Chapter 4-20: Transgenic Plants

DNA technology has allowed us to dramatically increase plant resistance to disease and grow plants under conditions that were once believed impossible. With DNA technology, the size of edible plant parts such as seeds, fruit, and storage roots may be significantly increased. In addition, foods may be rendered more nutritious by the alteration of their amino acid content, and it may also be possible to convert plants, which are notable for their production of carbohydrates, into producers of protein.

A genetically-altered plant is called a transgenic plant. All the cells of a transgenic plant are derived from one cell so that all of the plant's cells express the same genetic information as that cell. For many reasons, plants are difficult to work with, but the results of genetic engineering have been impressive.

This plate displays the series of events involved in the production of a transgenic plant. Focus on the first diagram as you begin your reading below.

In order to develop transgenic plants, DNA technologists had to devise an insertion method by which DNA could be brought into plant cells. They focused their research on the **bacterium *Agrobacterium tumefaciens* (A)**. The **chromosome (B)** of this bacterium is shown in the plate. Because the chromosome is large and difficult to work with, biochemists focus on a plasmid in the cytoplasm called the **Ti plasmid (C)**. A light color should be used to color the cell, and dark colors should be used to trace the chromosome and plasmid. Together, *A. tumefaciens* and the Ti plasmid cause plant tumors called crown galls; crown galls develop when a portion of the Ti plasmid inserts into a plant cell chromosome.

The Ti plasmid of the bacterium *A. tumefaciens* is the main vector for genes in transgenic plants. We shall now see how the Ti plasmid is used in DNA technology. Continue your reading below as you color. Light colors are recommended, since the structures are small.

The Ti plasmid (C) is isolated from the bacterium, and you should color it. You should use a different color to color the region of **T-DNA (D)**. Shown in diagram 2, the T-DNA region leaves the Ti plasmid and inserts in the chromosome. A dark color such as blue or red is recommended for this region.

To prepare a recombined chromosome, technologists next obtain a **gene for insertion (E)** from a suitable donor organism. For example, they might want to enhance the nitrogen trapping capabilities of a plant, and use a gene that encodes an enzyme that traps nitrogen from the atmosphere. They would then biochemically combine this gene with the T-DNA region on the Ti plasmid. Diagram 3 shows the gene inserted within the T-DNA region. The **recombined Ti plasmids (C_1)** are then inserted into **fresh bacteria (F)** of the species *A. tumefaciens*. We see the plasmids in these bacteria in diagram 3.

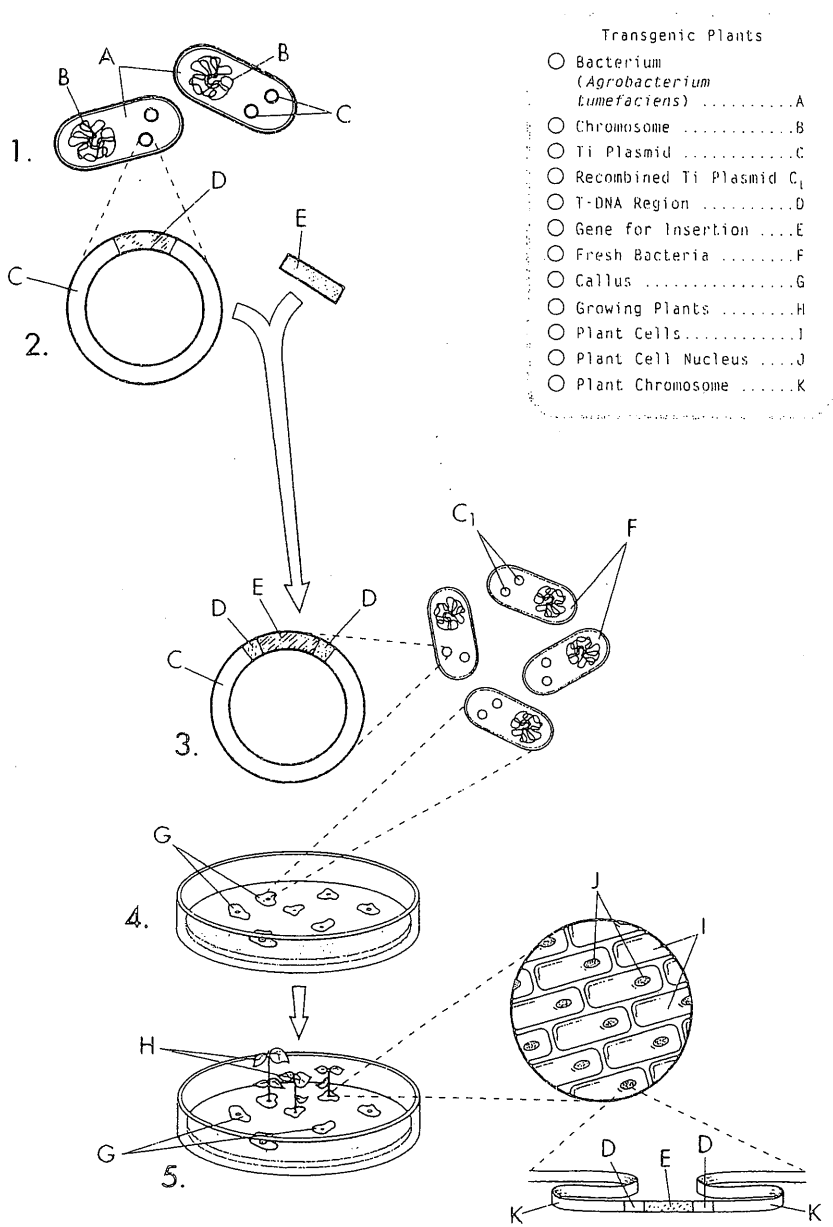
Having recombined the plasmids and inserted them into the bacterium *A. tumefaciens*, we are now ready to transform a regular plant into a transgenic plant. Continue your reading as you focus on diagram 4 of the plate.

To produce a transgenic plant, biochemists must be able to cultivate an entire plant from a single, nonreproductive cell. Scientists have been able to cultivate plants such as cabbage, carrots, and potatoes in this way, but technology for the cultivation of other plants is less advanced.

In DNA technology, a series of plant cells are combined with the recombined bacteria, in a sterile medium of carefully balanced plant nutrients and hormones (Diagram 4). Soon the cells develop into a random mass of cells called a leaf disk, also known as a **callus (G)**. A few days or weeks later, the forerunners of roots, stems, and leaves appear on the callus, and soon **growing plants (H)** can be seen on the callus. Diagram 5 shows these plants.

These miniature plants are now transferred to individual containers until they achieve sufficient size and hardiness for planting outdoors. When the biochemist takes a sample of the **plant cells (I)**, a **nucleus (J)** can be isolated, and a **plant chromosome (K)** can be examined. The chromosome contains the T-DNA region (D) of the Ti plasmid that was derived from the bacterium, and within this region is the inserted gene (E). A successful gene alteration has taken place in the plant, and the plant is now considered a transgenic plant.

Enhancing the nitrogen content of plants, developing plants' resistance to cold temperatures and insects, and producing new biotech foods are but a few of the possible uses of this type of biotechnology.



4-20: Transgenic Plants

a. What is a transgenic plant?

b. What did DNA technologists have to devise in order to develop transgenic plants?

c. Instead of the chromosome of the bacterium, on what did the biochemists focus?

d. What did the bacteria *A. tumefaciens* & the Ti plasmid cause in plants?

e. What is removed from the Ti plasmid after it is isolated from the bacterium?

f. What is inserted into the Ti plasmid?

g. Into what are the recombined plasmids insert?

h. When plant cells are combined with recombined bacteria in a medium of nutrients & hormones, the random mass of cells that develop is called a:

i. What are some possible uses of this biotechnology?