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COMPETENCE AND DETERMINATION IN DIFFERENTIATION

The development of different types of cells, tissues, and organs from common origins implies that: (1) the cells are competent to differentiate; (2) as development proceeds they lose the capacity to be easily transformed into other cell, tissue, and organ types. The cells become committed, i.e. fixed or determined, in their development. Leaves do not normally form roots, or roots leaves, but if a leaf is cut from the plant and its petiole is placed in soil it may form roots at the end of the petiole. Roots of some species can be used for propagation because, when excised, they will form buds and eventually leaves. Such observations show that determination is either not absolute or it can be reversed in appropriate circumstances. They also show that competence to follow a different type of development either persists in the differentiated and determined tissues or is restored by the experimental treatment. Competence to develop along a particular pathway means that the cells can go on to develop autonomously or can do so when given an appropriate signal. Astate of competence can, therefore, be recognized when development proceeds as expected or when the cells are given the appropriate signal, which may be environmental, chemical, or so me other experimental treatment. When competent cells begin to develop, the processes of development and differentiation become increasingly difficult to prevent or reverse. If the cells can be prevented from developing along a new pathway or can be diverted into a different developmental pathway, then the cells are not yet committed, i.e. they are not determined. The fact that cells, when left to themselves, will develop autonomously in some particular way shows only that they are specified (in the terminology of animal embryology) and not that they are necessarily determined, which would imply that the commitment is irreversible.

Regional specification in embryos: tate maps and determinationl We have seen (see eh. 1, section 1.3.4.1) that fate maps can be constructed showing which parts of the plant arise from which parts of the very young 16-celled embryo in Capsella. But this simply shows that cells in particular parts of the embryo will finish up in particular parts of the plant, e.g. the top part of the embryo forms the shoot and the lower part the root. It does not tell us whether there are differences, (except in position) between the cells at this stage, or when or whether different parts of the embryo have become determined for particular pathways of development. In embryogenesis, the first sign of differentiation of cells in the proembryo (apart from the suspensor) is the formation of an axis marked by the formation of an axial procambial strand and by the protrusion of the cotyledons. The root and shoot apices also form at about this time. Whether the different parts of the globular proembryo are determined is not known. Experiments have not been done because of the difficulty of keeping isolated globular embryos alive and growing. There are several reasons for believing that the determination of the cells occurs only at the end of the globular stage. These are: (1) Some gymnosperm embryos are, at first, free-nuclear and do not be co me cellular until a stage corresponding with the late globular stage. (2) Early development of embryos is not always precisely the same in each embryo, but this does not seem to affect subsequent development. Early embryogenesis in cotton is like embryogenesis in cell cultures in having no regular pattern of division, although the embryos develop normally. A notable example is the Degeneriaceae: after the first transverse division of the zygote, development of both terminal and basal segments does not follow an exact pattern and can vary from plant to plant and be rather irregular, but this still leads to normal development. Another example in which the initial segmentation pattern varies is the gymnosperm Sequoia (in which there is no free-nuclear phase).