MECHANISMS IN PLANT DEVELOPMENT pdf

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Plant development is a continuous process occurring throughout the life cycle, with similar regulatory mechanisms acting at different stages and in different parts of the plant.

Genetic screens can be used in Arabidopsis, just as in Drosophila or C. Some are required for formation of the seedling root, some for the seedling stem, and some for the seedling apex with its cotyledons. Another class is required for formation of the three major tissue typesâ€" epidermis , ground tissue, and vascular tissueâ€"and yet another class for the organized changes of cell shape that give the embryo and seedling their elongated form Figure Figure Mutant Arabidopsis seedlings. A normal seedling A compared with four types of mutant B-E defective in different parts of their apico-basal pattern: B has structures missing at its apex, C has an apex and a root but lacks a stem between them, D more The Parts of a Plant Are Generated Sequentially by Meristems Roughly speaking, the embryo of an insect or a vertebrate animal is a rudimentary miniature scale model of the later organism, and the details of body structure are filled in progressively as it enlarges. The plant embryo grows into an adult in a quite different way: These all-important groups of cells are called apical meristems see Figure Each meristem consists of a self-renewing population of stem cells. As these divide, they leave behind a trail of progeny that become displaced from the meristem region, enlarge, and finally differentiate. Although the shoot and root apical meristems generate all the basic varieties of cells that are needed to build leaves, roots, and stems, many cells outside the apical meristems also keep a capacity for further proliferation and retain meristem potential. In this way trees and other perennial plants, for example, are able to increase the girth of their stems and roots as the years go by and can sprout new shoots from dormant regions if the plant is damaged. The rudiments of the apical meristems of root and shoot are already determined in the embryo. As soon as the seed coat ruptures during germination, a dramatic enlargement of nonmeristematic cells occurs, driving the emergence first of a root, to establish an immediate foothold in the soil, and then of a shoot Figure This is accompanied by rapid and continual cell divisions in the apical meristems: A seedling of Arabidopsis. The brown objects to the right of the young seedling are the two halves of the discarded seed coat. Courtesy of Catherine Duckett. Development of the Seedling Depends on Environmental Signals From germination onward, the course of plant development is powerfully influenced by signals from the environment. The shoot has to push its way rapidly up through the soil, and must open its cotyledons and begin photosynthesis only after it has reached the light. The timing of this transition from rapid subterranean sprouting to illuminated growth cannot be genetically programmed, because the depth at which the seed is buried is unpredictable. The developmental switch is controlled instead by light, which, among other effects, acts on the seedling by inhibiting production of a class of plant hormones called brassinosteroids, discussed in Chapter Mutations in genes required for production or reception of the brassinosteroid signal cause the stem of the seedling to go green, slow its elongation, and open its cotyledons prematurely, while it is still in the dark. The Shaping of Each New Structure Depends on Oriented Cell Division and Expansion Plant cells, imprisoned within their cell walls, cannot crawl about and cannot be shuffled as the plant grows; but they can divide, and they can swell, stretch, and bend. The morphogenesis of a developing plant therefore depends on orderly cell divisions followed by strictly oriented cell expansions. Most cells produced in the root-tip meristem , for example, go through three distinct phases of development â€"division, growth elongation , and differentiation. These three steps, which overlap in both space and time, give rise to the characteristic architecture of a root tip. Although the process of cell differentiation often begins while a cell is still enlarging, it is comparatively easy to distinguish in a root tip a zone of cell division , a zone of oriented cell elongation which accounts for the growth in length of the root , and a zone of cell differentiation Figure Figure A growing root tip. A The organization of the final 2 mm of a growing root tip. The approximate zones in which cells can be found dividing, elongating, and differentiating are indicated. B The apical meristem and root cap of a corn root tip, showing more In the phase of controlled expansion that generally follows cell division , the daughter cells may often increase in volume by a factor of 50 or more. This expansion is driven by an osmotically based turgor pressure that presses outward on the plant cell wall , and its direction is determined by the orientation of the cellulose fibrils in the cell wall, which constrain expansion along one axis see Figure The orientation of the cellulose in turn is apparently controlled by the orientation of arrays of microtubules just inside the plasma membrane , which are thought to guide cellulose deposition discussed in Chapter These orientations can be rapidly changed by plant growth regulators, such as ethylene and gibberellic acid Figure , but the molecular mechanisms underlying these dramatic cytoskeletal rearrangements are still unknown. The different effects of the plant growth regulators ethylene and gibberellic acid. These regulators exert rapid and opposing effects on the orientation of the cortical microtubule array in cells of young pea shoots. A typical cell in an ethylene-treated more But apical meristems also give rise to a second type of outgrowth, whose development is strictly limited and culminates in the formation of a structure such as a leaf or a flower, with a determinate size and shape and a short lifespan. Thus, as a vegetative non-flowering shoot elongates, its apical meristem lays down behind itself an orderly sequence of nodes, where leaves have grown out, and internodes segments of stem. In this way the continuous activity of the meristem produces an ever increasing number of similar modules, each consisting of a stem, a leaf, and a bud see Figure The modules are connected to one another by supportive and transport tissue, and successive modules are precisely located relative to each other, giving rise to a repetitively patterned structure. This iterative mode of development is characteristic of plants and is seen in many other structures besides the stem-leaf system Figure Figure Repetitive patterning in plants. Accurate placing of successive modules from a single apical meristem produces these elaborate but regular patterns in leaves A , flowers B , and fruits C. A, from John Sibthorp, Flora Graeca. Although the final module is large, its organization, like that of an animal embryo, is mapped out at first on a microscopic scale. At the apex of the shoot, within a space of a millimeter or less, one finds a small, low central dome surrounded by a set of distinctive swellings in various stages of enlargement Figure The central dome is the apical meristem itself; each of the surrounding swellings is the primordium of a leaf. This small region, therefore, contains the already distinct rudiments of several entire modules. Through a well-defined program of cell proliferation and cell enlargement, each leaf primordium and its adjacent cells will grow to form a leaf, a node, and an internode. Meanwhile, the apical meristem itself will give rise to new leaf primordia, so as to generate more and more modules in a potentially unending succession. The serial organization of the modules of the plant is thus controlled by events at the shoot apex. It is the system of local signals within this tiny region that determines the pattern of primordiaâ€”the position of one leaf rudiment relative to the next, the spacing between them, and their location relative to the apical meristem itself. Figure A shoot apex from a young tobacco plant. A A scanning electron micrograph shows the shoot apex with two sequentially emerging leaf primordia, seen here as lateral swellings on either side of the domed apical meristem. B A thin section of a similar more Variations on this basic repetitive theme can give rise to more complex architectures, including structures such as tendrils, thorns, branches, and flowers. Thus, by switching on different sets of genes at the shoot apex, the plant can produce different types of primordia, in different spatial patterns. Cell Signaling Maintains the Meristem Central to all these phenomena is the question of how the apical meristem maintains itself. The meristem cells must continue to proliferate for weeks, years, or even centuries as a plant grows, replacing themselves while continually generating progeny cells that differentiate. Through all this, the size of the cluster of cells that constitute the meristem remains practically constant about cells in Arabidopsis, for example. New meristems may arise as the plant branches, but they too preserve the same size. Genetic screens have identified genes required for meristem maintenance. For example, mutations that disrupt the WUSCHEL gene , which codes for a homeodomain protein , convert the apical meristem into non-meristematic tissue, so that the seedling fails to sprout. Conversely, mutations in the CLAVATA group of genes, coding for components of a cell-cell signaling pathway see Figure , make the meristem abnormally big. These genes are expressed in different layers of cells in the meristem region Figure A. The two most superficial cell layers, called the L1 and L2 layers, together with the uppermost part of the L3 layer, contain the cells of the meristem proper, capable of dividing indefinitely to give rise to future parts of the plant. The meristematic cells of the L1 and L2 layers express Clavata3, a small secreted signal protein. Just beneath, in the L3 layer, lies a cluster of cells expressing Clavata1 the receptor for Clavata3. In the center of this Clavata1 patch are cells that express the Wuschel gene regulatory protein. Figure The feedback loops that are thought to maintain the shoot apical meristem. A The arrangement of cell layers constituting a shoot apical meristem. B The pattern of cell-cell communication that maintains the meristem. Artificial overexpression of Wuschel more The pattern of cell divisions implies that the cells expressing Wuschel are not themselves part of the meristem proper; new Wuschel-expressing cells are apparently continually recruited from the meristematic part of the L3 population, just above the Wuschel domain. Nevertheless, the Wuschel-expressing cells are at the heart of the mechanism that maintains the meristem. A signal that they produce maintains meristematic behavior in the cells above, stimulates expression of the CLAVATA genes, and, presumably, causes new cells recruited into the Wuschel domain to switch on Wuschel. Negative feedback from the upper meristematic cells, delivered by the Clavata signaling pathway, acts back on the regions below to limit the size of the Wuschel domain, thereby preventing the meristem from becoming too big Figure B. This account of the plant meristem is still uncertain in many details and other genes besides those we have mentioned are also involved. Nevertheless, mathematical modeling shows that systems of a similar sort, based on a feedback loop involving a short-range activating signal and a long-range inhibitory signal, can stably maintain a signaling center of a well-defined size even when there is continual proliferation and turnover of the cells that form that center. Analogous systems of signals are thought to operate in animal development to maintain localized signaling centersâ€"such as the Organizer of the amphibian gastrula, or the zone of polarizing activity in a limb bud. It is still not known how the Wuschel-expressing cells signal to their neighbors. One possibility is that the Wuschel protein itself diffuses directly from cell to cell through plasmodesmataâ€"a signaling pathway peculiar to plants. Some other gene regulatory proteins have in fact been shown to travel in this way in meristems, spreading from cells that contain the corresponding mRNA into neighboring cells that do not. Regulatory Mutations Can Transform Plant Topology by Altering Cell Behavior in the Meristem If a stem is to branch, new shoot apical meristems must be created, and this too depends on events in the neighborhood of the shoot apex. At each developing node, in the acute angle the axil between the leaf primordium and the stem, a bud is formed Figure This contains a nest of cells, derived from the apical meristem , that keep a meristematic character. They have the capacity to become the apical meristem of a new branch or the primordium of a structure such as a flower; but they also have the alternative option of remaining quiescent as axillary buds. Maize provides a beautiful example. Figure Axillary buds in the neighborhood of a shoot apex. The photograph shows a longitudinal section of Coleus blumei, a common houseplant. Eichhorn, Biology of Plants, 6th edn. Native Americans created it by selective breeding, over a period of several centuries or perhaps millennia between 5, and 10, years ago. They started from a wild grass known as teosinte, with highly branched leafy stems and tiny ears bearing inedible hard kernels. Detailed genetic analysis has identified a handful of genetic lociâ€"about fiveâ€"as the sites of the mutations that account for most of the difference between this unpromising ancestor and modern corn. One of these loci, with a particularly dramatic effect, corresponds to a gene called teosinte branched-1 tb1.

2: FASEB Mechanisms in Plant Development Meeting Summary - the Node

Plant development is acontinuous process occurring throughout the life cycle, withsimilar regulatory mechanisms acting at different stages and indifferent parts of the plant. Rather than focussing on the lifecycle, the b Intended for undergraduate and graduate courses in plantdevelopment, this book explains how the cells of a plant acquireand.

Further, he proposed a minimal gene regulatory network consisting of epidermis-expressed SHR and MYB36 combined with CIF2 peptide treatment, which is sufficient for endodermis differentiation and Casparian Strip formation. Finally, he presented a new root phenotyping system for direct monitoring of maize root architecture in an agricultural field setting. Using transcriptomics and whole genome resequencing in resistant and susceptible cultivars of tomato S. Furthermore, she discussed the roles of lignin deposition in cortex cells for dodder resistance. She outlined a signaling cascade involving NBS-LRR proteins as well as MYB and AP2-type transcription factors that controls the expression of genes involved in lignin biosynthesis in response to dodder infection. Finishing the first session, Anthony Bishopp University of Nottingham, UK presented mathematical approaches to explain vascular patterning in the root. His models suggest that vascular patterning can be established independent of initial asymmetry in auxin concentrations. Instead, a model solely based on spatial constraints and root growth are sufficient to enable vascular pattern in its final form to emerge from a simple genetic network, explaining the vast diversity seen in different flowering plants. Alternations between generations The first session on Monday was under the theme Alternations between generations and started off with Thomas Dresselhaus University of Regensburg, Germany presenting fascinating work on a number of small signaling peptides that regulate pollen tube attraction and other aspects of fertilization in Arabidopsis and maize. In addition, she discussed the developmental consequences associated with the attraction of supernumerary pollen tubes. He highlighted his recent paper showing delayed paternal rescue of zygotic patterning mutants, and presented a new, comprehensive hybrid embryonic transcriptome suggesting a maternal gene expression bias in young Arabidopsis embryos. Then, Duarte Figueiredo Uppsala BioCenter, Sweden highlighted the recently published work on the role of auxin in seed coat development. Auxin is produced in the endosperm and exported to the integuments in an AGLdependent manner, where it seems to repress Polycomb Complex genes and thus allows for seed coat formation. Additionally, she discussed ongoing work to understand the molecular basis of natural variation in fertility, resistance to powdery mildew, and ovule number. She presented her studies on the re-hydration of artificial cell walls and embryo development in Fucus â€” and highlighted the importance of charged cell wall polysaccharides for marine plant survival. Short Range Signaling Developmental mechanisms are often regulated by release of signaling molecules or mechanical forces and perception of these signals by neighboring cells. The afternoon session of the meeting on Short Range Signaling was opened by Dolf Weijers Wageningen University, the Netherlands discussing new players in early embryo development. Weijers showed that polarly-localized SOK proteins influence the direction of cell divisions during early embryo development. In addition, using a whole-genome approach to determine the transcription patterns along the ontogeny axis of the root, his lab found that the main patterns are expressed in two opposing gradients. He proposed the idea that in the root meristem cells gradually switch from undifferentiated to differentiated cells. Elizabeth Haswell Washington University in Saint Louis, USA introduced the role of mechanotransduction and mechanosensitive ion channels in development. In Arabidopsis ten genes encode proteins closely related to the canonical MscS mechanosensitive ion channel from E. Haswell showed that one of these Arabidopsis genes, MSL8, protects pollen grains from the osmotic shocks intrinsic to their development and showed that it serves as a mechanoreceptor. He used live cell imaging to observe the cytoskeleton dynamics during lateral root growth through the endodermal cell layer. Keiko Torii University of Washington, USA took us through the enigmas of receptor-ligand-based mechanisms defining stomata development. The next talk by Ora Hazak University of Lausanne, Switzerland was dedicated to the role of the first differentiating root vascular tissue called protophloem in sensing of CLE peptides. Protophloem is a dynamic continuously differentiating tissue providing the sugars and hormones necessary for the maintenance of the root meristem. Her findings show that this tissue is responsible for the sensing of high levels of CLE peptides that results in locking of the protophloem in an undifferentiated state and later in the suppression of the root growth. Prunet nicely showed that flower patterning associates with auxin depletion and cytokinin accumulation at the boundaries between floral whorls and organs. He could demonstrate that this balance is inverted at the boundary between whorls 3 and 4 in the superman mutant. Prunet and collaborators showed that auxin biosynthetic genes are direct targets of SUPERMAN; they proposed that disinhibition of local auxin biosynthesis at the boundary between stamens and carpels is the cause of the superman phenotype. After fertilization fruit undergoes a dramatic increase in size that is essential to nourish and protect the growing seeds inside. Ripoll exploited Arabidopsis thaliana as a working platform and combined modeling, live imaging technologies and molecular genetics to follow the mechanisms that regulate fruit size and shape. During differentiation, vascular conductive cells fully in xylem or partially in phloem lose their organelles and cytoplasm to become conductive tissues. Rodrigues-Villalon showed that imbalance in phosphoinositide homeostasis at the plasma membrane suppresses differentiation both in xylem and phloem conductive cells by affecting vacuolar biogenesis. From genetic studies and fluorescence microscopy he identified previously uncharacterized members of the CLE peptide family that potentially restrict meristem size from the periphery of the CLAVATA3 domain. He showed the genetic dissection of the narrow sheath ns mutant, which results from mutations in two WOX3 transcription factor genes, NS1 and NS2. From RNA-seq and ChIP-seq experiments on laser microdissected shoot apices he concluded that NS1 is expressed in the pre-primordial margins and functions in recruiting the lateral domain of the maize leaf. Agata Burian University of Silesia, Poland then proposed a microRNA-mediated signaling pathway that regulates axillary meristem development in Arabidopsis. Using live imaging she visualized miRNA expression patterns at the position of future axillary meristems that suggest roles of miRNAs in the timing of axillary meristem release. Next, Ken Birnbaum New York University, USA talked about mechanisms of tissue reorganization during regeneration, using wounded Arabidopsis root tips as an experimental model. He used single-cell transcriptomics and time-lapse microscopy to show that patterning of the root stem cell niche is re-established across groups of cells rather than from a cryptic stem cell niche, and that this re-establishment of cellular organization is preceded by the rapid expression of MONOPTEROS a root specification gene independent of auxin. He showed that enhanced AHL expression rejuvenates axillary meristems in the Arabidopsis inflorescence and allows Arabidopsis plants to flower and set seed multiple times. He concluded his talk with a discussion on the potential to exploit rejuvenation biology for increased crop productivity. She discussed roles for Programmed Cell Death PCD and abscission during periderm establishment, and further presented data showing that periderm development is not affected when lateral root development is compromised. Gene Regulatory Networks From roots to fruits, the gene regulation and regulatory networks session showed how NGS technologies are addressing fundamental plant developmental questions in diverse plant species; including topics such as: Siobhan Brady University of California, Davis, USA focused on how tomato roots develop the exodermis, a lignified and suberinised layer in the root. During drought these suberin genes are upregulated in commercial tomato varieties Solanum lycopersicum , but not in the drought-tolerant wild tomato Solanum pennelli , highlighting exodermis suberinization as a possible target for drought tolerance. Strawberry fruit flesh develops from the inflorescence stem tip, leaving the maturing achenes, seed-containing ovaries, on the outside. Classical experiments demonstrated that strawberry fruit flesh development is regulated by auxin released by the seed-containing ovaries, but the molecular mechanism of communication between the seed and the maternal tissue was unclear. RNAseq and tissue specific auxin measurements, identified bidirectional communication involved in the specification of which tissue becomes the fruit flesh; the endosperm and seed coat produce auxin transported into the stem tip, and there is a novel role for FT in flesh to seed communication. Next, Lars Ostergaard John Innes Centre, UK described how computational modelling and genetics explain the development of heart shaped fruits in Shepherds Purse Capsella rubella and the elongated fruits of Arabidopsis thaliana. Using inducible expression, ChIPseq, and ChIP re-ChIP, they described complex regulatory interactions with transcription factor homo- and heterodimers with both, shared and unique binding sites upstream of important developmental genes, especially in the cytokinin pathway. Capsella wild type and two fruitfull mutant alleles A maturing fruit of the wild strawberry studied in the Zhongchi Liu lab Patterning mechanisms The session on Patterning mechanisms opened with a talk by Teva Vernoux ENS de Lyon, France , who discussed the problem of robustly patterning organs at the periphery of the shoot apical meristem SAM. Combining experiments and computational modeling he showed how spatial-temporal fluctuations in auxin signaling filters out noise to confer robustness on organogenesis, and highlighted a role for the CLAVATA3 domain boundary in the regulation of this process. He also showed that wound-induced auxin depletion in the SAM rearranges the REV and KAN1 expression domains, leading to a new explanation for the influence of wounding on leaf dorsoventrality. Continuing the theme of patterning boundaries, Annis Richardson University of California, Berkeley, USA , explained how the understanding of boundary formation in grasses has been impeded by the dearth of mutants with organ boundary defects. She then presented fused leaf 1 fsl1 , a maize mutant with a range of phenotypes related to defective organ boundary formation and maintenance, and summarized work towards identification of the causal mutation in fsl1. Next, Dominique Bergmann Stanford University, USA outlined an integrated picture of stomatal patterning and the establishment of polarities in these lineages. She showed that broad induction of BASL expression in a developing leaf has coordinated cellular polarities across the entire organ that appear to be independent of the stomatal lineage, consistent with the existence of an intrinsic tissue-wide polarity. Finishing the session, Baoqing Ding University of Connecticut, USA discussed the molecular underpinnings of periodic pigment spot patterning in monkeyflowers Mimulus by reaction-diffusion. Mutant analysis and transgenic experiments show that these patterns are likely produced by diffusion and reaction of a compound activating anthocyanin formation a R2R3-MYB activator and a compound repressing the activator a R3-MYB repressor , leading to the periodic activation of pigmentation. Evolution and comparative development All the investigators in this exciting session generated new molecular, genetic tools in diverse plant model systems to understand the development of complex, ever-evolving plant forms. Miltos Tsiantis Max-Planck Institute for Plant Breeding Research, Germany studies leaf morphological diversity in Cardamine hirsuta, a relative of Arabidopsis thaliana with compound leaves. RCO was lost in A. The latter was supported by finding positive selection signatures in RCO. Tsiantis suggested that few strong-effect regulators of leaf shape like RCO act with additional small effect genes to cause leaf margin diversity. SEM of young petals showed that anisotropic growth contributes to the length of the final petal spur, with sustained cell elongation in Aquilegia species correlating with longer spurs. QTL mapping of spur length in interspecies populations has identified a single mendelian locus that controls the presence and absence of spurs. Nonetheless, the genetic architecture of spur morphology may involve multiple loci, not shared between all columbine species. Knowing that floral traits such as color, scent, and shape work together to attract pollinators, Cris Kuhlemeier University of Bern, Switzerland explored the genetics underlying the complex evolutionary history accompanying changes in pollinator preferences in petunia. QTL mapping of crosses between pollinator types P. Both species evolved from an ancestor carrying a pseudogene version of AN2 caused by a frame-shift deletion, leading to a white, hawkmoth-pollinated flower. Loci for UV floral display mapped to regulatory sequences of flavonol biosynthesis, together suggesting that somewhat simple molecular changes can underlie significant phenotypic and ecological niche changes. Unlike flowering plant sporophytes, where polar auxin transport and PIN genes are required to regulate lateral outgrowth, computational models of branch patterning in moss suggest that apolar auxin transport best explains observed architectures. Supporting this hypothesis, mutants in P. Using fluorescent fusion proteins, Devin saw that Sister-of-PIN1 SoPIN1 , an efflux protein lost in Arabidopsis but conserved in most flowering plants, is expressed in the epidermis of the meristem and localizes asymmetrically towards auxin maxima. Growth dependent morphogenesis Adrienne Roeder Cornell University, USA launched the session by presenting a fluctuation-based patterning mechanism in Arabidopsis sepals outermost floral organs. Sepals curvature is influenced by randomly patterned giant cells that form through endoreduplication. Giant cell formation requires the AtML1 transcription factor which has a linear, dosage-dependent role based on mutant and transgenic lines. Mathematical modelling of this, suggests that a specific threshold of AtML1 needs to be surpassed during the G2-phase of the cell cycle to allow endoreduplication and subsequent giant cell formation. Ari Pekka Mahonen University of Helsinki, Finland presented elegant work describing how cambium stem cells are formed post-embryonically in the Arabidopsis root. Cell lineage tracing revealed that only pericycle and procambial cells in contact with xylem precursors contribute to the formation of cambium. Conditional mutants also revealed a developmental module consisting of auxin, auxin response factors, HD-ZIP III transcription factors and WOX-like transcription factors required for radial cambium formation, secondary growth and correct patterning in the root. Carolyn Rasmussen University of California, Riverside, USA presented a probabilistic mathematical model to predict 3D division plane orientation in plant cells. Time-lapse imaging of young maize leaves expressing a tubulin-marker line allowed for visualization of division plane pre-prophase band establishment and the division itself. Pilar Cubas Centro Nacional de Biotecnologia, Spain presented work on identifying gene regulatory networks that regulate axillary bud dormancy. Transcriptomics analyses in repressed and activated buds in wild-type and brc1 plants identified three HD-ZIP I transcription factors, which together with BRC1 induce ABA biosynthesis in dormant buds triggering outgrowth. The triple mutant has a bushy phenotype when grown under shade conditions, which usually inhibit lateral growth and promote apical dominance. Using a combination of natural alleles and CRISPR engineering, this can be overcome, resulting in a continuum of inflorescence branching, where some hybrid combinations produced single-branched inflorescences and significantly higher yields. Hernan Lopez-Marin Max-Planck Institute for Plant Breeding Research, Germany reported on the identification of the super determinant sde mutant that fails to properly initiate axillary meristems in tomato. He proposes that a non-canonical PRC1 complex establishes competence for axillary meristem initiation. Finally, Katy Guthrie University of Missouri â€” Columbia, USA presented work on the Suppressor of sessile spikelet 2 Sos2 mutant, which suppresses the second spikelet formation specific to the maize clade of grasses. She showed that the Sos2 mutation seems to have roles in inflorescence, spikelet and flower meristems, and that the Sos2 mutation could partially suppress the indeterminate meristem mutation ramosa2. Environmental Adaptations The final session of the meeting on Environmental Adaptations kicked off with a talk by Stacy Harmer University of California, Davis, USA , who introduced us to Sunflower as a model system for studying circadian rhythms. Before dawn, sunflower inflorescences re-orient themselves to face east in preparation for the rising sun. Harmer demonstrated that this ability to anticipate sunrise is dependent upon a spatio-temporal separation of auxin responses between day and night across the East and West halves of the sunflower stem. Notably, she was able to show that inflorescence orientation impacts temperature-dependent pollen shedding, which has a significant influence on the frequency of pollinator visits and yield. The next talk was by Daniel Chitwood Independent Researcher , who talked about a new method for measuring topology, called Persistent Homology, can be used to compare diverse 2-dimensional and 3-dimensional shapes.

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@article{osti_, title = {Mechanisms in Plant Development}, author = {Hake, Sarah}, abstractNote = {This meeting has been held every other year for the past twenty-two years and is the only regularly held meeting focused specifically on plant development.

This conference is the only regularly held meeting devoted specifically to the topic of plant development. Unlike these other meetings, the focus of the FASEB conference and its small size participants will facilitate the distillation of new themes and principles emerging from recent work in the plant development field, as well as fostering new acquaintances and collaborations between participants with shared interests. This unique conference will provide participants with a current overview of a fundamental and rapidly moving area of plant biology, and is expected to generate new directions for future research. Project Methods The conference program includes eight sessions, each devoted to a topic of broad significance. Invited speakers were chosen based also on the high quality and interest value of their ongoing research, and on our knowledge of their ability to give a clear and engaging presentation. In addition, speaker choices were made to create a balance between male and female speakers, between U. Six speakers on the program will present work using crop plants as model systems. By including in the program daily poster sessions and short talks by meeting participants chosen based on their submitted abstracts , the meeting will provide opportunities for all participants to present their work to an international audience. The meeting schedule will also allow ample time for informal discussions among participants. At the meeting, an international community of scientists investigating plant development using a variety of experimental systems and approaches came together, participating in the conference through their presentations, questions and informal discussions, exchanging information and nurturing the emergence of new themes and syntheses. The program included eight sessions of talks, each devoted to a topic of broad significance. Nine of the twenty-six invited speakers presenting full length talks were supported by USDA funds. Scott Poethig University of Pennsylvania: Ton Bisseling Wageningen University: June Nasrallah Cornell University: Neelima Sinha University of California Davis: The evolution of leaf complexity in Session 8: Charles Gasser University of California Davis: Genes, patterns and polarity in ovule development and evolution in Session 2: The tenth invited speaker for whom USDA funds were requested, Takashi Araki, was unable to attend due to a family emergency. The small size of the conference, the remote and informal setting, and the inclusion of a significant amount of free time in the program synergized to promote the formation of new acquaintances, the rekindling of old friendships, informal discussions, and the birth of new collaborations. Moreover, in the conference evaluation survey the vast majority of participants said that the conference gave them new ideas for future research. Based on the success of this conference, an eleventh conference for this series was planned for August , which will be organized by Neelima Sinha one of the invited speakers supported by USDA funds and Cris Kuhlemeir. Advances in the field of plant development disseminated at this conference by USDA-supported speakers and others will promote agricultural improvements benefiting the U.

4: Mechanisms in Plant Development : Ottoline Leyser :

This is a "must have" volume for any scientist with even a peripheral interest in plant development. Leyser and Day have provided a welcome addition for anyone looking for an upâ€•toâ€•date book for an upperâ€•level undergraduate or graduate course in plant development. The classic book in the.

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Our understanding of the molecular mechanisms controlling plant development has exploded in the last decade, and this book provides an outstanding and much needed review and synthesis. Whilst primarily directed at higher-level undergraduates, it should be accessible and informative to scientists at all levels.

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It is an auxin, a member of one of six known classes of plant growth regulators (sometimes called plant hormones), all of which have powerful influences on plant development. The five other known classes are the gibberellins, the cytokinins, abscisic acid, the gas ethylene, and the brassinosteroids.

7: Mechanisms in Plant Development : Stephan Day :

Progress 08/01/06 to 07/31/07 Outputs The FASEB Summer Research Conference "Mechanisms in Plant Development" was a successful tenth meeting in a series of biennial conferences on this topic sponsored by FASEB.

8: Mechanisms in Plant Development - Ottoline Leyser, Stephen Day - Google Books

Get this from a library! Mechanisms in Plant Development.. [Ottoline Leyser; Stephen Day] -- Intended for undergraduate and graduate courses in plant development, this book explains how the cells of a plant acquire and maintain their specific fates.

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