Plant GIFTS Activity – Plant Modifications

1. **Spicy tomatoes:** Two pathways are upregulated to produce tomatoes that taste spicy and produce high levels of capsaicinoids, which are chemicals that are commercially useful in products like painkillers and pepper spray.

2. **Flavr Savr tomatoes:** Two added genes prolong shelf life and decrease premature ripening and softening, allowing these tomatoes to ripen on the vine while maintaining integrity and flavor during storage and shipping.

3. **Increased nutrient production:** Insertion of the MYB12 transcription factor causes these tomatoes to produce much higher levels of flavonols and phenylpropanoids, which are important in signaling and protection against UV damage.

4. **Increased yield:** Mutation of two MADS-box genes increases tomato production while decreasing branching and drooping. These plants produce more fruit that is easier to harvest mechanically.

5. **Vitamin D production**: Mutation of a gene that converts provitamin D3 into cholesterol results in tomato fruits that contain very high levels of provitamin D3. Vitamin D deficiency is a common problem in human health.

6. **Purple-fleshed tomatoes:** A gene from snapdragon is added to dramatically increase the production of anthocyanins in the tomato's skin and flesh. These anthocyanins are antioxidants that confer health benefits, such as improved cardiovascular function and protection against cancer.

7. **Increased resistance to fungal wilt:** Insertion of three resistance genes, I, I-2, and I-3, helps plants fight off infection from three different strains of fungus that can infect roots and kill vascular tissue. With the addition of these three genes, plants can recognize the fungus and stop it from growing throughout the plant.

8. **Increased resistance to root-knot nematodes (roundworms):** Insertion of the *Mi* resistance gene helps prevent infection by microscopic roundworms that live in the soil. With the addition of this gene, plants are able to recognize the presence of these roundworms and prevent them from infecting the plant.

9. **Heat-tolerant tomatoes:** The "Sun Leaper" tomato hybrid was bred so that it begins fruiting (growing tomatoes) when nighttime temperatures are high (in the 70s). Most varieties of tomatoes will not begin fruiting when temperatures at night remain this high.

10. **Salt-tolerant tomatoes:** Tomatoes overexpressing a vacuolar Na+/H+ antiport are able to grow, flower, and produce fruit in the presence of high concentrations of NaCl.

11. **Drought-tolerant tomatoes:** Tomatoes bred using this dry-farming technique are able to withstand drastic reductions in surface water during the growing season.

12. **Cherry tomatoes:** These tomatoes are cultivated to select for small size and round shape while maintaining the taste, texture, and aroma of a typical tomato.

13. **Resistance to Tomato Yellow Leaf Curl Virus:** Expression of the Ty1 and Ty3 genes results in resistance to TYLCV, which is a virus that causes yellowing and curling of leaves, a bushy growth pattern, and the lack of flowers and fruit.

14. **Resistance to Tomato Spotted Wilt Virus:** Addition of the dominant sw-5 gene confers resistance tomato spotted wilt virus and several other tospoviruses that cause chlorosis and necrosis of stems, leaves, and fruit; wilted leaves; uneven growth; or death.

15. **Bush Goliath Tomato:** This tomato variety has been bred to grow in small containers rather than open fields. While only growing up to three feet tall, this variety produces large, flavorful fruits with consistent production throughout the growing season.

16. **Herbicide-resistant tomato:** Site-directed mutations in the pds1, ALS, and EPSPS genes produce tomatoes resistant to the three most commonly used herbicides. Farmers can then use an herbicide to selectively target weeds, which reduce crop productivity by competing for critical resources like water, light, and carbon dioxide.

17. **Blue tomatoes:** Bred for their intense blue color and increased anthocyanin production, this variety confers the health benefits of anthocyanin consumption, including improved cardiovascular function and protection against cancer.

18. **Increased GABA Production:** CRISPR-Cas9 technology was used to introduce genes that promote accumulation of 4-5 times greater amounts of gamma-aminobutyric acid (GABA) in tomatoes. GABA has been shown to protect glucose homeostasis and lower blood pressure.