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Dynamic functional morphology in mushrooms - how mushrooms make mushrooms

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Morphogenesis is not simply a matter of playing out a predefined genetic programme. Expression of developmentally important genes is epigenetic and place- and time-dependent. Gene expression relies on previously-formed tissue structures and is consequently dependent on the overall context into which the developmentally regulated gene product(s) is (are) inserted. The 'overall context' includes chemical, electrical and structural/mechanical tensions. Though research on fungal developmental biology is regrettably sparse, homologues and analogues of all of the mechanisms known in animals and plants can be found in fungi.

Key words at each stage of development in fungi are: competence, induction and change. Developmental change occurs when the competent tissue is induced. Each developmental step takes the tissue to a higher order of differentiation. Most differentiated hyphal cells require reinforcement of their differentiation 'instructions'. This reinforcement is part of the context within which they normally develop. Another common feature of fungal morphogenesis is its compartmentalization into a collection of 'sub-routines' which are distinct genetically and physiologically. These sub-routines can be recognised at the levels of organs, tissues, cells and cellular components. Sub-routines may run in parallel or in sequence. When played out in their correct order the morphology which is normal to the organism under consideration results. If some of the sub-routines are disabled (genetically or through physiological stress), the rest may still proceed. Partial execution of developmental sub-routines produces an abnormal morphology but may allow a crop of spores to be formed. Homologous sub-routines can be recognised in different fungi, and gross differences in morphology can then be related to the different ways in which homologous sub-routines are executed. Flexibility in expression of developmental sub-routines illustrates that tolerance of imprecision is an important attribute of fungal morphogenesis.