Chapter 5

Genetically Modified Foods are Not Fearful

The discussion of the subject of genetically modified foods has been avoided, because it has delicate problems politically, economically and from various points, so the government, the enterprises and the scientific societies dared not discuss the problem. However, we, scientists, should report the truth of our research to consumers.

5.1 Are Genetically Modified (GM) foods safe?

We are eating genes every day. We are eating eggs, which are filled with genetic DNA that leads to birth of chickens. In spite of these facts, we have not heard that we, human beings, were somewhat influenced by genes of chickens. It never happens that genes of cows and fishes, usually we eat them, are put into our cells and recombined in them.

It is possible for us to make GM cows by inserting genes of fish into cows with genetic engineering technique. However, there is no problem if we eat the GM cows, for the genetic DNAs are soon digested in saliva and gastric juice. After DNA (the abbreviation for Deoxyribonucleic acid) is digested, it is changed into sweet sugar, phosphoric acid and delicious nucleic acids such as inosinic and guanylic acids. It is because DNA is made of double-stranded helix consisting of sugar and nucleotides in the form of phosphate and 4 types of nucleic acids, such as adenine, guanine, cytosine and thymine (Fig. 5.1).

I suppose you have had many chances to see similar figures and I hope you will try to understand modern bioscience. If you understand this figure and Figure 2.8 in Chapter 2, you are supposed to understand the basic principle of molecular biology. And then you will find a beauty of life mechanisms.

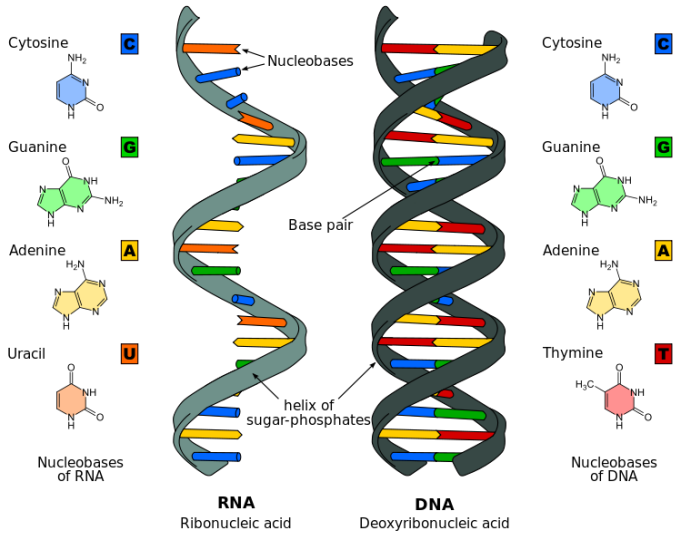

Fig. 5.1 *Structures of DNA and RNA and their chemical components.*

DNA and RNA are composed of nucleic acids such as cytosine, guanine, adenine and thymine or uracil and deoxyribosaccharide or ribosaccharide and phosphates. The difference between DNA and RNA is that the structure of DNA is double helix and composed of deoxyribonucleic acid, whereas RNA is single strand and composed of ribonucleic acid. DNA uses thymine instead of uracil as one of 4 nucleic acids. Three nucleobases (codon) determine the corresponding amino acid code.

Because soy sauce and *miso* are processed foods, genetic DNA and proteins do not remain keeping their forms in these foods. GM crops like soybeans or corns which are allowed to grow now are examined very carefully, and only GM crops which are recognized safe are allowed to be grown. On the other hand, natural cultivation or organic fertilizer cultivation are believed to be safe from our experiences, but safety of crops produced in these ways of cultivating is not completely proved scientifically.

5.2 How to make genetically modified foods

Figure 5.2 shows how to make genetically modified plants[*1]. We need 'vectors' which mean carriers, when we want to insert some useful genes into plant cells. Very minute DNA named Ti plasmid, which was discovered out of plant knots and can be replicated by itself, is used as vectors for plants. We insert genes taken from other organisms into vectors. For instance, genes which have tolerance against herbicide, genes which have tolerance against insecticide and which we can take without anxiety, genes which supply insufficient amino acid or genes which make vitamin, *etc*. are inserted. We, scientists, have tried to insert these genes into various plants in test tubes; therefore this technique is called 'Genetically modified (or Recombinant) technique in test tubes'.

We need a special skillful device in order to express these modified genes in *Escherichia coli* or other organisms. The resulted recombinant organisms read the recombinant gene and next make it copy on 'messenger RNA' (transcription) and furthermore transform them into proteins. Promoter and terminator in Figure 5.2 are examples of devices. Inserted genes do not work effectively without such special devices. Therefore, you need not feel afraid if a foreign gene like human oncogene was inserted into *E. coli* in accident, because the recombinant gene cannot work active without the special device.

5.3 Gene technology was beginning to develop when I visited the USA for the second time

Genetic engineering was beginning to draw the attention of the world, when I started my life as a visiting scientist at NIH in 1980. I developed a system of producing aimed proteins after I inserted various genes, such as genes of a

membrane protein related to vaccine against animal VSV viruses, a gene of protein taken from monkeys which binds heavy metals and other various genes of enzymes of animals and plants into *E. coli* vector in test tubes. My research work of genetic engineering of plant cells has developed from these experiences.

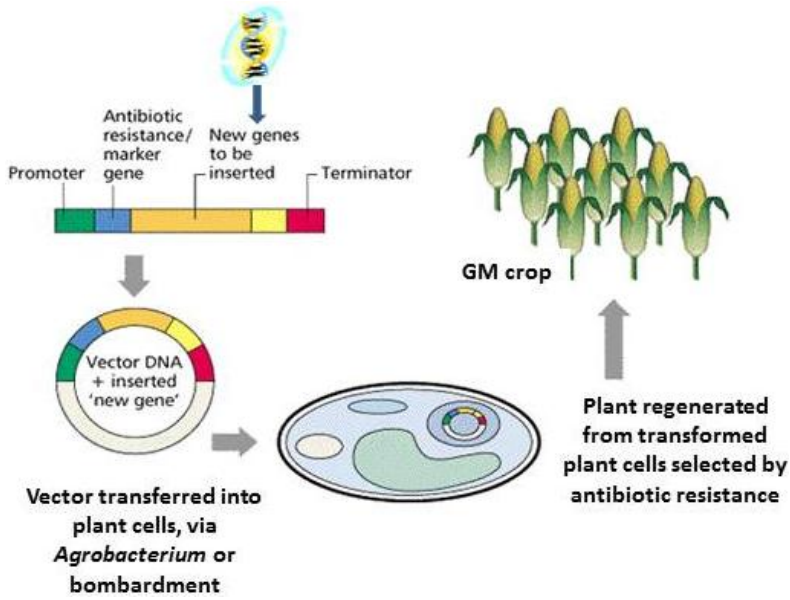

Fig. 5.2 *Schematic procedure of genetically modified (GM) crop.*

An aimed new gene is inserted into a vector, which has a special device for the aimed gene to be expressed in plant cells. The recombinant vector is transferred into plant cells by bombardment or with *Agrobacterium* infection method. The recombinant plant cells selected by drug resistance are regenerated to mature GM plant.

The process of this GM plants is as follows; first, we transfer this GM vector into the target plant cells by using devices such as *Agrobacterium* or bombardment (electroporation) (Fig. 5.2). After that, we select GM cells which were inserted into nucleuses skillfully as markers of drug resistance, such as kanamycin resistance, in the presence of the drug and grow them as new GM plants by callus cell culture.

Plants differentiate into mature plants even from callus cells or leaves, because plants have the power of totipotent, which has been known well by gardeners who graft trees together. It has come to be known recently that animals and human beings also have this kind of totipotent power. These cells are iPSC (Induced Pluripotent Stem Cells) in the public eye. However, the iPS cells cannot grow to become a human body.

5.4 Labeling of GM foods is helpful to consumers, but it is consumers who decide to eat them or not

One of the most concerned problems of GM food was that of an allergy which may be caused by gene product which is drug resistant protein used for the selection of GM organisms. However, it was proved that this protein was digested to amino acids soon in tens of seconds in gastric juice, and allergic diseases were not caused by people who are eating the GM foods. It was also proved that epitope configurations (amino-acid sequences of allergen causing allergy) known at this time were not detected in any GM foods.

On the other hand, some natural foods contain allergic materials, such as soybeans proteins, the white of eggs (egg albumin), *soba*, buckwheat, *etc*. Allergic materials in these natural foods have properties that they cannot be digested soon in gastric juice. Some kinds of allergic proteins take more than one hour when they are decomposed in gastric juice.

However, we catch many reports that give us warning to GM foods which may affect our health[*2]. For example, Bt corn in our gut bacteria could turn our intestines into "pesticide factories". Bt corn is equipped with a gene found in the soil bacteria *Bacillus thuningensis*, which produces Bt toxin, a pesticide that kills certain insects. Commercially raised chickens fed on genetically altered

food show higher levels of pathogenic gut bacteria than normal ones. Corn rootworm which is resistant to Bt corn is growing increasingly. These reports may be true. However, if you were all nerves about the foods, you could not eat any foods cultivated with chemical fertilizers and chemical pesticides or even with organic fertilizers. You may also fear more than millions of the derivatives of chemical compounds which exist on the earth. It would be better to choose foods by yourself. In Japan, Korea, Australia, New Zealand and EU countries, GM foods have to be labeled and consumers decide to eat them or not. GM labelling is not for safety. It is for helping consumers make a choice about the food they buy by information.

5.5 GM foods can solve food crises in the world

I know well that the problem of GM foods is controversial. Some people say, "I managed to understand that GM foods are safe, but it would be better for us to take plants which use organic fertilizers or natural plants instead of GM plants". I agree to this opinion. However, I also want you to understand that there are other points in this problem of GM foods. There is necessity for GM foods using besides its economic merits. It is the solution of future food crises in the world. I think GM foods can lighten farmers' heavy work such as weeding and they can grow plants which is tolerant against dry or cold weather and salty water.

I tried to develop GM rice plants, which are tolerant against salt by recombining of compatible solute genes, by the collaborated work with Dr. A. Shinmyo of Nara Institute of Sciences. It has not been put to practical use, but it will play a role of the solution of food crises in the world. If we succeed in development of the salt-tolerant GM rice, the rice can be cultivated at tidal land of sea or at salt hazard fields.

In spite of the merits of GM foods, I am anxious about two problems that may be caused by this technology. One of them is that a big enterprise may control agriculture exclusively in developing countries by selling GM seeds which cannot reproduce by farmers. We always have to watch the safety and continue to do research about improving the genetically modified organisms (GMO). The other one is an environmental concerning. Several research papers are reported as to the influences to the environments. They say GM foods may have influences on wild species. Scientists have to try to solve these problems.

5.6 Summary

GM crops like soybeans or corns which are allowed to grow now are examined very carefully, and only GM crops which are evaluated as safe are allowed to be grown. In Japan, EU and many other countries, GM foods have to be labeled. GM labelling is not for safety. It is for helping consumers make a choice about the food they buy by information. Besides GMO's economic merits, the GMO should be used for the solution of future food crises in the world by enrichment of nutrients, by improving plants growth which is tolerant against dry weather, salty water and cold weather cultivation.

[*1] Murooka, Y. and Imanaka, T. (eds.) Recombinant Microbes for Industrial and Agricultural Applications, p. 1-877, Marcel Dekker Inc. Co., New York (1994).

[*2] http://articles.mercola.com/