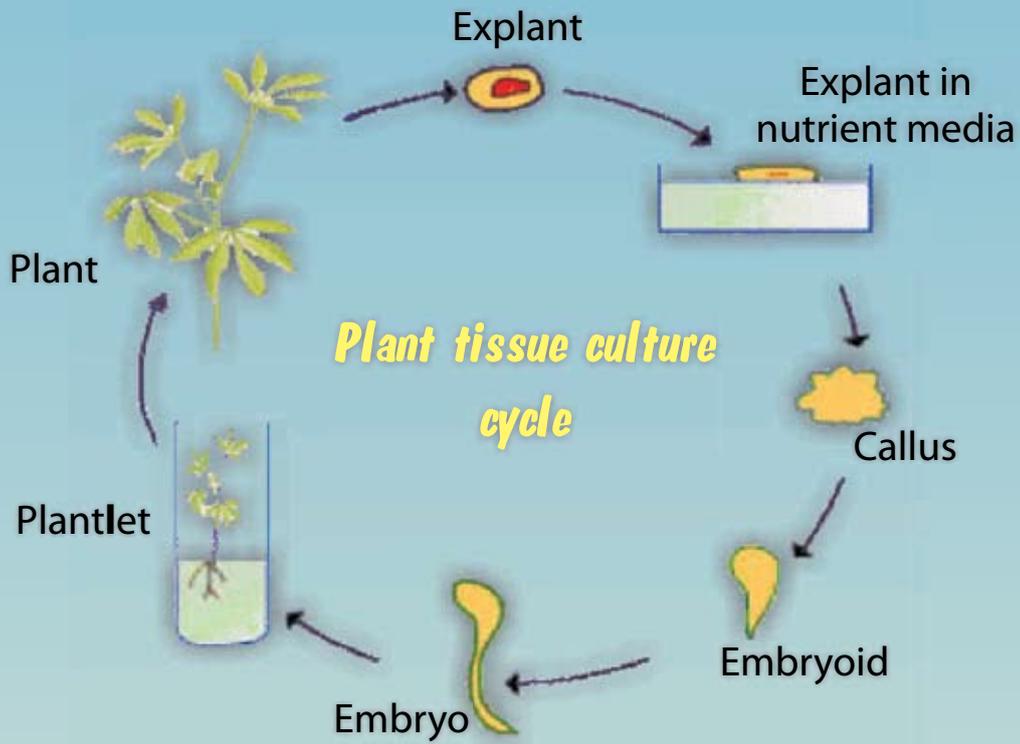


Teacher:

Yes. The biotechnology tools used in growing and propagating these varieties are called plant tissue culture and micropropagation.



Plant tissue culture



Cassava culture
Source: GD Stone



36 **Cassava plantlet growing from callus**



Cassava plantlet growing in test tube

Efia:

Are these tools also useful for conserving these varieties?

Teacher:

Yes. The tissue culture technique is very useful for conserving the richness of plant diversity. The technique helps in preparing and storing disease-free plants and plant material. At the same time plant genetic resources are the raw materials for any application of biotechnology.

Efia:

If we want to reuse something we must have a way to save and store it. If we want PGR for future use then we must conserve them in some way.

Dafina:

So, what type of plant tissue is used for tissue culture?

Teacher:

Tissue culture utilizes plant cells that are capable of generating a whole new plant; in other words, these cells are totipotent. The totipotent single cell or group of cells can be encouraged, in the right nutrient medium, to grow into a whole new plant.

Dhakiya:

What is so special about tissue culture in comparison with the normal way of growing a plant?

Teacher:

Tissue culture can produce many identical copies of a plant from a single cell of that plant, so this speeds up the process of making a new variety available to everyone. It is done in a laboratory under sterile conditions. Don't you think this biotechnology tool is amazing, Dhakiya?

Dhakiya:

Yes, it is very interesting. Tissue culture increases the number of plants, but how can this technique help in conserving PGR?



Efia



Teacher



Efia



Dafina



Teacher



Dhakiya



Teacher



Dhakiya

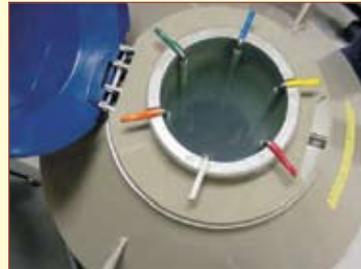
Cryopreservation



Collecting liquid nitrogen from a big container to a small flask



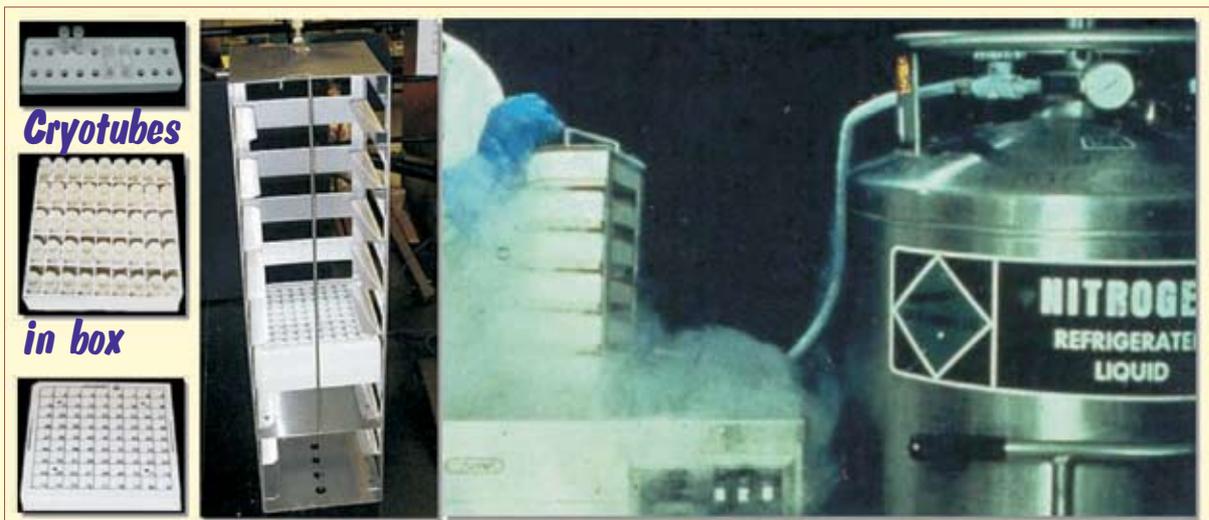
Storing samples in a smaller container



Open container



Closed container



Cryotubes

in box

box

Rack

Rack with boxes in Cryo-tank

Equipment for cryopreservation

Teacher:

Tissue culture technique is not only used to multiply the number of cells but also to store the plants for use over a long period of time in the future. This technique has a huge potential to contribute towards conservation.



Teacher

Hakika:

Do farmers protect their PGR using biotechnology tools?



Hakika

Teacher:

Not the farmers themselves, but for their benefit, many national and international organizations do. In many ways, saving, storing and reusing PGR requires a knowledge of biology and biotechnology.



Teacher

Kunto:

I know what "biotechnology" means but I still do not understand what the term "biotechnology tool" means?



Kunto

Dhakiya:

Kunto, that is very easy. Biotechnology tools are the techniques used to increase, improve and conserve biological materials such as plants. We need to know biology, the appropriate methods and the kinds of equipment needed for these techniques, so as to actually use the biotechnology tools in the laboratories.



Dhakiya

Teacher:

Can anyone give me some examples of techniques that are commonly used to conserve biological materials?



Teacher

Dalila:

How about cryopreservation? It is a quick deep-freezing method for biological materials.



Dalila

Ekow:

Is cryopreservation a biotechnology tool for the conservation of PGR?



Ekow

Teacher:

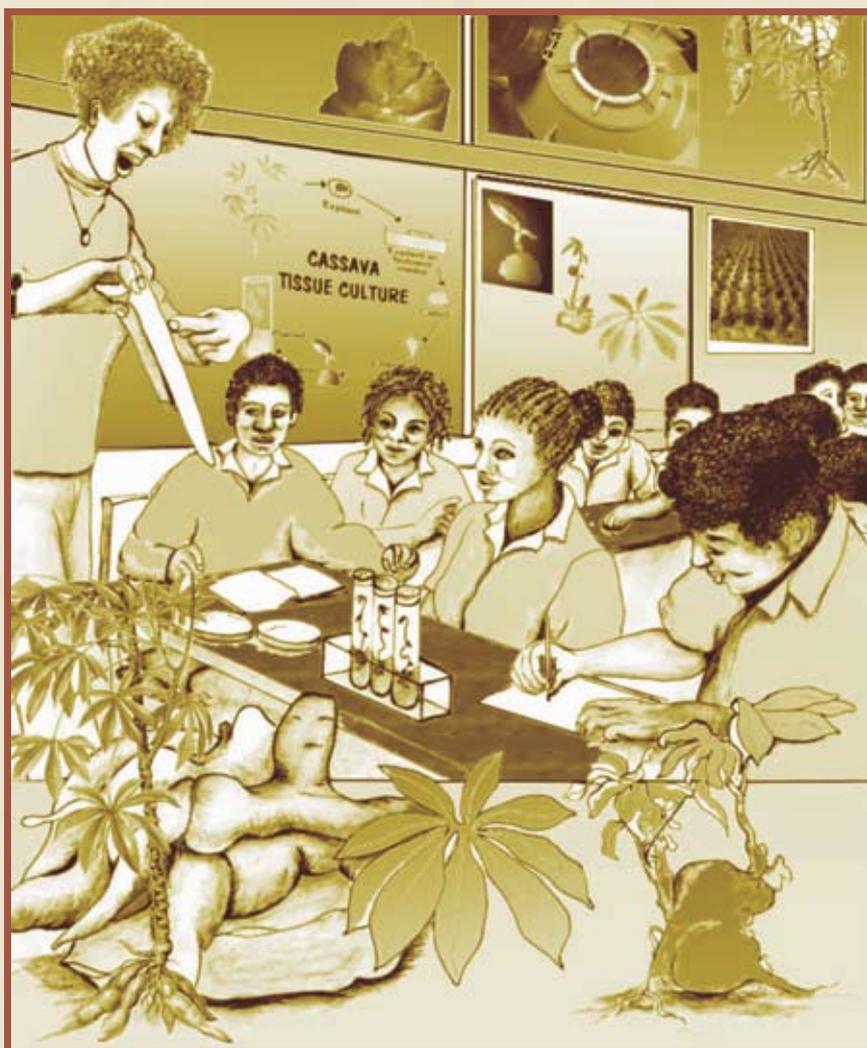
Well, to find out the answer to your question, you will have to wait until the next biology class. We have a guest speaker called Dr Mardea who will tell us about it tomorrow. She is a biotechnologist who knows all about cryopreservation and tissue culture.



Teacher

That is all for today. I will see you in the next class with Dr Mardea.

Scene Seven



Monday afternoon

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Place:

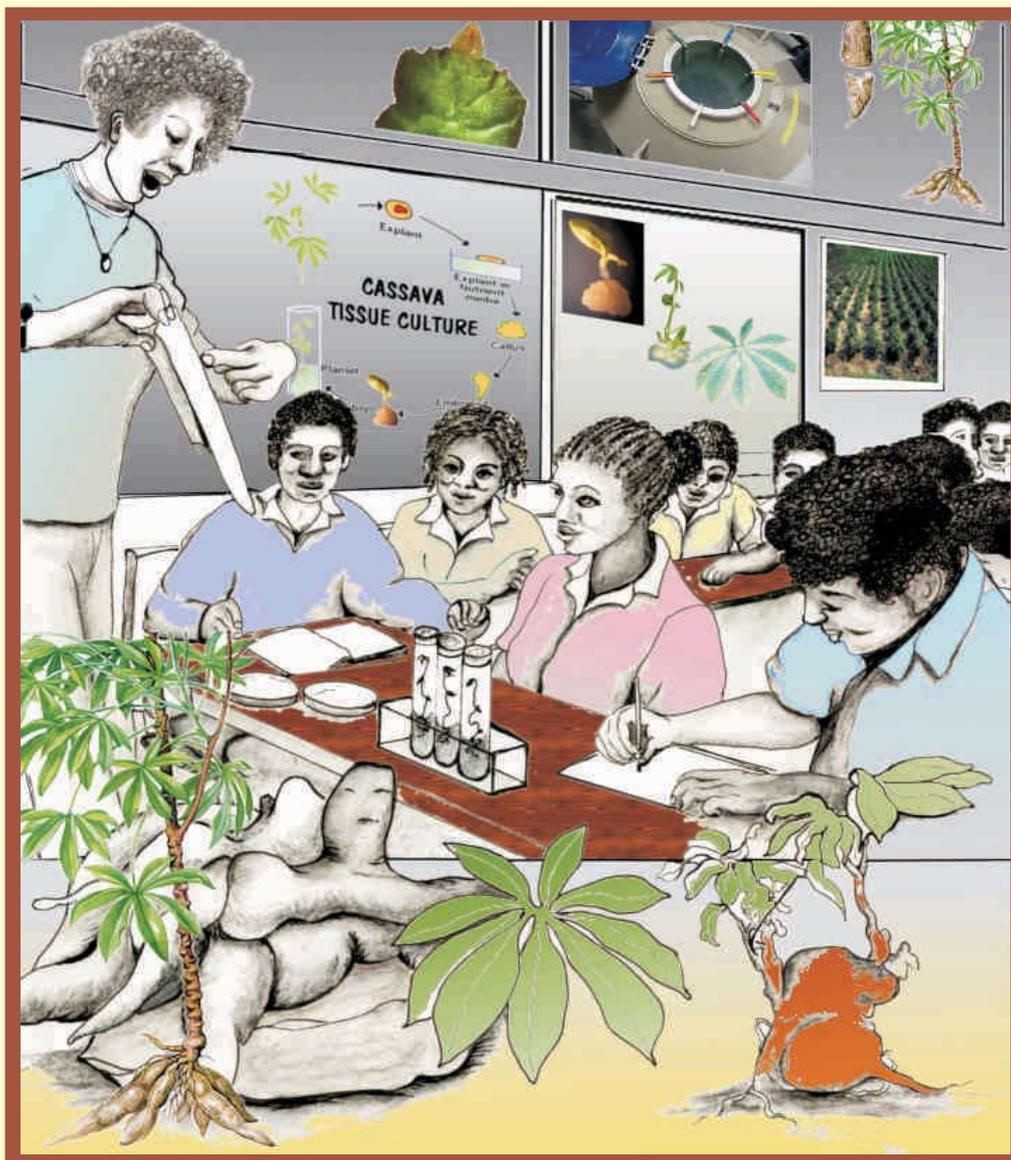
Classroom

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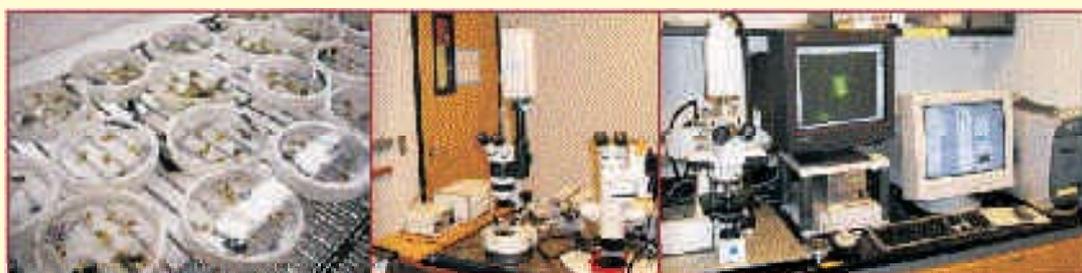
Students, teacher and
Dr Mardea

Situation:

Dr Mardea visits: discussion
about the link between
biotechnology tools and PGR
conservation



Dr. Mardea is explaining plant tissue culture to students.



Culture grown in petri dishes

Plant tissue culture room with microscopes

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Students, teacher and
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Situation:

Dr Mardea visits: discussion
about the link between
biotechnology tools and PGR
conservation

Teacher:

Good morning everyone. This is Dr Mardea. She will talk to you about plant tissue culture and explain why it is one of the biotechnology tools used for conserving PGR. Listen carefully. If you have questions write them down immediately so that you can ask her when it is time to ask questions.



Dr Mardea:

Hello everyone. Are you all ready to listen to some fascinating information about biotechnology?



Students:

Yes, Dr Mardea.

Dr Mardea:

Right. Everything I will talk about is related to one of our favourite and most important tuber crops here in Africa, called cassava. Do you know cassava?



Students:

Yes, we do; our teacher has already told us a lot about it.

Dr Mardea:

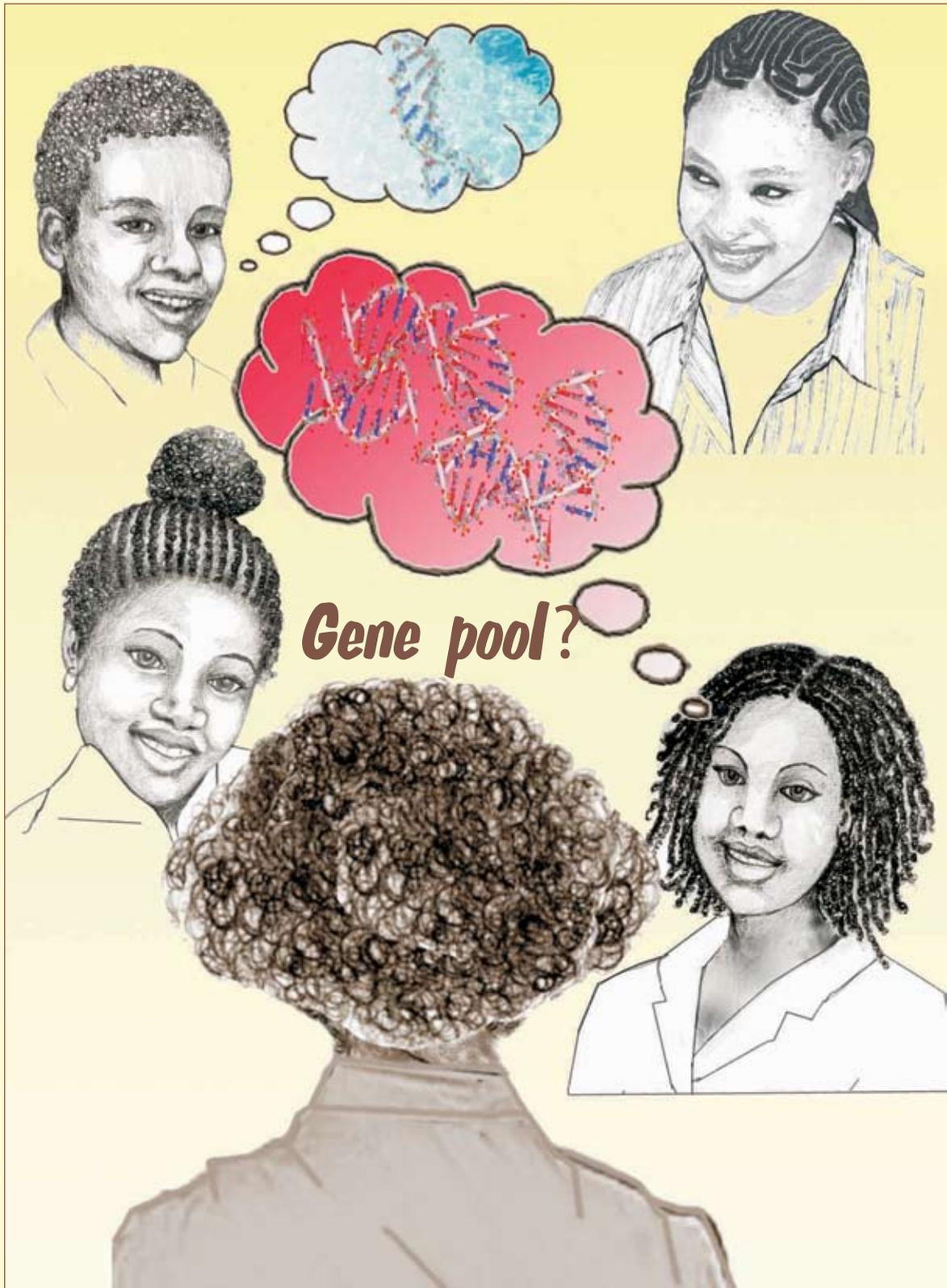
Do you also know what scientists do to improve, conserve and reuse cassava using tissue culture?



Ekow:

Is this what you are going to tell us about today?





A gene pool is the sum of all the genetic information carried by all members of a population of a (plant) species.

Dr Mardea:

Yes, today I will tell you about cassava conservation. The plant tissue culture technique is useful for many different purposes but, most of all, it is useful for conserving clean, disease-free and healthy genetic resources in a safe manner, so that they can be used in the future when they are needed.

Ekow:

We already know this because our teacher discussed it in our last class.

Efia:

Ekow, please be patient and listen.

Hakika:

(With a smile) I think we should quiz Ekow after class as he knows everything.

Ekow:

Yes, that would be great.

Dr Mardea:

You seem to be very bright students. I am glad that you are knowledgeable in this field. The plant tissue culture technique involves the utilization of biological materials and therefore it is a biotechnology tool. Before we learn the details of tissue culture, I think we must discuss the term germplasm and PGR and what PGR conservation means. Who can tell me what germplasm means?

Dafina:

Germplasm is the genetic material that carries the inherited characteristics of an organism.

Dr Mardea:

Very good. Can anyone tell me what a gene pool is?

Hakika:

The gene pool is the sum of all the genetic information carried by all members of a population of a plant species.

Ekow:

Hakika, do you realize that there is no diving in the deep end of the gene pool? **(Everybody has a good laugh. Efia makes faces to let Ekow know that it is not the joking time)**



Dr Mardea



Ekow



Efia



Hakika



Ekow



Dr Mardea



Dafina



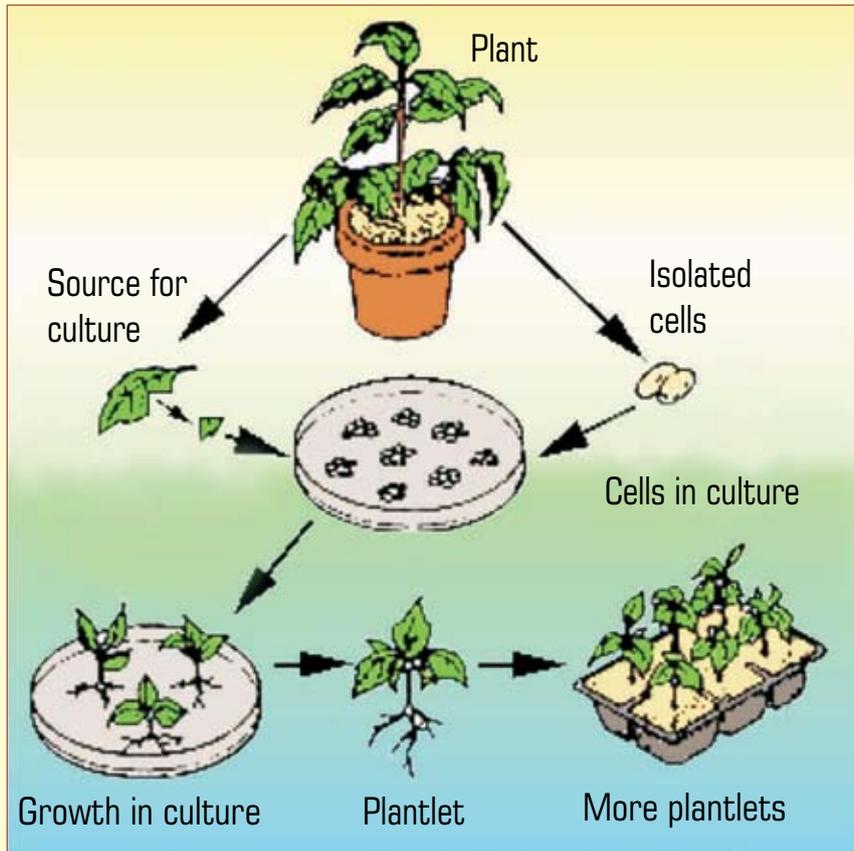
Dr Mardea



Hakika



Ekow



Steps in Micropropagation



Simple mathematics...micropropagation

Micropropagation is a very efficient tool for propagation of a genetic material. This is especially so in the case of the “elite plants” which cannot be multiplied through seeds or even through horticulture. Somatic embryogenesis, especially with cell suspensions, offers a powerful tool for multiplication.



In the labs

In a green house

Dr Mardea:

Very good Hakika. I am impressed. Can anyone tell me what PGR means in this context?

Dene:

The genetic resource of a particular crop type is any genetic material of the original crop that has the potential value to create a new, or even an improved, crop.

Ekow:

Dr Mardea, our biology teacher told us, that we must protect the germplasm diversity of any crop from being lost, so as to make it available for future use. Does this mean, we have to store, I mean conserve, all PGR?

Dr Mardea:

Yes, it is true. Now, in order to save and store the germplasm and the genetic variety, the germplasm has to be stored in a place where it can be distributed for further use. This has to be somewhere outside the plant body itself. This type of conservation is called in vitro conservation.

Sabola:

Dr Mardea, if we have to conserve the germplasm outside the plant, it has to be in a form that can be stored in a container. Then later on it has to be taken out and grown to increase the number of plants. How does the tissue culture technique help in this?

Dr Mardea:

The tissue culture technique is essential for the entire process of germplasm conservation, maintenance, distribution and micropropagation. We shall see this later on.

Efia:

I know that "micro" means small, but what is micropropagation?

Dr Mardea:

Micropropagation involves growing very small plant parts in a test tube or other container with a nutrient medium under sterile conditions. You can simply say that micropropagation is plant tissue culture for regenerating a whole plant from the cells, tissues or organs of that plant.

There are two important concepts that we must know about plant cells to understand micropropagation; these are "totipotency" and "plasticity".



Dr Mardea



Dene



Ekow



Dr Mardea



Sabola



Dr Mardea



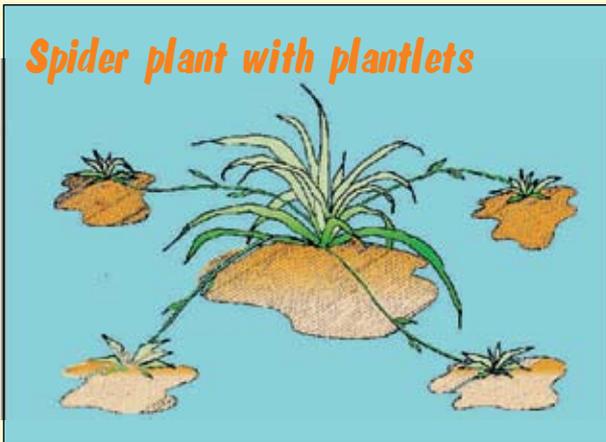
Efia



Dr Mardea

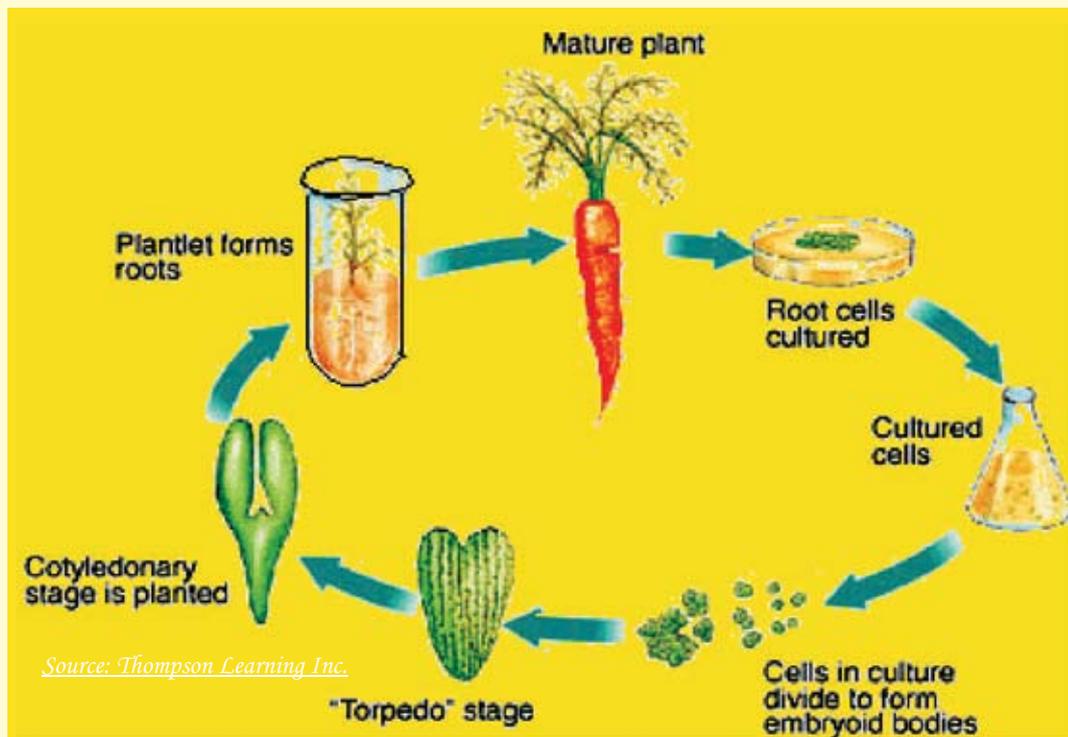
Link between "Totipotency" and "PGR"

Spider plant with plantlets



A plant reproduces itself vegetatively using its totipotent cells.

Totipotency: the ability of a cell to multiply into a whole organism.



Source: Thompson Learning Inc.

A carrot root is cut into discs and cultured in a liquid nutrient medium. Individual cells are divided to form clumps of undifferentiated cells known as embryoid bodies. Transferring the embryonic tissue to a solid nutrient medium stimulates the tissues to form small plants, called plantlets, which then develop into mature plants.

Dhakiya:

Totipotency is familiar to us because our teacher talked about it. Plasticity sounds like the cells would be flexible. Am I correct, Dr Mardea?



Dr Mardea:

You are almost right. First, can you explain what "totipotency" means?

Dhakiya:

"Totipotency" of the cell or tissue means, that the starting tissue has the potential to generate all other cells and tissues necessary to grow a whole new plant. In other words, the starting cell or tissue has the ability to generate not just its own type of cell but any type of cell found in that particular plant.



Dr Mardea:

Very Good. "Cellular totipotency" is a very old concept. The term was coined in 1902. Your comment about plasticity is also correct. Plasticity of a cell or tissue means that it is able to adjust to the changes in the environmental conditions.



Ekow:

Dr. Mardea, please wait, I am very confused. I think we are talking about two different things here. One is that plant tissue culture is a biotechnology tool. It can be used to grow a whole new plant from a small part of a plant in sterile conditions with proper nutrition using cells that are totipotent. But how is this subject connected to our previous discussion about PGR and the need to conserve PGR in the form of germplasm so that we can use it when we need it. Tissue culture is a biotechnology tool, but how is it used for germplasm conservation?



Dr Mardea:

A very good question. This means that you have understood everything up to now.

Ekow:

(With a big smile) But I still don't understand the direct link between plant tissue culture and plant germplasm conservation.



Dr Mardea:

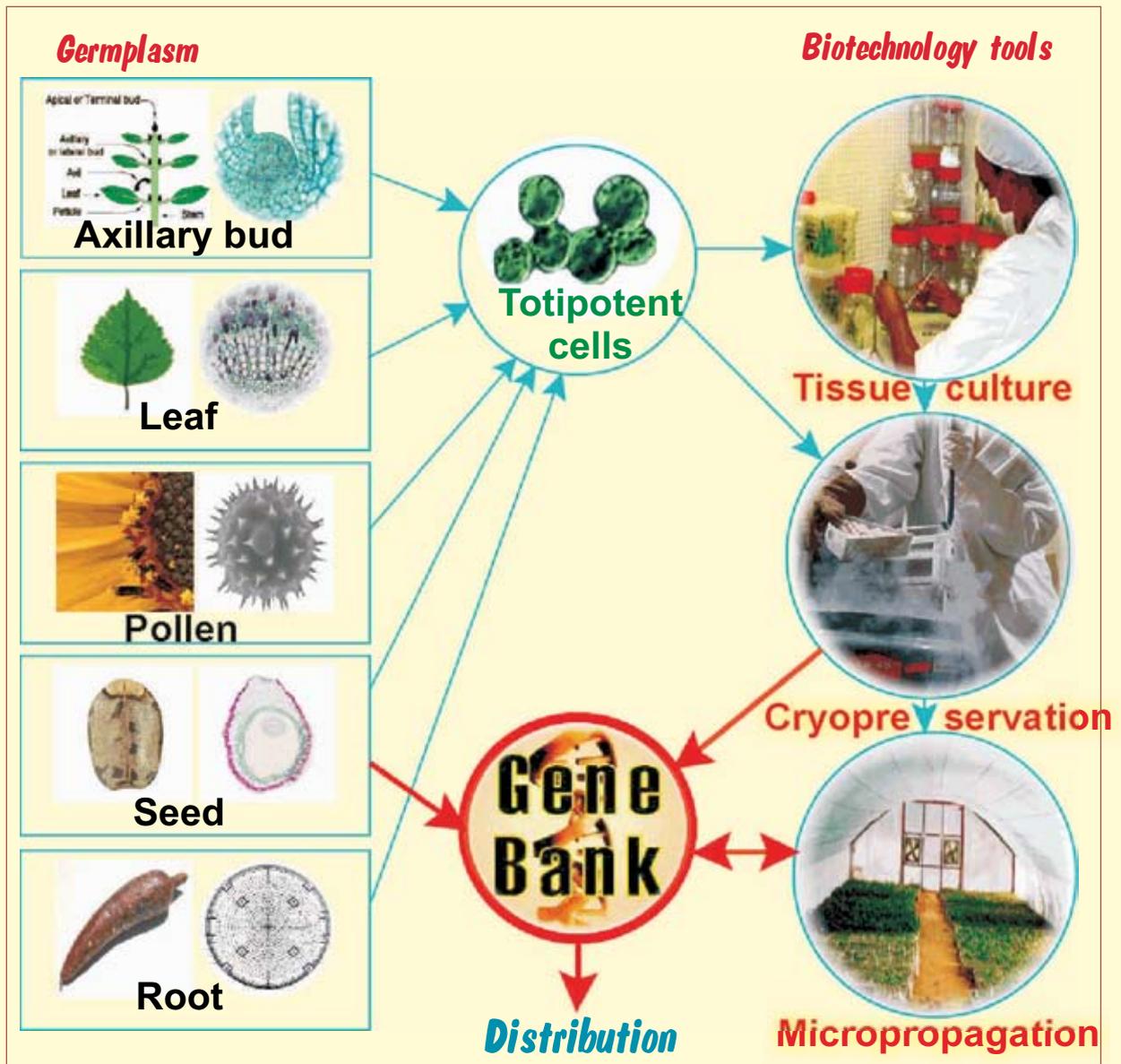
OK. Now, tell me, what is plant germplasm?

Ekow:

Plant germplasm is the genetic material of the plant that can give rise to a new plant.



Link between biotechnology tools and PGR conservation



Plant germplasm is the living tissue from which new plants can be grown. Germplasm is usually seed, or another plant part - a stem, a leaf, or pollen or even just a few cells that can be cultured into a whole plant.

Use of biotechnology tools, when appropriate, will stop the decline of agricultural biodiversity and will enhance the wealth of genetic resources for future sustainable use.

Dr. Mardea:

And what is that genetic material?

Safwani:

It is the seed of a plant that contains the whole genome of that plant.

Dr. Mardea:

So, if a plant does not have any seeds or cannot produce good seeds, would you then say that it does not have any germplasm to produce a new identical plant?

Ekow:

No, that is not true. We know that cassava plants can be propagated by the asexual method or through tissue culture. It is not necessary to have cassava seeds to grow a cassava plant.

Dr. Mardea:

Right. Plant germplasm is the living tissue from which new plants can be grown. Plant germplasm is not only the plant seed but also other plant parts, such as the stem, leaf or pollen. For example, a few cells from a plant can be cultured into a whole new plant. Plant germplasm contains all the genetic information for the plant's hereditary make-up.

Now do you understand why the tissue culture technique is used for germplasm conservation, exchange and micropropagation?

Ekow:

Not really.

Dr. Mardea:

If you think logically, you will understand Ekow.

If we want to conserve or propagate a plant, tissue culture techniques and sterile conditions are essential, to get a clean sample of the germplasm from the appropriate part of that plant.

If the germplasm is to be transferred from place to place and is to be used after a long period of time, it has to be stored in a suitable way using cryopreservation. All these activities are steps in germplasm conservation, exchange and reuse, to save and provide healthy and disease-free resources which then can produce healthy disease-free plants. Therefore, a knowledge of biotechnology tools is essential for the conservation and use of plants.

Ekow:

Now I understand. **(Smiles with relief)**

Dr. Mardea:

Wonderful! I am glad that you understand.

(Bell rings and the class is dismissed and the students leave.)



Dr Mardea



Safwani



Dr Mardea



Ekow



Dr Mardea



Dr Mardea



Ekow



Ekow



Dr Mardea



Dr Mardea



Ekow



Ekow



Dr Mardea



Dr Mardea

