

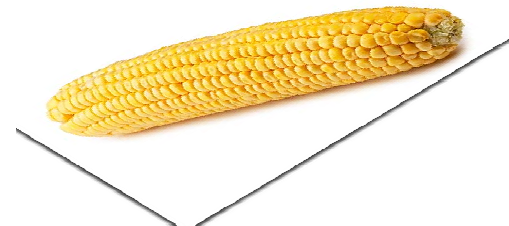
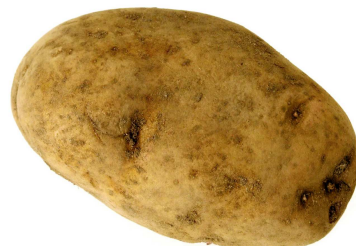


Juggling Genes-

An Overview of Plant Breeding Methods



Helga Hofmann-Sieber March 15th, 2010



The Roots of Plant Breeding

Domestication of plants (artificial selection of plants with desired features/ elimination of unwanted plants)

early forms of wheat and barley in the Middle East 10000 years ago

early forms of maize in Mexico 7000 years ago

1866 Birth of Plant Breeding

Gregor Mendel- Augustinian monk and scientist- publishes his „principles of heredity“ which he had derived from genetic studies with peas

He describes how genetic features are passed on from one generation to the next.

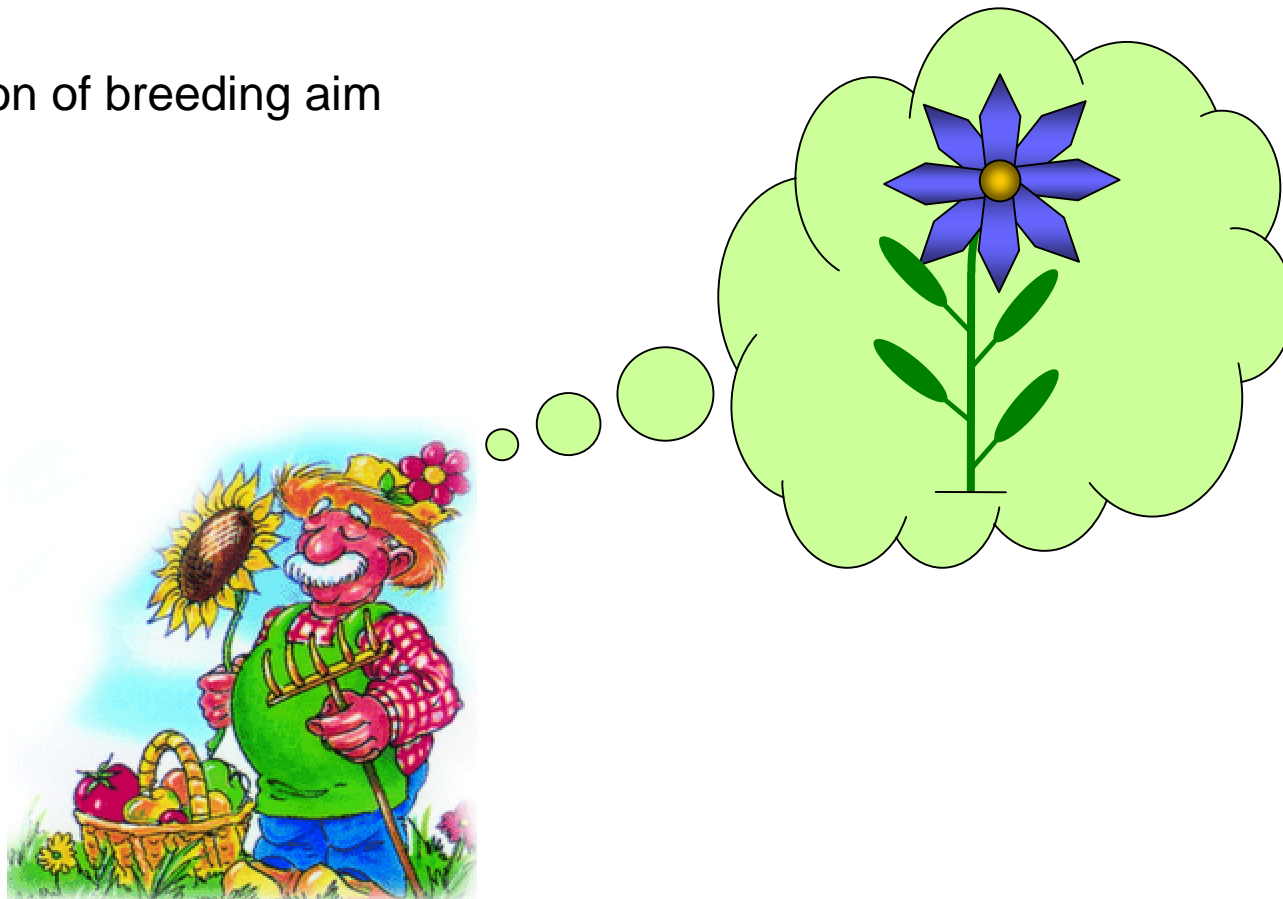
He establishes the basis of effective plant breeding



Gregor Mendel
(1822-1884)

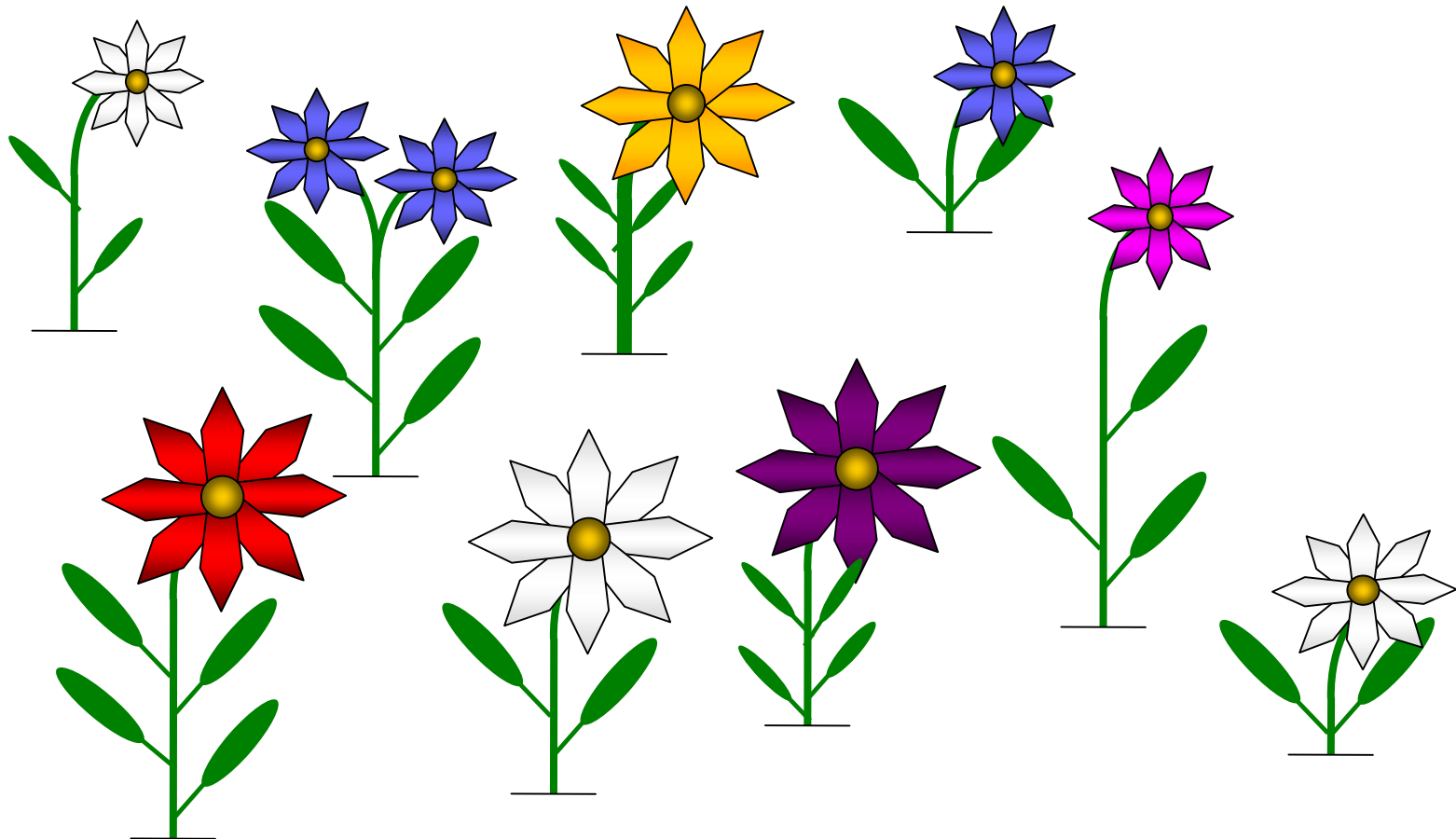
Classical Plant Breeding

Determination of breeding aim



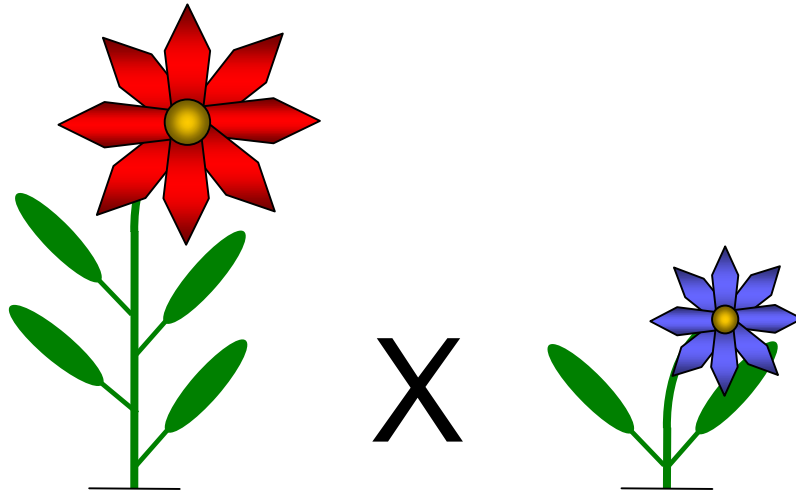
Classical Plant Breeding

Selection of plants containing the desired features



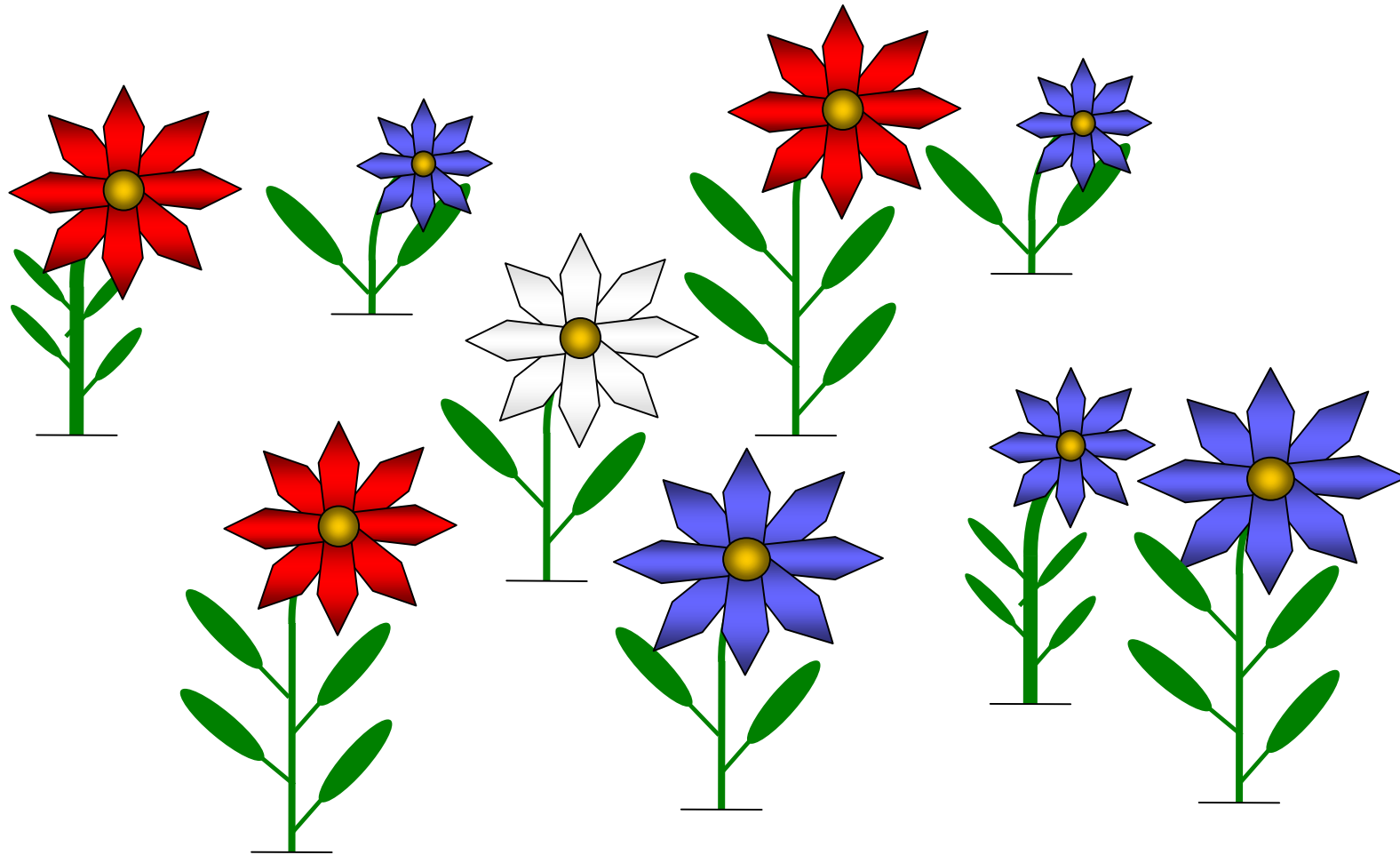
Classical Plant Breeding

Crossing of selected plants



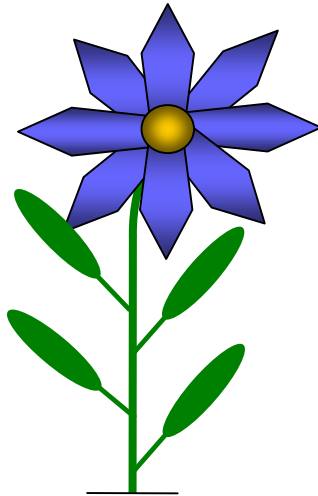
Classical Plant Breeding

Evaluation of progeny and selection of plants for further crossing



Classical Plant Breeding

Repetitive selection, crossing, evaluation until breeding aim is reached



Characteristics of Classical Plant Breeding

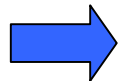
- most-frequently used plant breeding method
- usage of whole plants
- time-consuming method



RAPE

20 years of breeding to generate breed without erucic acid glucosinolate.

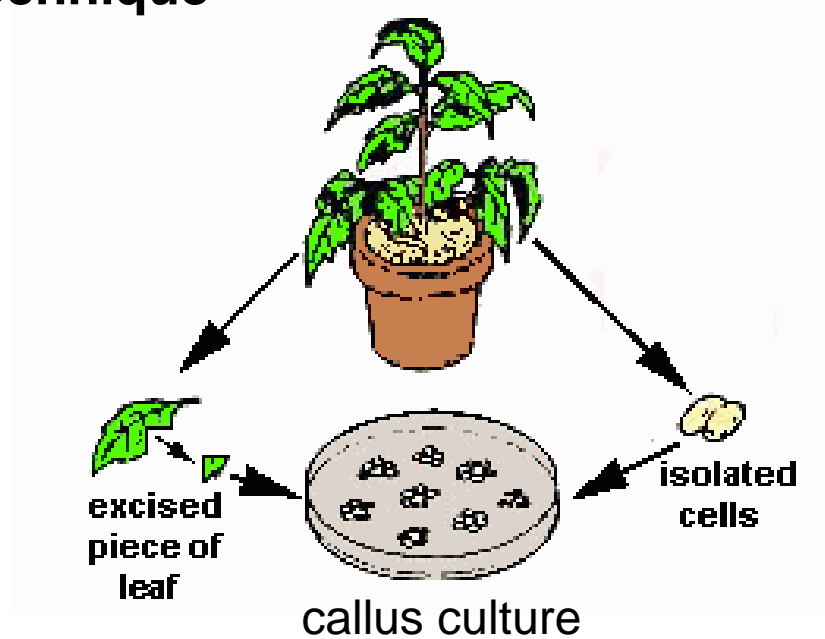
- often reduced fertility in inbred lines



Establishment of cell culture techniques working with single plant cells

Modern Plant Breeding Methods

Callus Technique



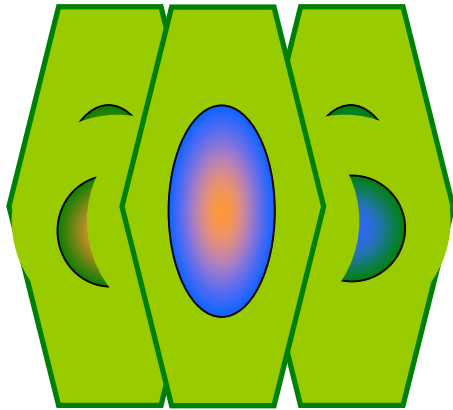
Quick generation of multiple, genetically identical plants (clones) independent from fertility of parental plant

Regeneration of full plants



Modern Plant Breeding Methods

Protoplast Fusion



Isolation of plant cells (microspores or somatic cells)

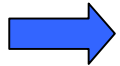
Enzymatic digestion of cell wall

Chemical or electrical fusion of protoplasts

Reconstitution of cell wall

Propagation of cells in callus culture

Regeneration of full plant

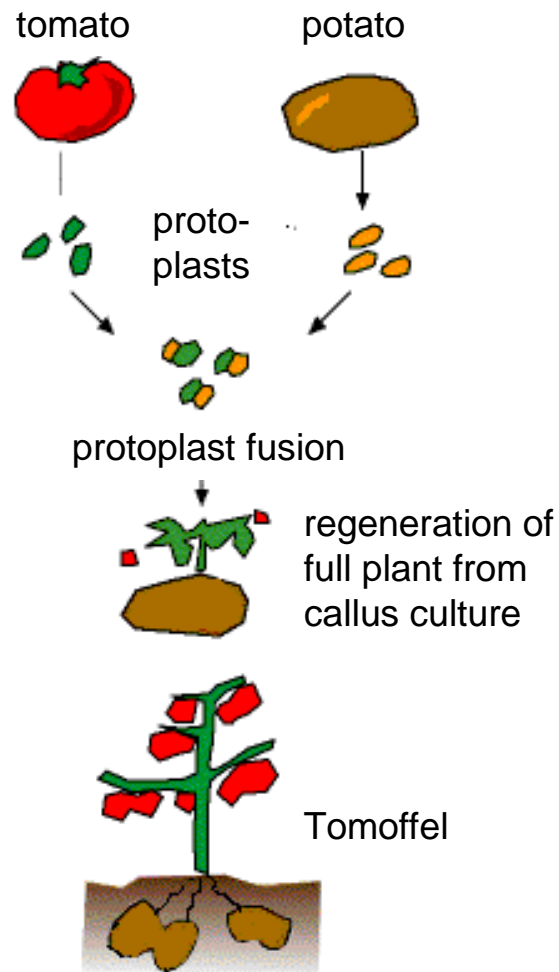


Crossing of plants even if parental plants are infertile or could not be crossed under natural conditions

Sometimes difficult to regenerate full plant after protoplast fusion

Modern Plant Breeding Methods

Tomato-Potato-Hybrid (Tomoffel)



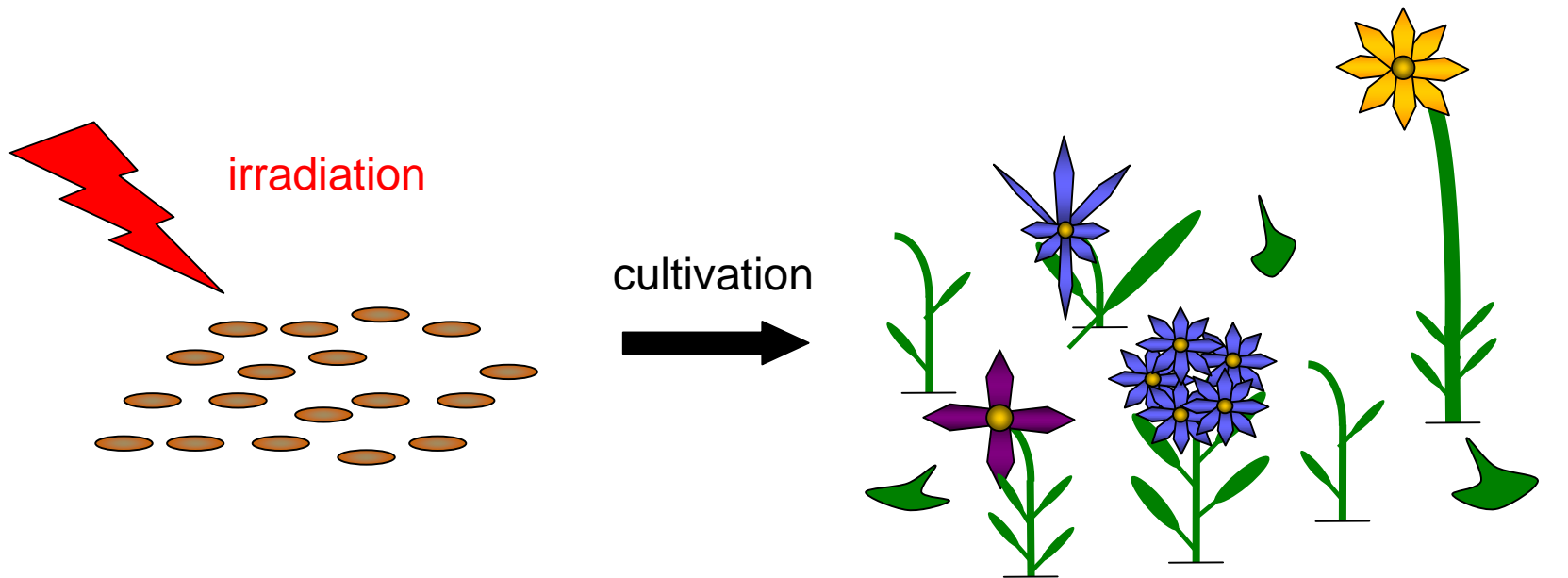
generated by the German biologist Georg Melcher in 1978 by protoplast fusion of tomato and potato cells

Tomoffel is genetically instable and infertile (no productive seeds)

Modern Plant Breeding Methods

Mutagenesis Method

- Irradiation of seeds with UV, X-ray or nuclear radiation to trigger mutations



Selection of mutants with desired features

Further breeding with classical breeding methods

Genetic Engineering of Plants

Characteristics of Genetic Engineering

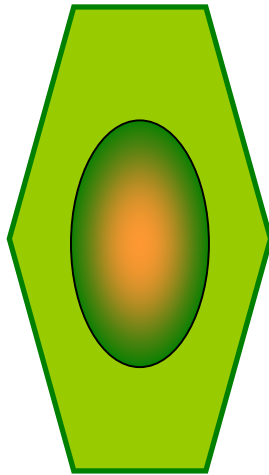
Directed introduction or removal of specific genes

No limitations by species barrier

Selection of modified plant (cells) with specific selection markers

Genetic Engineering of Plants

Gene Transfer



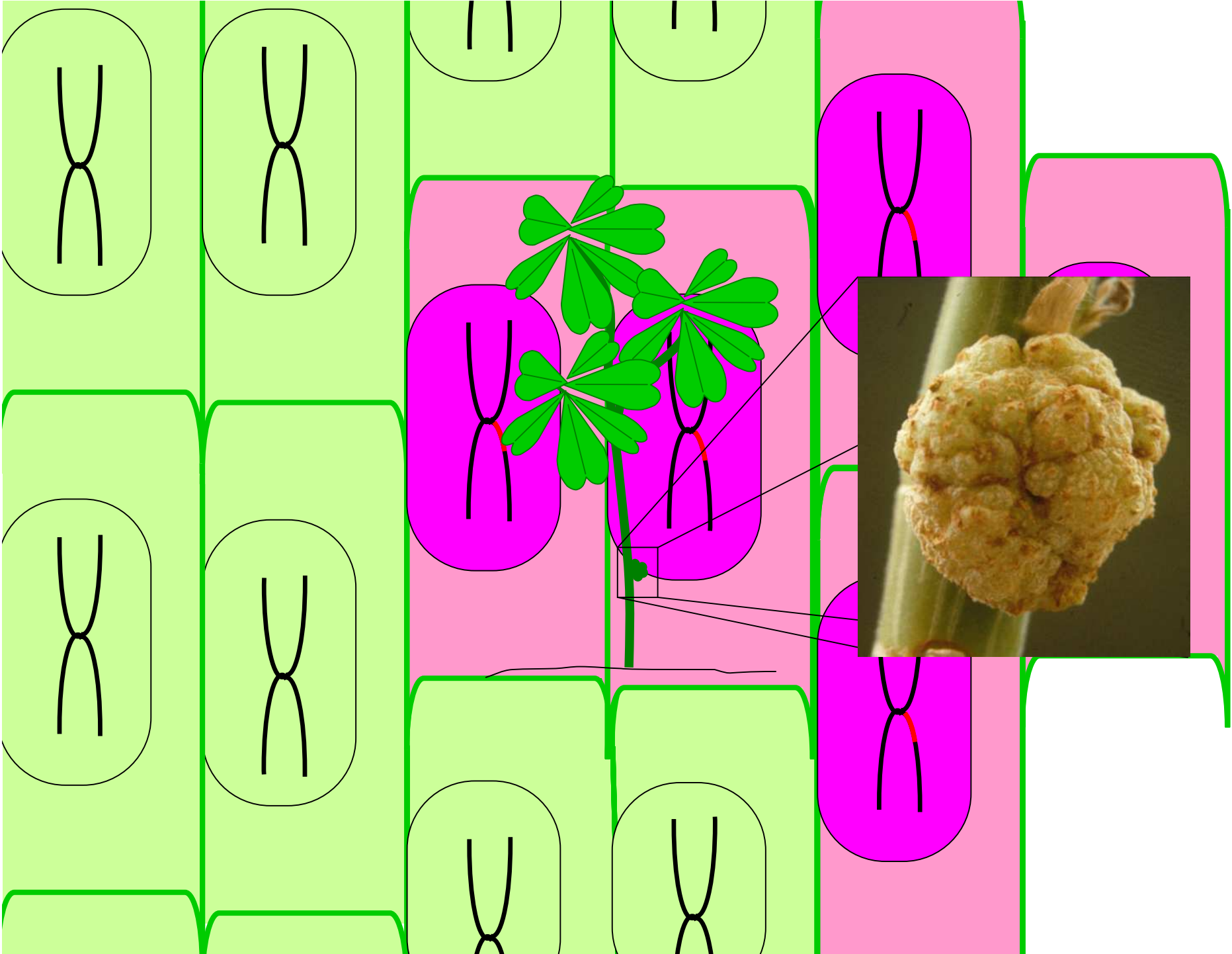
using

- *Agrobacterium tumefaciens*
- biolistic particle delivery system (gene gun)

Genetic Engineering Methods

Agrobacterium tumefaciens

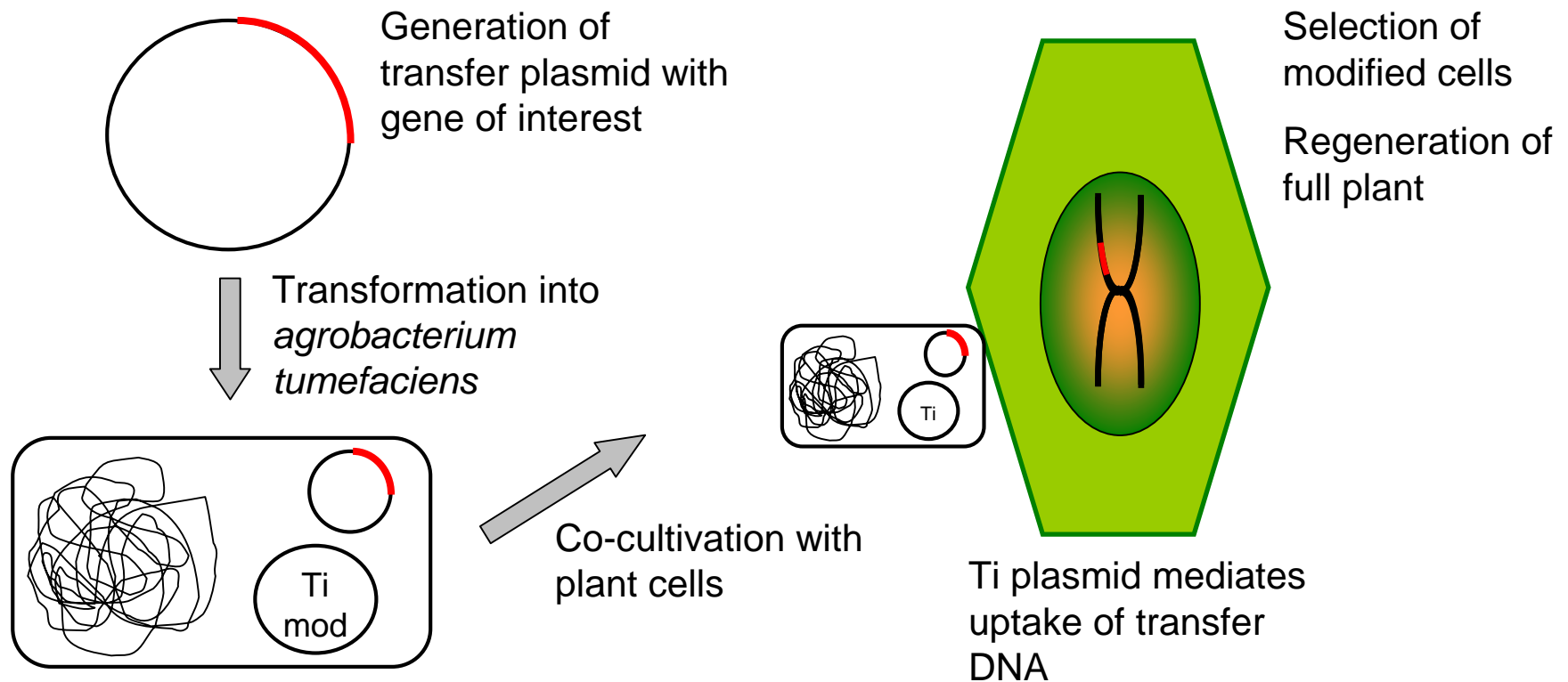
- Discovered in 1907 as a tumor-inducing bacterium in plants



Genetic Engineering Methods

Agrobacterium tumefaciens

- Discovered in 1907 as a tumor-inducing bacterium in plants
- 1983 removal of tumor-inducing genes from bacterial Ti-plasmid (Ti mod)



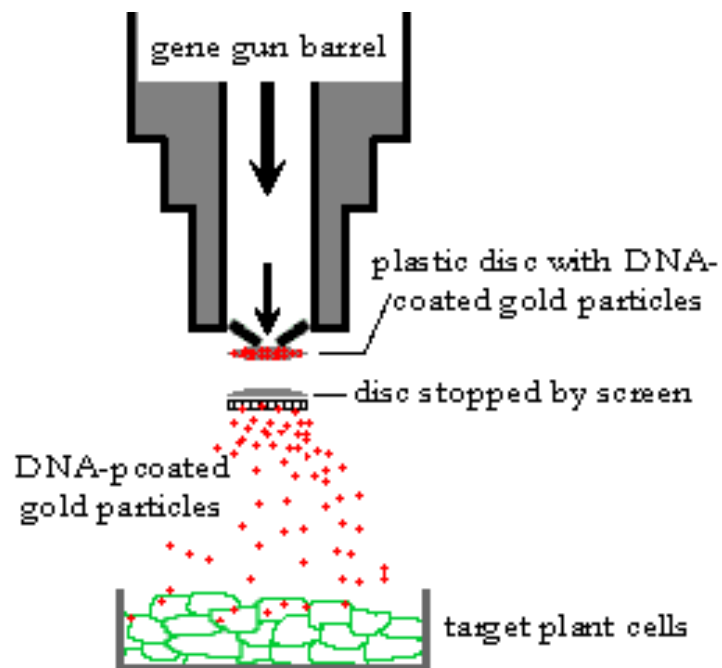
Genetic Engineering Methods

Gene Gun

DNA is attached to gold particles ($\text{\O} 1\text{-}2 \mu\text{m}$)

Plant cells are bombarded with particles

DNA gets into nucleus or cell organelles and integrates into plant DNA



Selection of modified cells

Regeneration of full plant

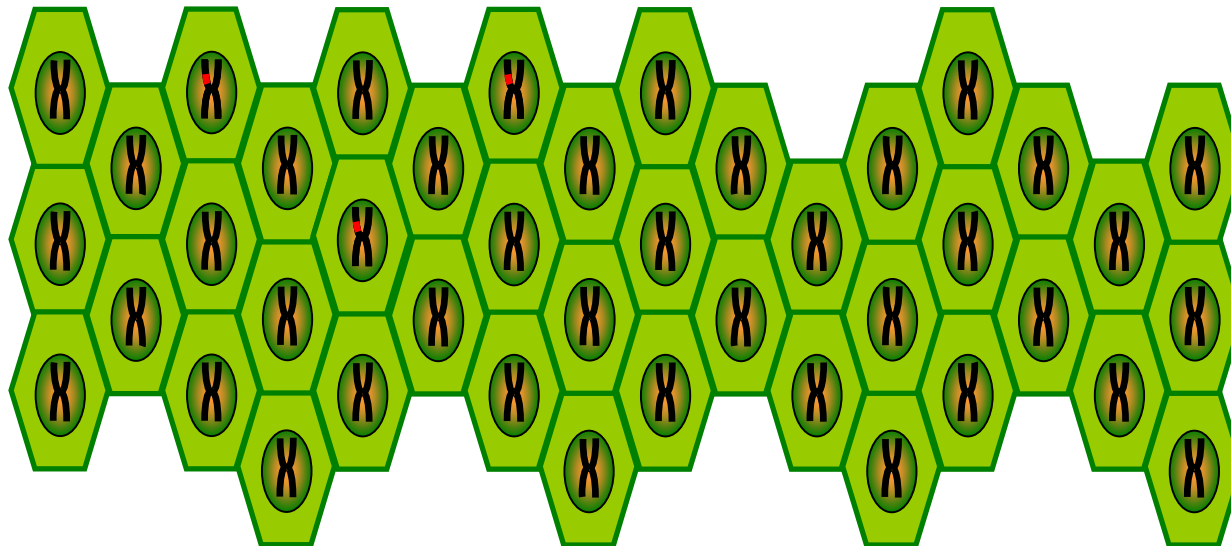
Efficacy of method 0,05%

Genetic Engineering Methods

Selection Marker

Low efficacy of transformation methods accounts for use of selection markers

- Antibiotic resistance
- Herbicide resistance

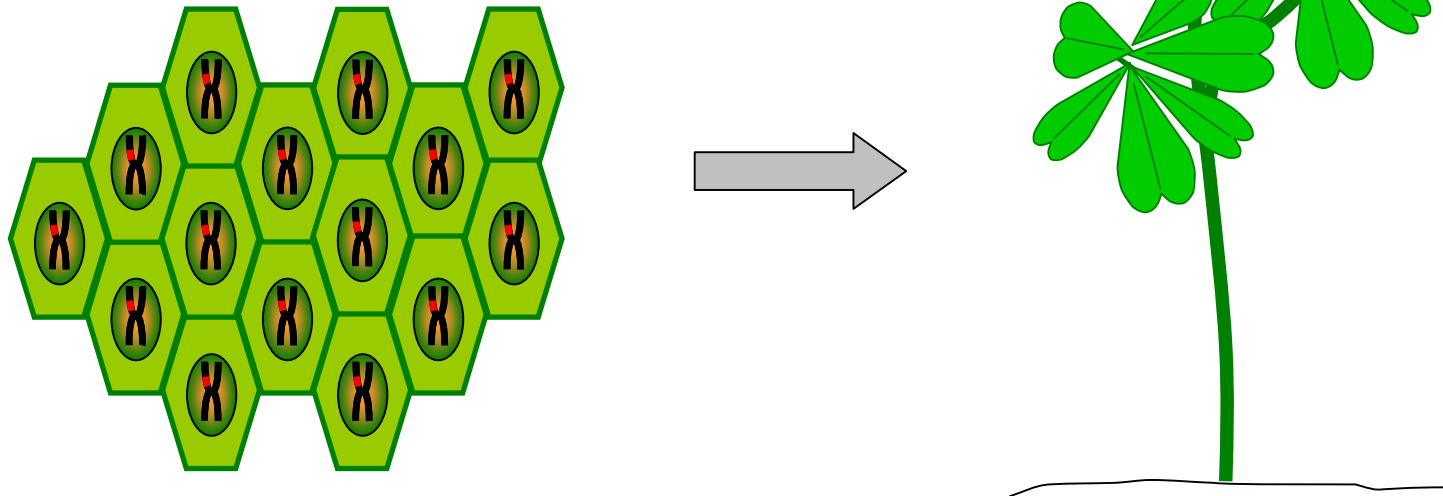


Genetic Engineering Methods

Selection Marker

Low efficacy of transformation methods accounts for use of selection markers

- Antibiotic resistance
- Herbicide resistance



Genetic Engineering Methods

Use of Selection Markers in Genetic Engineered Plants

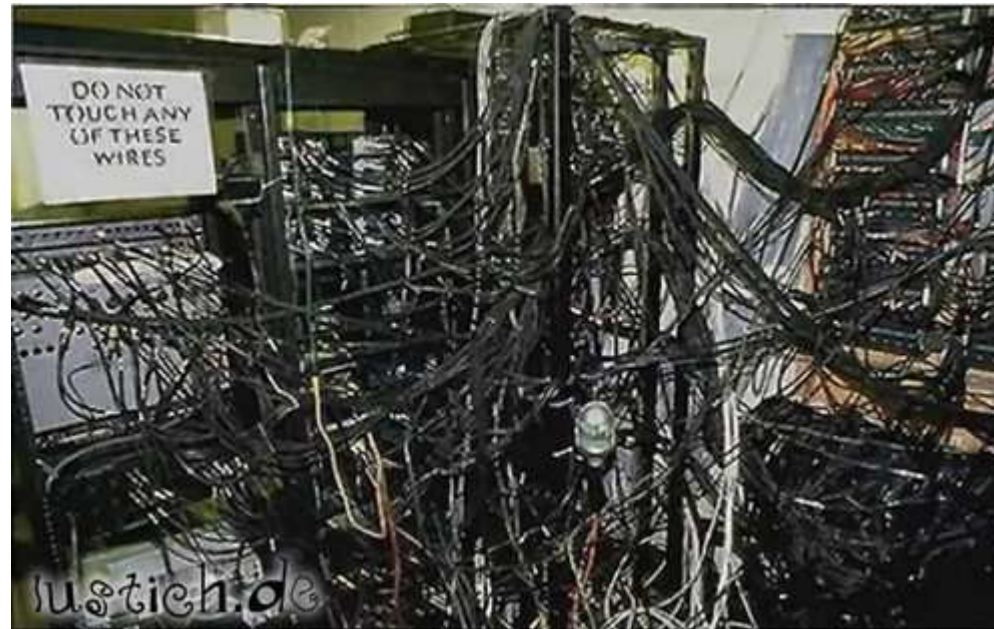
Amflora	Potato for Industrial Purposes (BASF)	Kanamycin Resistance
Bt-Maize	Maize producing insecticide (Monsanto)	Ampicillin Resistance

Conclusions

Human genome 1.000.000.000 bases of DNA

40.000 genes regulated by non-coding DNA regions

Most plant genomes are even more complex



➔ Genetic engineering is a powerful tool which is not quite understood

Conclusions

