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**Using Biotechnology to Understand
Herbivore Resistance in Native Plants**

Plants have evolved a remarkably sophisticated suite of phenotypic and genetic responses, through evolution, that have allowed them to cope with herbivore attack. They respond with direct defenses which make them resistant to further herbivory. Examples include the production of toxic secondary metabolites, such as nicotine or furanocoumarins which can kill attacking herbivores outright, and defensive proteins, such as protease inhibitors (PIs) or polyphenoloxidases (PPOs), which decrease nutrient availability and slow the growth of herbivores. However, the physiological autonomy of herbivores allows plants to use other defensive strategies: namely, indirect defenses that facilitate "top-down" control of herbivore populations by the herbivore's predators, parasitoids, and pathogens (third trophic level). Some plants, for example, release volatile organic compounds when attacked that guide parasitoids or other members of the third trophic level to the feeding herbivore. The type of defense a plant might deploy against a particular herbivore is therefore contingent on a plant's ecological circumstances. For example, some direct defenses, particularly those that slow herbivore growth by reducing their digestive efficiency (such as PIs), may not function as defenses (i.e., do not increase the fitness of plants in environments with herbivores) without the third trophic level, because slow-growing herbivores may eat more leaf material to complete development than fast-growing herbivores. Hence, for some direct defenses we should expect coordinated induction of direct and indirect defenses. On the other hand, these higher-level ecological interactions can wreak havoc with the defensive function of other direct defenses. Plant toxins are frequently sequestered by specialist herbivores for their own defense against their parasitoids and predators, thereby turning a plant's defenses against itself. With such chemical defenses, the use of direct defenses may be incompatible with the deployment of indirect defenses. The ecological contingencies of herbivore resistance should select for the recognition of particular herbivores and the first molecular evidence is emerging for such specificity. If we are to understand and eventually use the ecological sophistication of native plants in agricultural practices, we need to understand the genetic basis of insect resistance. A strategy for attaining this goal will be presented for a group of *Nicotiana* species that are native to the deserts of North America.