potting mix. Roots emerge readily from the rockwool blocks into all standard potting mixtures. Plants propagated in rockwool blocks may be hand potted or put through potting machines. Growers who use hydroponic systems may wish to put up the young plants into wrapped cubes which have previously cut holes for the purpose. Plants are then grown on in these cubes until they are set out in the hydroponic system.

A wide range of plants have been successfully propagated from either seed or cuttings in Australian horticultural rockwool. The material also shows promise as a medium in which to establish tissue cultured plants when they are taken out of the propagating flasks.

Interest has also been shown in using rockwool as a propagation and growing medium for plants which are intended for export to countries where the import of soil and similar growing media is not permitted.

INTRODUCING STUDENTS TO PLANT TISSUE CULTURE

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I believe that tissue culture is something that is here to stay and something that all horticulturists should be aware of. So what are we doing about it in the classroom? Just that — making students aware of the benefits and the problems it presents and giving them an idea of the laboratory work involved.

We only have 4 hours in our curriculum allotted to this topic, and, because most of our students are not doing this type of work and laboratory techniques and hygiene are so important, I divide them into 2 hours each of theory and practical. Of course, there are students who do more practical work but this has to be apart from normal school hours.

The theory I tackle on a "what, when, why, who, and how basis."

The "WHAT," of course, covers not only a basic definition but also the fact that tissue culture is a term of convenience covering both techniques like, *in vitro*, micro-propagation, and mericloning, and also different parts of the plant — protoplast, cell, tissue and organ culture. I think it may be this rather loose descriptive term that causes some of the criticism — on the one hand it is praised as a marvelous method for the exact reproduction of clones (18); on the other, a scientist extolls it as a wonderful source of variation (8). Both are true but the

former is more likely to occur in using quite a large piece of organised tissue, and the latter only a cell or disorganised callus.

"WHEN" did it start goes back to Haberlandt (7) at the turn of the century, White (19) in the 30's, and Morel (11,12), who really excited the commercial world with his papers on orchids. Of course I also pay tribute to Dr. de Fossard (3) who has done so much to break through the mystique and make tissue culture a commercial reality in Australia.

"WHY." Listing the reasons for doing it (3) — the main point I try to get across is that it is not a kind of magic micro-chip that will make all other methods of propagation history. From the plant propagator's point of view, it is just another method to be tried if there are problems with traditional methods. These problems can be wide ranging — not just difficult to propagate material — shortage of material or space to stock it — seasonal problems — disease problems — and this brings me to my second point, which is the need for virus indexing. There is a laconic comment in an article in HortScience that whereas before mericloning, orchid viruses were a minor problem; they are now common, widespread and costly (9). Obviously rapid multiplication can apply equally to the good and the bad.

"WHO" is doing it ranges from back kitchen operators to sophisticated nurseries — genetic engineering and plant improvement to botanical research.

Lastly, "HOW" do we set about it — plant material, programmes, media, equipment, disinfestation, taking the explant, incubation, and finally growing on. A formidable list but possible by the enormous amount of research that has been done giving well-documented regimes for a vast array of plants. What our students need, I think, is an idea of where to look for the information they require and, hopefully, to understand it when they have found it.

We discuss media — the reasons for various ingredients, and the total lack of reasons for others as well as the relevant merits of moles and milligrams.

Equipment — I show slides of a wide variety of what can be used as opposed to what we use ourselves.

Disinfestation again is usually well documented and, of course, depends greatly on the delicacy of the plant material to be used.

Incubation facilities I also show on slides, varying from those in research laboratories to Dr. de Fossard's plastic sausages. Regimes of daylength and temperature, again depending on the material used.

The three stages, as suggested by Prof. Murashige are: establishment of the culture, proliferation, and preparation for transfer to soil (13). Lastly potting up — the need for increased humidity and controlled temperature in the early stages.

So we come to our 2 hour practical session; 2 hours, that is, for the students — but an enormous amount of time goes into the preparation.

Obviously it is more interesting for everybody if we get results so I choose some of the easier material — usually carnations and chrysanthemums, plus something extra to see what happens. And this is where the fun comes in. All this material has to have a standard disinfestation and the same incubation regime but we mix up several media and try everything on each of them.

Usually one or more just add water — M & S Medium A (14) or B (15) or something like that and one or more specific ones. This year we made up Cooke's 1977 African violet brew (1). We use the little disposable tubes, colour coding the media by different tops. To dispense the media I have a veterinary syringe. This I find much easier on the hand than a Cornwell one — it has a greater capacity, so for 10 ml it is really a very easy movement. For sterilization we have an ancient autoclave, or we use a pressure cooker.

At the same time we sterilize petri dishes with filter papers and McCartney bottles with ordinary water for cooling instruments after flaming.

We also prepare our chlorine mix using 5% calcium hypochlorite, and 0.1% 7 × detergent as recommended by Dr. de Fossard (3). Originally we used powder but have now discovered the granulated, which makes weighing and mixing much pleasanter — it doesn't affect your throat and nose like the powder.

Next came one of our biggest problems — masses of sterile water in convenient containers with a tap so that the plant material could be rinsed after the chlorine treatment; 3 rinses in 30 ml McCartney bottles and say 6 bottles per student and up to 14 students in each of two classes plus spillage — approx. 15 to 16 liters.

We use tea urns — seal the ventilation holes — cover the taps and boil the water for an hour. This has worked with great success for several years but I have now been told that is unsafe unless it is boiled 3 times each time for an hour, cooling in between so I am investigating the possibility of using UV light instead of heat. We do not have laminar flow cabinets so we prepare the lab as best we can, putting away unnecessary equipment, washing over the benches and spraying with 70% ethanol (3) before putting out the sets of instru-

ments and equipment for each student. I have copied Dr. de Fossard's idea of a screen but make them a little larger and of Perspex. Lastly, the plant material is collected and put under the shower for an hour.

And so we come to the laboratory session, where we try to underline that this is a laboratory and not a potting shed operation. Not that hygiene is not important in both but it is critical here.

Our lab has fixed wall benches around 3 sides and four rows of movable ones in the centre. The sterile equipment is laid out round the sides and the students, after "scrubbing-up", come to the centre benches where there is a set of dummy equipment for each.

The first thing is to get their plant material, prepare it, put it in McCartney bottles, label them and fill with the chlorine solution. There, once again, we opt for a standard disinfestation process of 20 minutes in 5% that is suitable for the main material we use — the extra material just has to have the same — last year the leaves and petioles of African violets came through it perfectly well despite other evidence to the contrary (4).

During the 20 minutes I demonstrate excising axillary buds, dissecting leaves and petioles, and sterilising seed. The students then practice.

The less movement by numbers of people at the actual work area the better. How are they going to place their equipment so that, hopefully, they try to cool their red-hot scalpels in water and not alcohol, and so on until the buzzer goes. Then armed with paper tissues saturated in 70% ethanol for their benches and hands, away they go to their side bench work stations.

What are our results? I am amazed and delighted with them. Students average about 8 to 10 tubes each and our contamination rate runs at about 6% which I consider remarkable.

Our biggest problem is probably an understandable lack of dexterity resulting in mangled material and ending up with a piece of dead surface tissue being placed on the medium so that statistics are not really possible on adverse effects of treatment or medium. However positive results can be interesting.

The African violet, for instance, proliferated from both leaf and petiole segments on Cooke's medium, also on M & S medium A.

Chrysanthemums seem to grow on anything but also rooted well on M & S 1962 (16) as well as on Eark & Langhans (6).

In the early stages I had problems getting roots and so took the plant out of the medium, cut off the shoots, dipped them in Formula 20 and potted them up. Away they went saving a whole stage of sterile culture. This is now recommended for *Saintpaulia* (8) and *Episcia* (17) but I think might well be tried for many more species.

Mark Cunningham of Waldron, Ind. recommends a 2 year special academic training and suggests that, for greater opportunities, at least a Masters degree in lab management (2) be obtained.

Miss Lila Dick, teaching micropropagation to students in Scotland, reports on it as a Horticulture Science topic in schools, a compulsory lab class in 1st year of Ordinary National Diploma in Horticulture at college and also as a thesis topic for B.Sc. post graduate and for the Ph.D. degree (5).

Dr. de Fossard's tissue culture course in Australia runs for a week.

Ryde School of Horticulture teaches tissue culture as a third year elective, and at Burnley Horticultural College, the Diploma student learns to use tissue culture techniques to produce fern and orchid mericlones (10). All we are doing is making students aware of a new technique. Should we be doing more or is this a laboratory rather than a horticultural exercise?

Our course is being revised. Should laboratory techniques and chemistry calculations be compulsory subjects? Should tissue culture be an elective or a post certificate course or do we keep it low profile and leave the laboratory training to the School of Biological Science, College of Advanced Education or to the university level?

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PASTEURIZATION OF GROWING MEDIA BY MICROWAVE RADIATION

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Abstract. The pasteurization or disinfestation of growing media is now an accepted part of nursery hygiene. Media can be pasteurized by physical or chemical means, but the preferred method of treatment involves steaming the medium at 60°C for 30 minutes. Such methods are essentially a disinfestation, as some organisms survive the treatment.

Methods of pasteurization suffer from disadvantages such as high cost, time consumption, and a limitation in the volume treated. Thus a new