MINITOPIC

Template-Assisted Ligation Model, Collapsed Ribosomes Raise Primordial Questions

Although unrelated, these two recent developments address fundamental questions about how life might take shape. “Even if all you have is template-assisted ligation, you can still bootstrap the system out of primordial soup,” says Sergei Maslov at the University of Illinois, Urbana-Champaign and Brookhaven National Laboratory. In their new model for template-assisted replication, he and his collaborator Alexei Tkachenko argue that the joining of two polymers by using a third, longer one as a template could have enabled polymers to become self-replicating. Template-assisted ligation in this model thus “allows for heritable transmission of the information,” they note. Details appeared 28 July 2015 in the Journal of Chemical Physics (doi:10.1063/1.4922545). In a separate development, ribosomes can be collapsed from two subunits into one, according to Alexander S. Mankin of the University of Illinois, Chicago, and his collaborators. By engineering a hybrid ribosomal RNA (rRNA) composed of both small and large subunit rRNA sequences, they produced a ribosome whose subunits form a single entity that not only functions in vitro, but also supports the growth of Escherichia coli cells in the absence of wild-type ribosomes. Details appeared 29 July 2015 in Nature (doi:10.1038/nature14862).

Endofungal Bacteria May Determine How These Symbionts Affect Host Plants

Shannon Weiman

Bacteria living within fungi influence host metabolism, reproductive activity, and ecosystem effects, according to several researchers who spoke during the symposium, “Microbes in Microbes (Russian Dolls),” at the 2015 ASM General Meeting, held in New Orleans last May. Thus, for example, some endofungal bacteria and their host fungi form partnerships with plants that range from beneficial to pathogenic. In some cases, these symbioses promote growth among all participants while, in others, the microbial symbionts thrive at the expense of their host plants.

Endophytic fungi and their bacterial symbionts, while previously recognized for their role in plant rhizomes, are also widespread in plant leaves, according to David Baltrus and his collaborators Elizabeth Arnold and Kayla Arendt, all of the University of Arizona, Tucson. “These bacteria occur in living hyphae of phylogenetically diverse endophytes isolated from various plant lineages and in multiple biogeographic provinces,” says Arnold. Earlier, Arnold and her collaborators identified 15 distinct bacterial species, primarily of the Proteobacter lineage, within 414 species of leaf endophytic fungi. These bacterial species differ from those found within endophytic fungi in other plant tissues, suggesting they play special roles within leaves.

By treating these systems with antibiotics, Baltrus and his collaborators “cure” the endophytic fungi of their bacterial symbionts, thus dissecting the bacterial influences from the purely fungal impacts of these species on various metabolic properties and ecological functions within the host plants. “Plant-associated fungi harbor bacteria that can alter fungal interactions with host plants in diverse ways,” Arnold says. For example, Luteibacter bacteria increase cellulase activity of the host fungus Pestalotiopsis, which may help the latter to colonize its plant hosts.

In addition, the fungal-bacterial symbiosis benefits the host plant by producing the phytohormone indole-
3-acetic acid (IAA), which stimulates plant growth, according to Arnold. “The endophyal bacterium significantly enhances IAA production, but does not itself produce measurable IAA when grown outside of the fungus,” she says. Thus, the bacterial-fungal relationship sustains the fungal-plant symbiosis. This cooperative IAA production may also diminish plant defenses against the fungal endophyte, a topic for future research.

However, other bacterial-fungal symbioses can prove detrimental to host plants, according to Laila Partida-Martinez of Cinvestav in Irapuato, Mexico. The phytopathic fungus Rhizopus microspores, which causes rice seedling blight, requires the endofungal bacterium Burkholderia to produce the phytotoxin rhizoxin, she says. Genomic sequencing reveals that these bacteria provide a critical enzyme, polyketide synthase, in the rhizoxin biosynthetic pathway. Evidence of metabolic symbiosis implies a mutualistic relationship between the bacteria and fungi. “Prediction of primary metabolic pathways and transporters suggests that endosymbionts consume host metabolites like citrate, but might deliver some amino acids and cofactors to the host,” she says.

Furthermore, these bacteria are indispensable to the host fungus, playing an essential role in their reproduction. “The persistence of this fungal-bacterial mutualism through symbiont-dependent sporulation is intriguing from an evolutionary point of view and implies that the symbiont produces factors that are essential for the fungal life cycle,” Partida-Martinez continues. “Reproduction of the host has become totally dependent on endofungal bacteria, which, in return, provide a highly potent toxin for defending the habitat and accessing nutrients from decaying plants.”

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NEW FROM ASM

Fungal eisosomes are shallow, trough-shaped invaginations of the plasma membrane, of unknown function, that are ubiquitous in fungi. Fungal eisosome assembly requires two conserved proteins carrying “BAR” domains, triple-coiled-coil motifs associated with generation of membrane curvature. Now Ursula Goodenough of Washington University, St. Louis, et al. have identified eisosomes in a subset of red and green microalgae and in cysts of a ciliate. “Microalgal eisosome assembly is correlated with the presence and nature of cell walls,” she says. Though sequenced microalgae lack fungal BAR proteins, she has identified two lineage-specific BAR-encoding gene families that are candidate eisosome organizers. “The presence of eisosomes in algae, fungi, and ciliates indicates that these membrane differentiations were present in ancient eukaryotic common ancestors,” she says. “Experiments probing function in microalgae may yield functional insights. Some fungicides are known to bind to ergosterol, which is enriched in fungal eisosomes.” And this, she says, “is the first report of a stable structural patterning of membrane


NEW FROM ASM

When researchers evaluate the severity of inflammatory disease in experimental mice, they typically must euthanize the mice and then subject tissues to a variety of analytical techniques. For all this, they gain a