Plant genetics

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Plant genetics is a very broad term. There are many facets of genetics in general, and of course there are many facets to plants. The definition of genetics is the branch of biology that deals with heredity, especially the mechanisms of hereditary transmission and the variation of inherited characteristics among similar or related organisms.[1] And the definition of a plant is any of various photosynthetic, eukaryotic, multicellular organisms of the kingdom Plantae characteristically producing embryos, containing chloroplasts, having cell walls which contain cellulose, and lacking the power of locomotion.[2] Although there has been a revolution in the biological sciences in the past twenty years, there is still a great deal that remains to be discovered. The completion of the sequencing of the genomes of rice and some agriculturally and scientifically important plants (for example Physcomitrella patens) has increased the possibilities of plant genetic research immeasurably.

An image of multiple chromosomes, making up a genome

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Features of plant biology

Plant genetics is different from that of animals in a few ways. Like mitochondria, chloroplasts have their own DNA, complicating pedigrees somewhat. Like animals, plants have somatic mutations regularly, but these mutations can contribute to the germ line with ease, since flowers develop at the ends of branches composed of somatic cells. People have known of this for centuries, and mutant branches are called "sports". If the fruit on the sport is economically desirable, a new cultivar may be obtained.

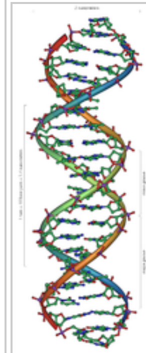
Some plant species are capable of self-fertilization, and some are nearly exclusively self-fertilizers. This means that a plant can be both mother and father to its offspring, a rare occurrence in the animals. Scientists and hobbyists attempting to make crosses between different plants must take special measures to prevent the plants from self-fertilizing.

Plants are generally more capable of surviving, and indeed flourishing, as polyploids. Polyploidy, the presence of extra sets of chromosomes, is not usually compatible with life in animals. In plants, polyploid individuals are created frequently by a variety of processes, and once created usually cannot cross back to the parental type. Polyploid individuals, if capable of self-fertilizing, can give rise to a new genetically distinct lineage, which can be the start of a new species. This is often called "instant speciation". Polyploids generally have larger fruit, an economically desirable trait, and many human food crops, including wheat, maize, potatoes, peanuts, [3] strawberries and tobacco, are either accidentally or deliberately created polyploids.

Hybrids between plant species are easy to create by hand-pollination, and may be more successful on average than hybrids between animal species. Often tens of thousands of offspring from a single cross are raised and tested to obtain a single individual with desired characteristics. People create hybrids for economic and aesthetic reasons, especially with orchids.

DNA

Deoxyribonucleic acid (DNA) is a nucleic acid that contains the genetic instructions used in the development and functioning of all known living organisms and some viruses. The main role of DNA molecules is the long-term storage of information. DNA is often compared to a set of blueprints or a recipe, or a code, since it contains the instructions needed to construct other components of cells, such as proteins and RNA molecules. The DNA segments that carry this genetic information are called genes, but other DNA sequences have structural purposes, or are involved in regulating the use of this genetic information. Geneticists, including plant geneticists, use this sequencing of DNA to their advantage as they splice and delete certain genes and regions of the DNA molecule to produce a different or desired genotype and thus, also producing a different phenotype.



The structure of part of a DNA double helix

Gregor Mendel

Gregor Mendel was an Augustinian priest and scientist born on 20 July 1822 in Austria-Hungary and is well known for discovering genetics. He went to the Abbey of St. Thomas in Brno. He is often called the father of genetics for his study of the inheritance of certain traits in pea plants. Mendel showed that the inheritance of these traits follows particular laws, which were later named after him. The significance of Mendel's work was not recognized until the turn of the 20th century. Its rediscovery prompted the foundation of the discipline of genetics allows geneticists today to accurately predict the outcome of such crosses and in determining the phenotypical effects of the crosses. He died on 6 January 1884 from chronic nephritis.

Modern ways to genetically modify plants

There are two predominant procedures of transforming genes in organisms: the "Gene gun" method and the *Agrobacterium* method.

"Gene gun" method

The "Gene Gun" method is also referred to as "biolistics" (ballistics using biological components). This technique is used for in vivo (within a living organism) transformation and has been especially useful in transforming monocot species like corn, otherwise known as maize, and rice. This approach literally shoots genes into plant cells and plant cell chloroplasts. DNA is coated onto small particles of gold or tungsten approximately two micrometres in diameter. The particles are placed in a vacuum chamber and the plant tissue to be engineered is placed below the chamber. The particles are propelled at high velocity using a short pulse of high pressure helium gas, and hit a fine mesh baffle placed above the tissue while the DNA coating continues into any target cell or tissue.

Agrobacterium method

Transformation via *Agrobacterium* has been successfully practiced in dicots, i.e. broadleaf plants, such as soybeans and tomatoes, for many years. Recently it has been adapted and is now effective in monocots like grasses, including corn and rice. In general, the *Agrobacterium* method is considered preferable to the gene gun, because of a greater frequency of single-site insertions of the foreign DNA, which allows for easier monitoring. In this method, the tumor inducing (Ti) region is removed from the T-DNA (transfer DNA) and replaced with the desired gene and a marker, which is then inserted into the organism. This may involve direct inoculation of the tissue with a culture of transformed Agrobacterium, or inoculation following treatment with micro-projectile bombardment, which wounds the tissue.[4] Wounding of the target tissue causes the release of phenolic compounds by the plant, which induces invasion of the tissue by Agrobacterium. Because of this, microprojectile bombardment often increases the efficiency of infection with Agrobacterium. The marker is used to find the organism which has successfully taken up the desired gene. Tissues of the organism are then transferred to a medium containing an antibiotic or herbicide, depending on which marker was used. The *Agrobacterium* present is also killed by the antibiotic. Only tissues expressing the marker will survive and possess the gene of interest. Thus, subsequent steps in the process will only use these surviving plants. In order to obtain whole plants from these tissues, they are grown under controlled environmental conditions in tissue culture. This is a process of a series of media, each containing nutrients and hormones. Once the plants are grown and produce seed, the process of evaluating the progeny begins. This process entails selection of the seeds with the desired traits and then retesting and growing to make sure that the entire process has been completed successfully with the desired results.

Genetically engineered crops

Main article: Genetically modified food

Genetically engineered crops

The use of genetically engineered crops has helped many farmers deal with pest problems that reduce their crop production. The impact of pest-resistant crops has led to a much higher yield for farmers in today's world. They can use less pesticides which reduces the chemicals that they put into the ground. Certain engineered crops have led to farmers all over the world and in the United States to increase crop yield exponentially in recent years. Farmers can use a glyphosate herbicide to kill weeds, yet the genetically engineered corn is resistant to the herbicide and is left unaffected. Thus, fields are produced that are virtually weed free. Genetically engineered crops can also benefit farmers when dealing with potentially harmful viruses and bacteria. In the case of the 1990s a mutant strain of virus was decimating the commercial corn fields of the United States. Scientists found a virus resistant strain of maize in the highlands of Mexico and extracted the part of the maize's genome that coded for resistance against the virus and incorporated it into their existing strain of commercial corn. This allowed the commercial strain to produce progeny that were resistant to the virus. Thus, the crops were saved from decimation.

Potential detrimental effects of genetically engineered plants

According to Vaughan A. Hilder and Donald Boulter at the Department of Biological Sciences, University of Durham, there have been serious failures in resistance to targeted pests in Bt cotton; most plant-derived resistance factors produce chronic rather than acute effects; and many serious pests are simply not susceptible to known resistance factors.[5] According to John E. Berringer the outcome of releasing genetically modified organisms into the environment is still not known.[6]

See also

- Bioethics
- Biological engineering
- Biotechnology High School-- a high school in New Jersey focusing mostly on Biotechnology.
- Biotechnology
- Canola
- Cloning
- DuPont
- Ethics of technology
- Eugenics
- Experimental evolution
- Gene flow
- Gene pool
- Genetic erosion
- Genetic pollution
- Genetically modified organisms
- Human genetic engineering
- Ice-minus bacteria
- List of emerging technologies
- Marker assisted selection
- Monsanto Company
- Paratransgenesis
- Recombinant DNA
- Research ethics
- Stem cell
- Synthetic biology
- Transgene
- Transgenic bacteria

References

1. ^ Brooker, Robert. Genetics Analysis and Principles. 3rd. New York: McGraw-Hill Irwin, 2009. Print.
2. ^ Stern, Kingsley. Introductory Plant Biology. 11th. New York City: McGraw-Hill, 2008.
3. ^ http://link.springer.com/article/10.1007%2Fs11816-011-0200-5
4. ^ "Microprojectile bombardment of plant tissues increases transformation frequency by Agrobacterium tumefaciens". *Plant Mol. Biol.* **18** (2): 301–13. January 1992. PMID 1310058 (//www.ncbi.nlm.nih.gov/pubmed/1310058).
5. ^ Vaughan A. Hilder, Donald Boulter Department of Biological Sciences, University of Durham, Durham DH1 3LE, UK Received 1 March 1998
6. ^ Releasing Genetically Modified Organisms: Will Any Harm Outweigh Any Advantage? John E. Beringer. The Journal of Applied Ecology, Vol. 37, No. 2 (Apr., 2000), pp. 207-214. Published by: British Ecological Society

External links

- Ministry for the Environment NZ - Report of the Royal Commission on Genetic Modification (http://www.mfe.govt.nz/publications/organisms/royal-commission-gm/)
- GMO Safety - Information about research projects on the biological safety of genetically modified plants. (http://www.gmo-safety.eu/en/)
- Introduction to Genetic Engineering (http://www.bootstrike.com/Genetics/) Covers general information on Genetic Engineering including cloning, stem cells and DNA.
- bEcon - Economics literature about the impacts of genetically engineered (GE) crops in developing economies (http://www.mendeley.com/groups/1296883/becon)
- Introduction to plant genetics curated by a Michigan State University professor (http://knowledgenetwork.alumni.msu.edu/weebadde/css350introductiontoplantgenetics.html)

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