APPLICATIONS OF PLANT TISSUE AND CELL CULTURE IN THE STUDY OF PHYSIOLOGY OF PARASITISM

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ABSTRACT

The technique of growing plant tissues and cells on nutrient media under conditions of controlled environment has greatly enlarged the scope of experimental investigations. In phytopathology, application of this technique has given an insight into the nature of abnormal growth, factors affecting penetration, infection and multiplication of pathogens, the weapons of attack of the pathogen, and the morphogenetic potential of the diseased cell. The paper reviews recent applications of the technique in studies on parasitism and points some future possibilities.

INTRODUCTION

In 1902 the German botanist Haberlandt suggested culturing isolated cells of green plants. This, he believed, should tell what a cell is capable of doing when freed from the influence to which it is subjected within the multicellular organism. Toward this objective, firstly organs, then tissues and later free cells have been grown in vitro. These three classes of culture have been commonly, although incorrectly, termed "Tissue Culture". Only in the past few years single somatic cells of some green plants have been induced to develop into entire individuals and eventually produce flowers and fruits (Vasil and Hilderbrandt, 1965; Steward et al., 1966). This has proved that a living cell has an inherent potentiality to produce a plant. That is a living cell is totipotent. Thus the objective with which plant tissue culture was initiated has been realized and tissue culture has now become a remarkably useful tool in experimental studies. In this paper the potential applications of this methodology in understanding the characteristics of pathological growth, the processes of infection by plant pathogens, their multiplication and the response of host to infection are discussed. A recent review has appeared on this subject (Braun and Lipetz, 1966).
The advantage of the *in vitro* technique is the aseptic condition under which tissues and cells are grown. The recent work on auxin metabolism demonstrates that results of investigations on plants grown under non-sterile conditions may be misleading. Libbert and co-workers (1966) have shown that the major quantity of indole-3-acetic acid (IAA) extracted from plant is not a product of the plant itself but of the epiphytic bacteria. Further, the ability of plants or crude enzymes prepared therefrom, to convert tryptophan to IAA is mainly the action of epiphytic bacteria. Works with aseptic plants have shown that IAA is largely synthesized from some source other than tryptophan (Libbert *et al.*, 1966, 1967; Thimann *et al.*, 1967), probably indole-3-glycerol phosphate (Libbert *et al.*, 1966). Therefore, the biosynthesis of IAA from tryptophan in plants, as described in texts of plant physiology, is questionable. Thus plant tissue cultures should find wider application in studies on metabolism.

With the discovery of vitamins and plant growth regulators it has become possible to grow some plant tissues on chemically defined media. This makes possible to control the chemical (nutritional) besides the physical environment for plant growth. Thus, the metabolic and structural changes brought about in cells by the manipulation of these factors can be followed. The effect of interacting factors on cell growth can be easily measured in terms of increase in weight. Comparative studies on nutritional requirements for the growth of different organs and tissues in culture can reveal differences in their biosynthetic capacities.

When agitated in a liquid medium plant parts and callus tissues derived from them yield a suspension of cell aggregates and free cells. Such a suspension can be serially propagated by pipetting aliquots into fresh medium. This bacteriological approach towards cell propagation offers numerous advantages and opens new lines of investigations. Colonies of single cell origin, called clones, may be established. In this direction the first successful attempt with plant cells was by Muir *et al.* (1954) at Wisconsin (Plate IV, Fig. 1). The "Microculture Method" of Jones *et al.* (1960) (Text-Fig. 1) permits continuous observation on single cells as they divide and form colonies. Such techniques have been responsible for providing unequivocal evidence of cell totipotency (Vasil and Hildebrandt, 1965, 1967) (Text-Fig. 2).

Because of genetic uniformity tissue and plantlets produced from the differentiation of cell clones should prove useful. However, this may not often be true. Melchers (1966) has shown that callus of *Nicotiana tabacum*