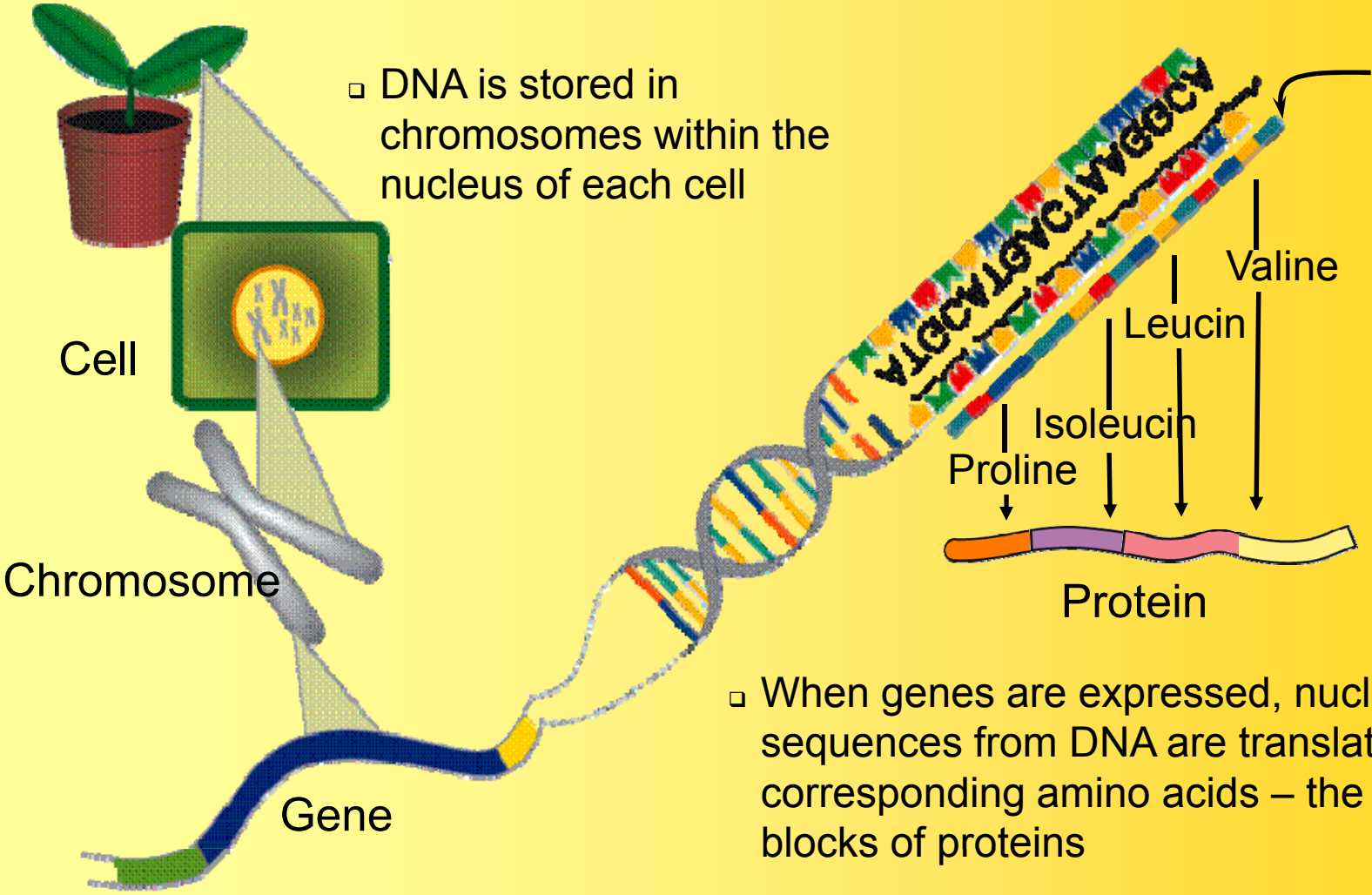
A brief introduction to Marker-Assisted Breeding

DNA LandMarks
a BASF Plant Science Company

Gene Expression

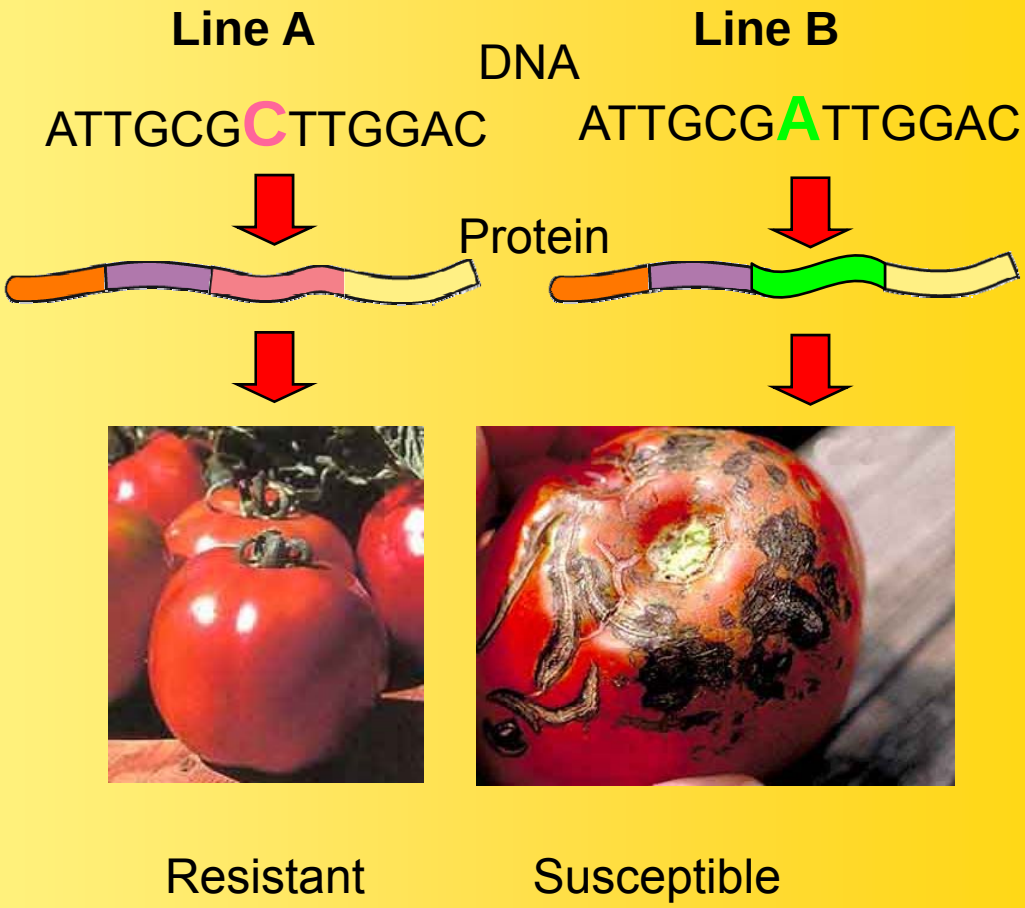
- DNA is stored in chromosomes within the nucleus of each cell



- When genes are expressed, nucleotide sequences from DNA are translated into corresponding amino acids – the building blocks of proteins
- RNA & Proteins carry out all cell functions

How Genotype Effects Phenotype

- Mutations can occur in DNA (e.g. cytosine to adenine or C to A)
- Some mutations cause a change in the amino acid coding at the protein level
- The new protein may have an altered function and the plant a different phenotype

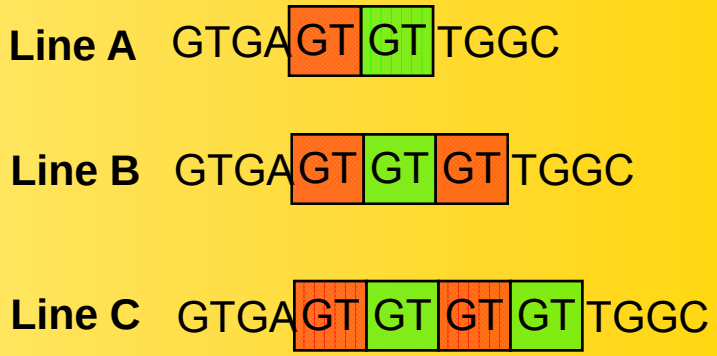


What are DNA Markers?

Genetic markers are specific DNA sequence differences that can be identified through biochemical assays. There are two main types:

Simple Sequence Repeats (SSR)

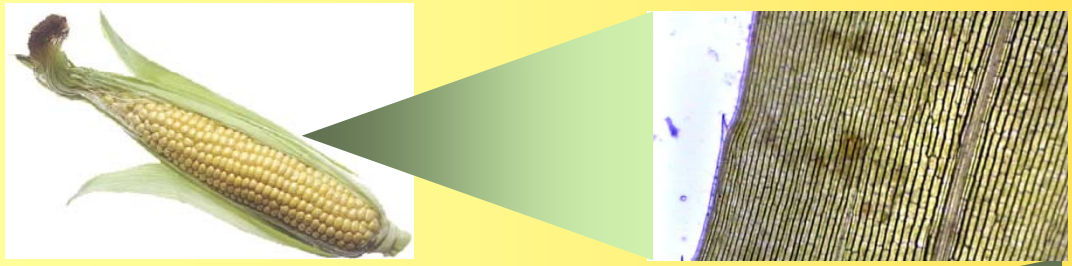
- Usually consist of di or tri nucleotide repeats
- Also known as microsatellites
- Variation occurs in the number of repeats
- The difference in the length of each fragment can be measured
- Co-dominant marker system (more informative when dealing with heterozygotes)



Single Nucleotide Polymorphism (SNP)

- Based on the allelic variation of single nucleotides
- Co-dominant marker system
- Most prolific of all marker types
- Very efficient and inexpensive to use once developed

How Genetic Markers Track Genotype

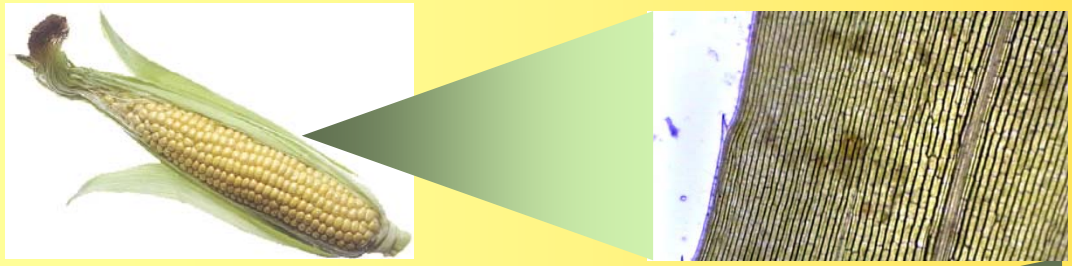


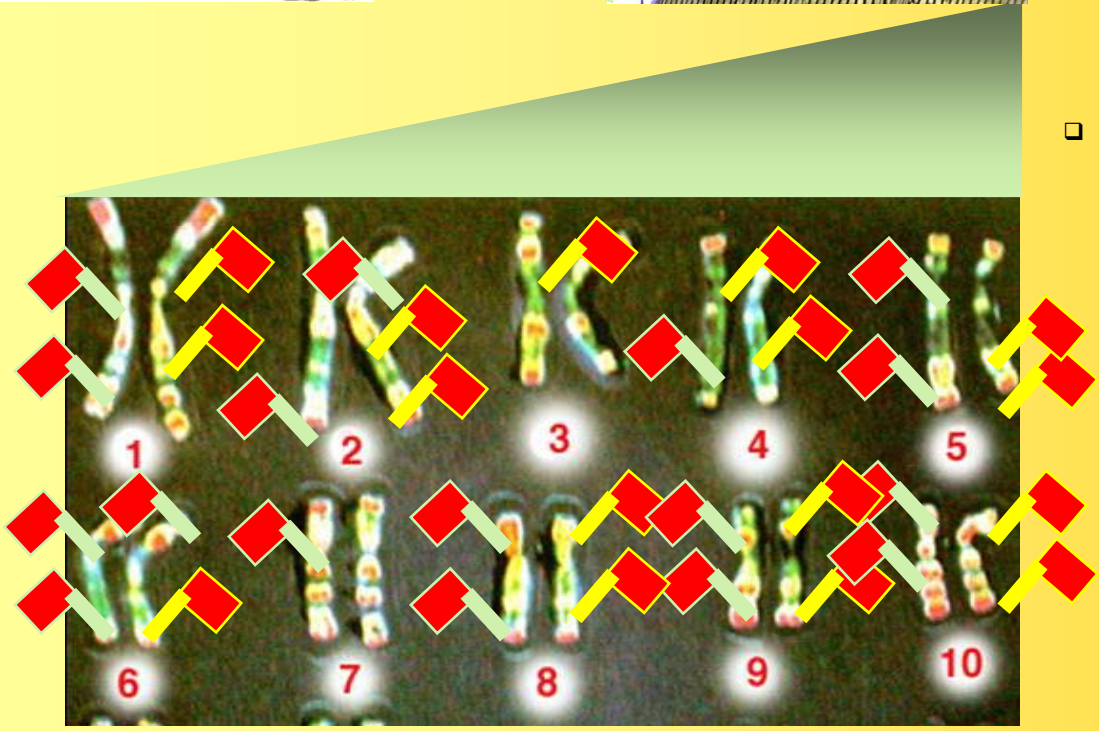
- DNA markers can occur anywhere across the genome

Chromosome picture

Raven, PH and GB Johnson 1991. **Understanding Biology**. 2nd Edition. Mosby. St. Louis.

How Genetic Markers Track Genotype





- DNA markers can occur anywhere across the genome
- The more markers you have, the more useful they become

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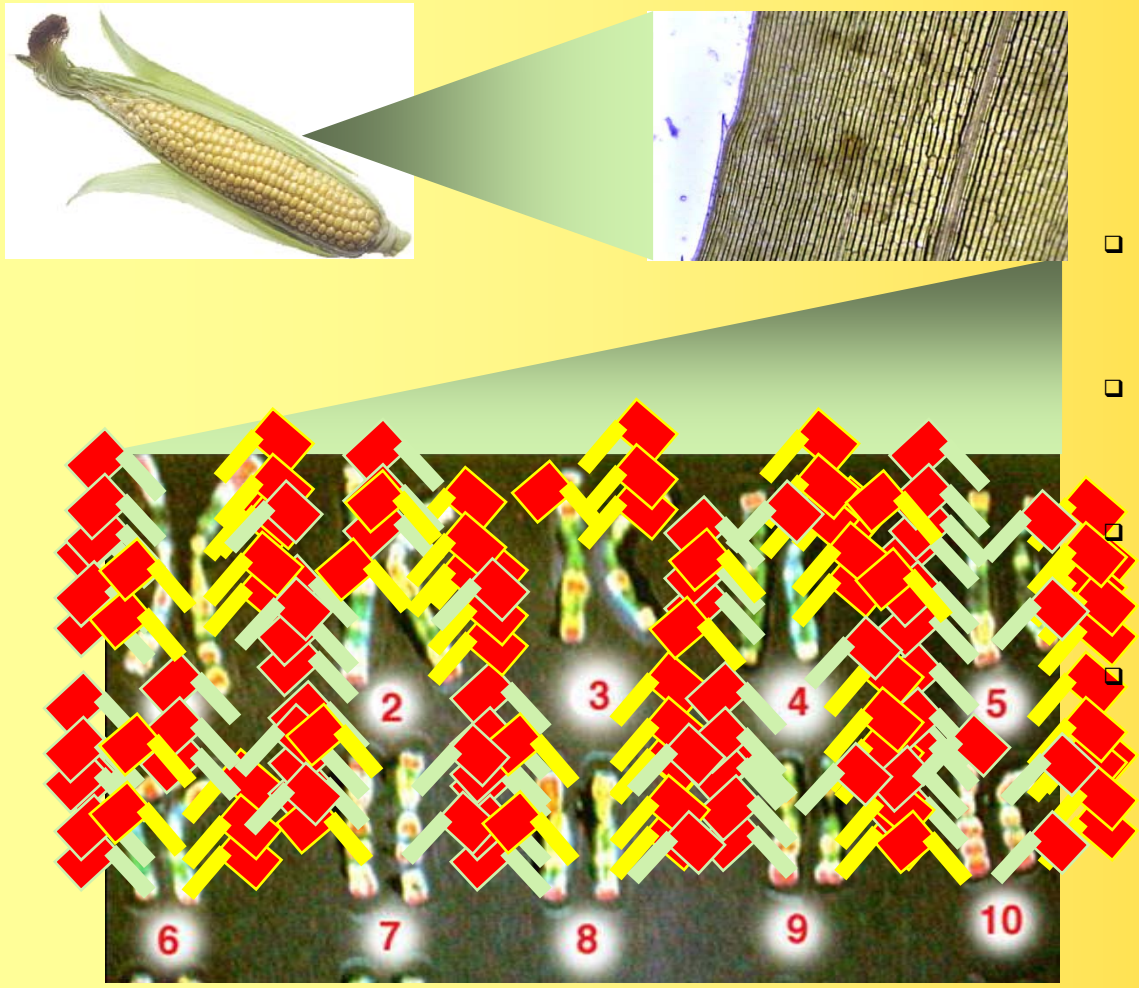
How Genetic Markers Track Genotype



- DNA markers can occur anywhere across the genome
- The more markers you have, the more useful they become
- The ultimate goal is a “saturated” genetic map
- This allows you to find markers closely linked to any gene of interest

Chromosome picture

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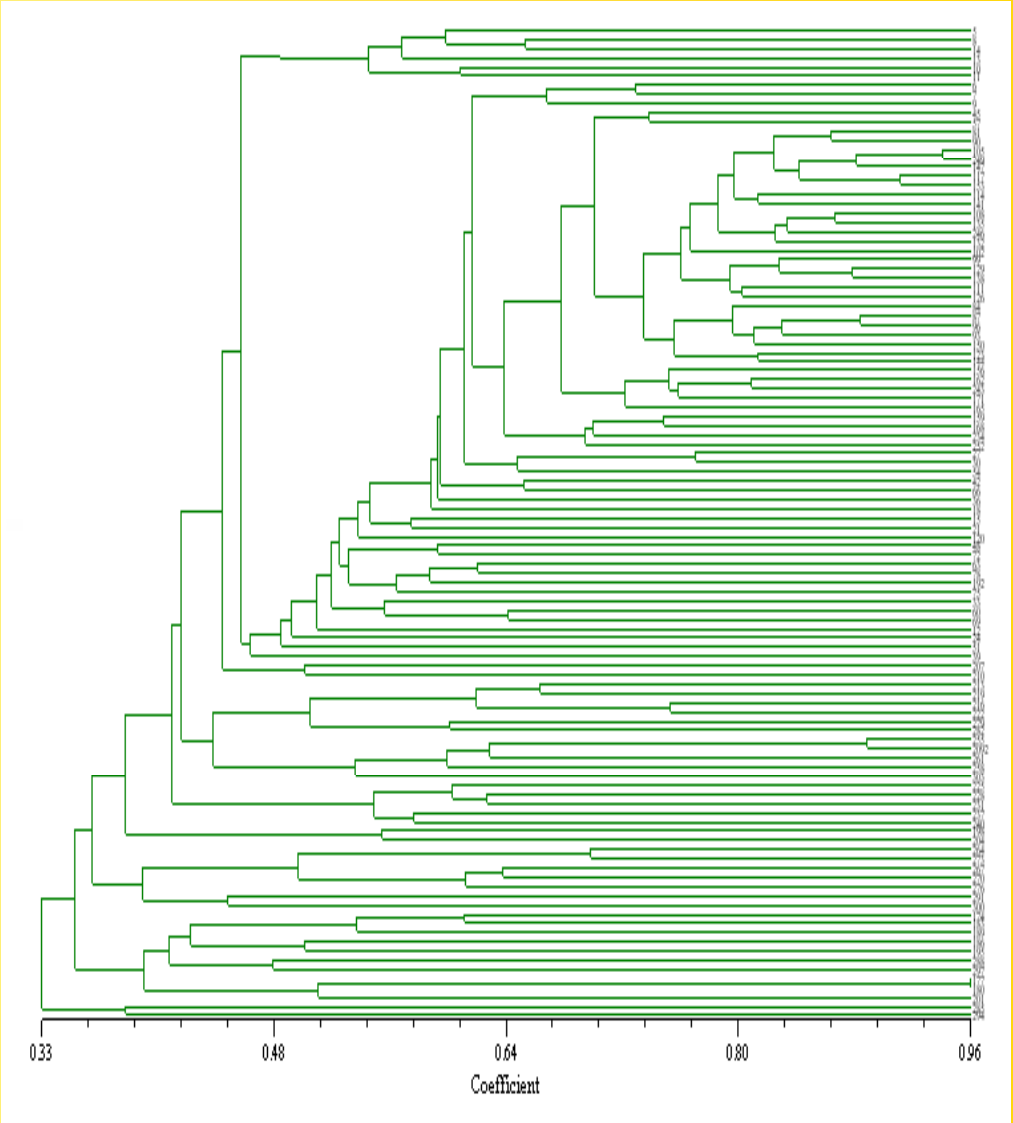
Applying Genetic markers

DNA Fingerprinting

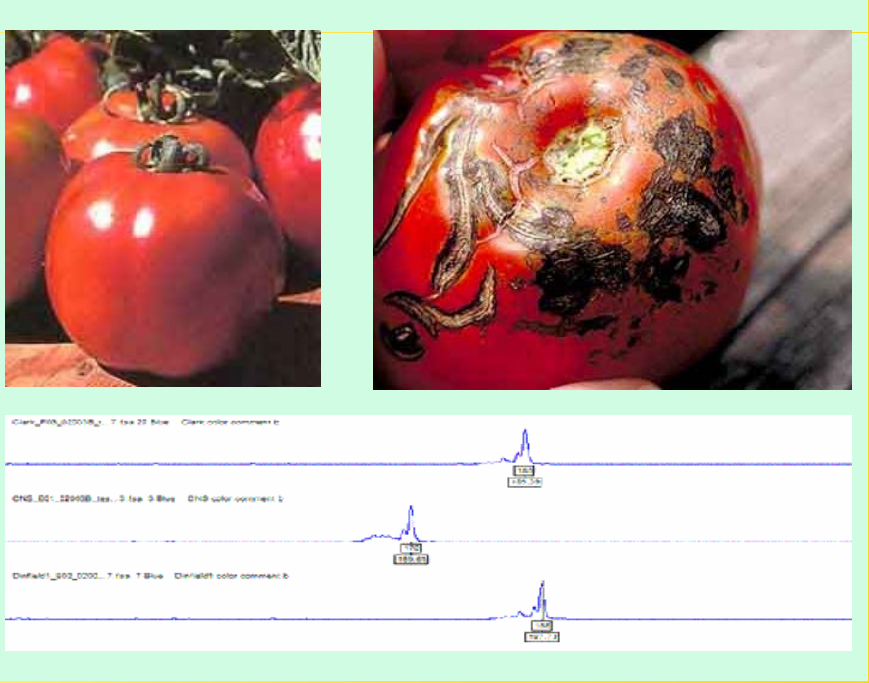
- Use a standard set of genetic markers evenly distributed across the genome
- Fingerprint each line with the same standard set of markers
- Creates a genetic “scorecard” that can be used to plan crosses
- Also widely used for quality control and protection against variety infringement



Applying Genetic markers

Marker-assisted selection

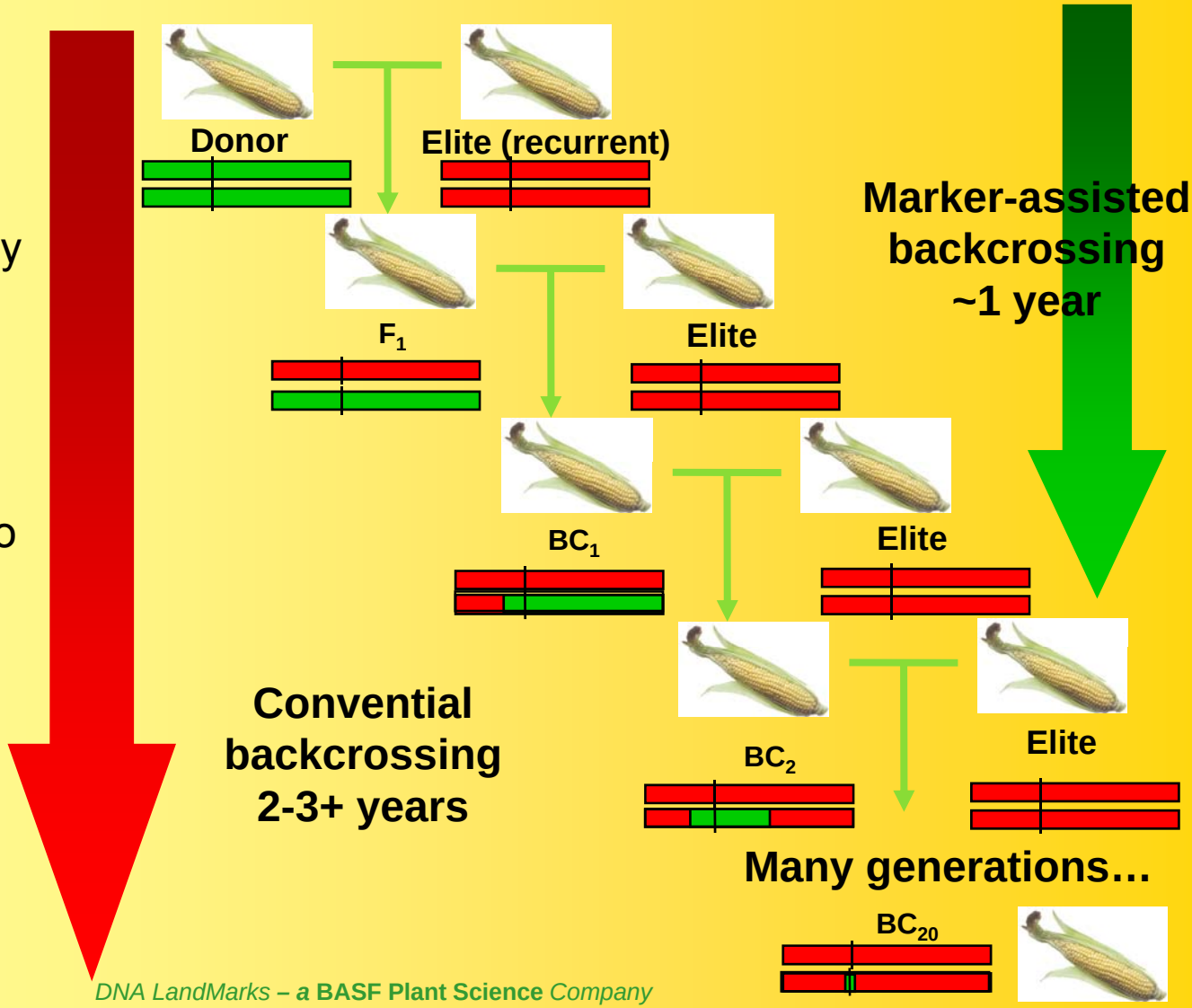
- Track traits of interest over generations using markers that are tightly linked to the trait's gene
- Most widely used application of genetic markers in plant breeding
- Possible to screen for single traits, multigenic traits (QTL) and to pyramid multiple desirable traits into a single variety
- Eliminates environmental effects
- Accelerates selection process
- Allows selection of traits that are difficult to evaluate phenotypically



Applying Genetic markers

Marker-Assisted Backcrossing

- Uses markers to compare BC progeny to the recurrent parent (RC)
- Analysis identifies rare progeny with very high similarity to RC
- Possible to find BC_2 progeny with ~95% similarity to the RC



Conclusion

Markers have become an essential and affordable tool for a competitive breeding program:

- Examine your germplasm resources at the genomic level
- Determine the components of multigenic traits through QTL mapping
- Manage complex agronomic traits
- Pyramid multiple traits into elite germplasm through selection and accelerated backcrossing
- Ensure quality control at the genetic level
- Protect your genetic investment once it is in the marketplace

Get the best varieties to market faster!