# International Journal of Plant Developmental Biology

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**Scope and target readership:** The *International Journal of Plant Developmental Biology* deals exclusively with the issues of development and embryogenesis in plants, higher or lower.

The primary topics that are covered include:
1) Control of gene expression during development of any cell, tissue or organ;
2) Developmental mechanisms leading to a further understanding of the industrial use of plants;
3) Gametogenesis and fertilization, and gametophytic embryogenesis;
4) Molecular genetics of development;
5) Mechanisms of differentiation and dedifferentiation; (programmed) cell death and apoptosis;
6) Somatic embryogenesis;
7) Uncontrollable developmental processes;
8) General plant regeneration and *in vitro* tissue culture.

Hormonal, physiological, environmental, genetic, biophysical, developmental or molecular approaches to the study of the regulation of plant growth and development are all encouraged. Practical *in vitro* regeneration protocols will also be considered.

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**Cover photos**: Types of phyllotactic patterns with stick models from side and top views (Korn, pp 1-12).



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International Journal of Plant Developmental Biology



**ABSTRACT**

**Invited Review:** The lively topic of phyllotaxis is based on ever improving descriptions of two important parameters, the divergent angle and parastichy patterns, along with several minor aspects, including the roles of stem size and leaf primordium diameter. Most theories to explain these features are quite old yet continue to hold botanists' attention. The major theories are Hofmeister's available space theory, Schwenderen's packing theory, Schüepp's biophysical theory, Schoute's field theory including Reinhard's auxin efflux theory, and Larson's vascular theory. Each theory explains some feature but falls short on explaining others: the available space theory is not a mechanistic explanation and so it describes only what is observed; the packing theory cannot explain fern apices having well spaced primordia; the biophysical model has not yet generated the precision of leaf siting; the field theory cannot explain the false whorled pattern of phyllotaxy; the auxin efflux theory does not distinguish auxin's role in leaf siting from that of leaf development; and the vascular theory predicts nothing as it is a correlation phenomenon. It is recommended that two new features be considered in explaining leaf arrangement as a complex biological process, the precision of leaf siting and the occurrence of node and internodes. Some workers prefer the surface theories (available space, field, contact pressure), others the internal (vascular) theory and progressively more see it as a combination of the two.



**ABSTRACT**

**Invited Review:** A characteristic feature of plant development is the continual elaboration of lateral organs such as leaves, from the flanks of the shoot apical meristem (SAM). To maintain this pattern of growth, cells destined for organ formation are constantly generated by a small group of pluripotent stem cells located in the apex of the SAM. While this developmental strategy differs from that of animals, many of the underlying mechanisms regulating cell proliferation and cell fate are similar. For instance, positional cues play an important role in regulating cell identity in plants as they do in animal systems, suggesting the presence of extensive cell-cell signalling networks operating within plants. The last decade has seen considerable progress in identifying the molecular components of these signalling pathways. In some cases the signal operates over short distances, and typically involves the activation of transmembrane receptors by ligands. In other cases, signals are conveyed using RNA, transcription factors or hormones and may operate over greater distances both within developing organs and between organs of the plant. The goal of this review is to provide both a historic prospective as well as current insights into signalling pathways regulating leaf initiation and patterning.



**ABSTRACT**

**Invited Mini-Review:** Apricot (*Prunus armeniaca* L.) is a fruit species that, in certain cultivation area, shows several problems related to floral biology, appearance of flower bud anomalies, inconstant and extremely low yield. In this review, environmental, biological and physiological aspects affecting flower bud development are discussed and the complex phenomena of flower bud anomalies are analyzed. Three phases of the whole flower bud development periods are considered: 1) from flower bud initiation to beginning of dormancy; 2) from deep dormancy to bud swelling; 3) from beginning of flowering to petal drop. The early appearance of flower bud anomalies is related to the first growth period, involving flower bud induction, differentiation, organogenesis and beginning of dormancy, when several environmental and agronomical factors can heavily modify these processes. The second flower bud growth period is characterized by the dormancy phase followed by the resumption phase, when bud dormancy release occurs. Several types of anomalies have been observed when the buds are still dormant and also at the end of dormancy. During the third period, the development of the female and male gametophyte is completed and all organs are functional. At this time, the appearance of anomalies determines significant problems, such as morphological abnormalities of pistil, stamen, and a reduction of male and female fertility.

**ABSTRACT**

**Mini-Review:** Fertilization in angiosperms is a complex process. When the pollen tube enters the degenerated synergid of an embryo sac, two sperm cells are released inside. The two sperm cells are connected in the pollen tube but after their release in the degenerated synergid, they must separate. One of the two sperm cells moves to the egg cell and fuses with it to form a zygote, the other one moves to the central cell to form the endosperm. The process of male and female gamete recognition is a critical interaction but remains poorly understood. In this review, we discuss recent progress in the study of the cell cycle of male and female gametes before fertilization, and the question of synergid degeneration. Herein we analyze the status of research on the movement of the two sperm cells in the degenerated synergid, and the phenomenon of signal reactions between male and female gametes. We also evaluate our progress in understanding the preferential fertilization of sperm cells and egg cell activation.



**ABSTRACT**

**Invited Review:** The development and differentiation of anther cells, including specification of cell lineage and cell fate, are well-regulated programs. Sporogenous cells differentiate into pollen mother cells (PMCs) and enter meiosis. In addition, differentiated anther wall cells degrade sequentially during pollen maturation and their dehiscence excludes mature pollen. This degradation process appears to be controlled by programmed cell death (PCD). Maternally-inherited male sterility is common in various plant species and is referred to as cytoplasmic male sterility (CMS). In some examples of CMS, floral organ identity is unperturbed, but the anther tissues degenerate by processes of PCD or necrotic cell death. In addition, abiotic stresses dominantly affect male reproductive development. In particular, high-temperature stress causes male sterility in many plant species. We use the double-rowed barley (*Hordeum vulgare* L. cv. 'Haruna-nijyo') as a model for male reproductive development and high-temperature injury in plants. This type of injury relates to premature progression of early developmental programs in anthers and includes proliferation arrest, degradation of anther wall cells and progression to meiosis in PMCs, all of which require comprehensive alterations in transcription. Given the involvement of PCD in anther-specific sequential and cooperative programs, as well as in cell fates, these findings suggest that male reproductive development might be more sensitive to environmental stresses than female reproductive development and vegetative growth. We also introduce certain key genes that have been identified recently and relate specifically to male reproductive development and sterility.



**ABSTRACT**

**Invited Mini-Review:** The present review summarizes the factors involved in the process of banana somatic embryogenesis and somaclonal variation during this process. Being a polyploid and vegetatively propagated crop, development of an efficient somatic embryogenesis system is critical for the application of genetic transformation or other biological technologies in genetic improvement of banana. Since the 1980s, considerable progress has been made in understanding and refining somatic embryogenesis and plant regeneration in banana, but there are still many bottlenecks that remain to be overcome. The low induction percentage of embryogenic callus is the major limitation in the process of somatic embryogenesis in banana. It strongly depends on genotype/cultivar, incubation condition and some other factors. Success rates for the initiation of good quality embryogenic cell suspensions depend largely on the quality of the selected embryogenic calli. The successful establishment of an embryogenic cell suspension in banana also relies on genotype/cultivar. The germination of somatic embryos into plants is not very efficient and needs to be further improved. This step is also highly variable and found to be affected by genotype/cultivar, regeneration system, and quality of embryogenic cell suspension among other factors. Fortunately, the proportion of somaclonal variants in banana regenerated through somatic embryogenesis obtained from most studies using field tests were low, which suggested that somatic embryogenesis could be used for genetic improvement of banana.



**ABSTRACT**

**Invited Review:** *In vitro* androgenesis is one of the most efficient methods to obtain haploid plants. Obtaining dihaploids of high

frequency is of great importance for wheat breeding since in this way the possibility to create homozygous lines within one generation is provided, thus shortening the breeding process. In this review we consider and discuss many articles whose results show that wheat's response to anther culture is determined by genetic and environmental factors as well as by the interaction between them. The present state-of-the-art of the studies on the genetic control of *in vitro* response of wheat as well as on the prospects of haploid/doubled haploid induction in this important crop and its practical use are presented. The genetic factors affecting different stages of callus induction and organogenesis in anther culture are discussed on the basis of our and other authors' investigations. The dominant role of the genotype on *in vitro* processes and the influence of the cytoplasm are demonstrated. The interactions between the genotype-environment and that between the nucleus-cytoplasm are analyzed. A number of environmental factors influencing the response of anthers to *in vitro* cultivation are discussed. These include the growth condition of the anther donor plants, the developmental stage of the microspores, the culture conditions, and the medium composition. In spite of intense research in this field, many issues remain insufficiently clarified, and therefore need further investigations.

**Jaime A. Teixeira da Silva (Japan)** Plant Thin Cell Layers: Challenging the Concept (pp 79-81)


**ABSTRACT**

**Research Note:** The concept of a thin cell layer, or TCL, was initially coined by Khiem Tranh Than Van in two key papers, one of which was in Nature, exactly 35 years ago. At that time *Nicotiana tabacum* had been used as a model plant to establish three main pathways for *de novo* organogenesis by establishing a flower, vegetative bud and root "programme" from pedicel tissue. Over the last 35 years, a wealth of research in plant tissue culture based on TCLs has emerged to fortify the importance of this very simple technique, highlighting its continued fundamental importance as a front-runner tool in plant cell and tissue differentiation and organ development. In this conceptual paper, I primarily wish to point out and explain the logic behind some of the inherent contradictions, paradoxes and incongruencies of the concept, based on basic, fundamental definitions in cellular biology and botany, even though I have been one of its most avid supporters.