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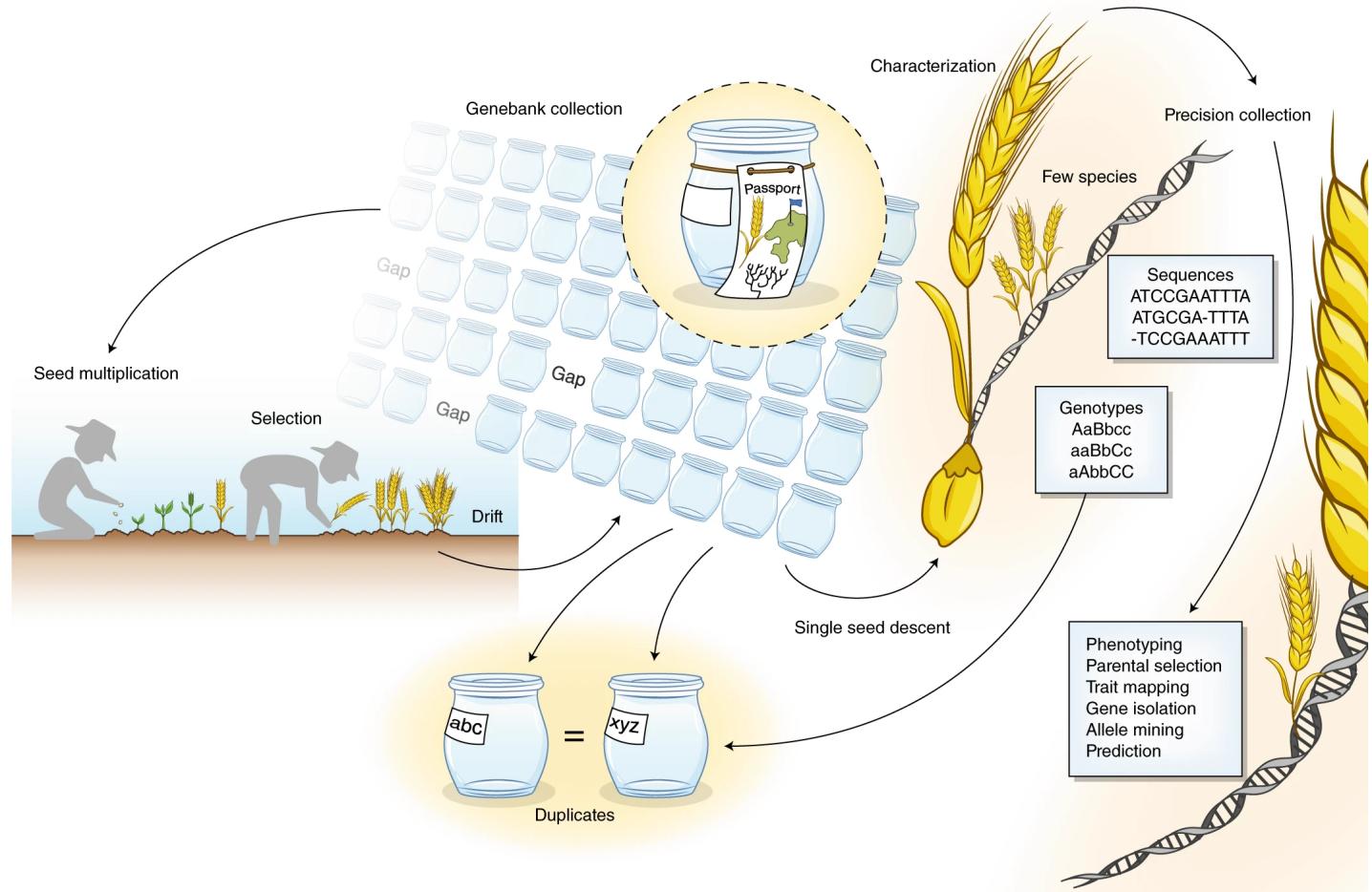
- The first thing is to go over the program or “syllabus” that I am going to post on the workshop website, where I will have all the workshop details.
- In that program I am going to write the objectives and topics that we are going to address in the workshop (WS).
- I am going to create a slack channel as well to have contact with all of them and to encourage them to create or consolidate an African group to share papers, knowledge, and issues about GS.
- In the website I am going to publish links about R, because would be good if they are more familiar with R before the hands-on part.

Genomic Selection Workshop

Day 1

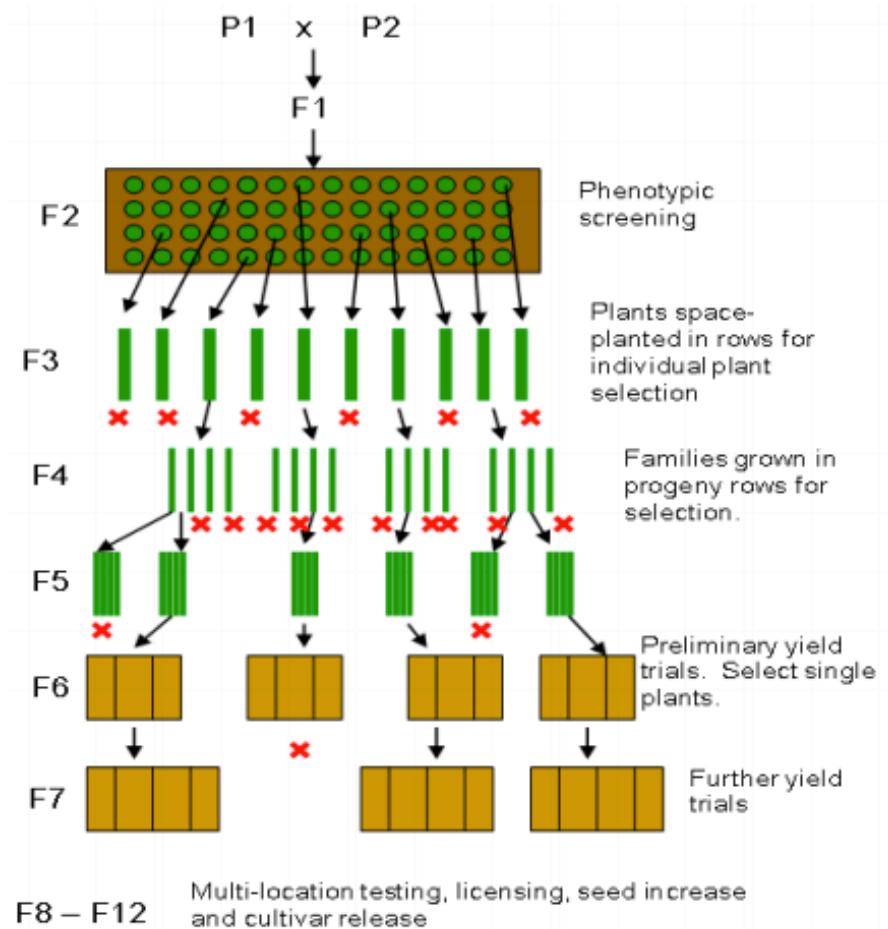
Where are we and where are we want to go?

- Conventional breeding
- Marker Assisted Selection
- Genomic Selection

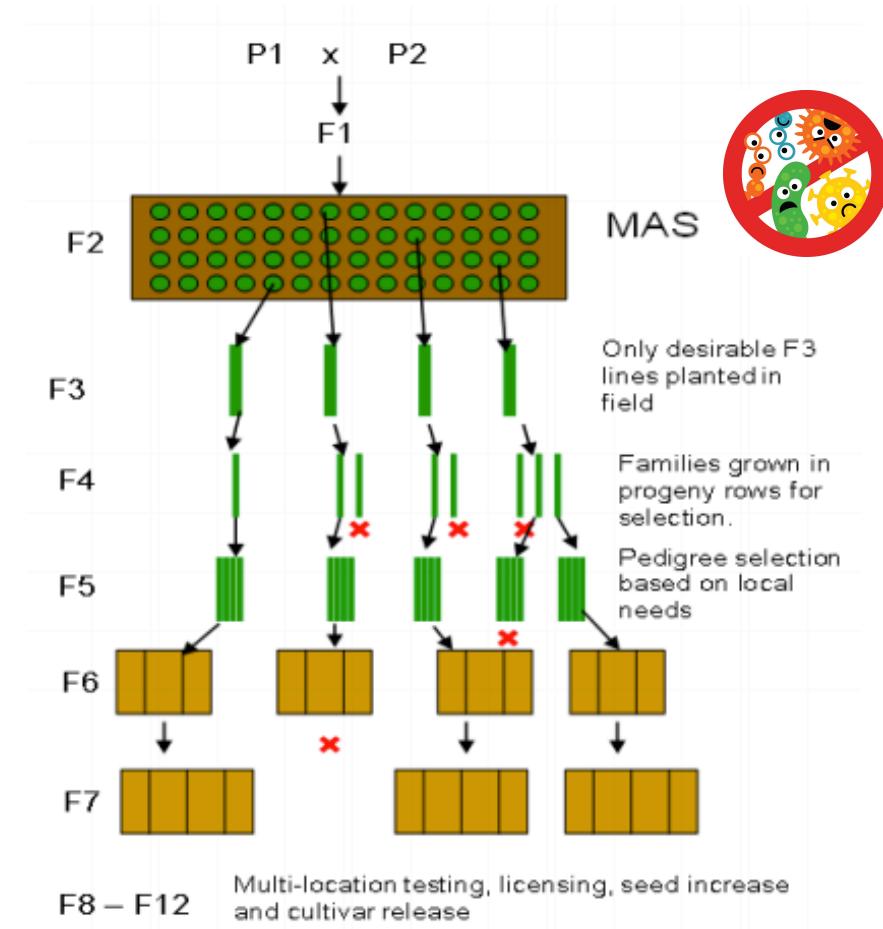


Mascher et al 2019

Conventional Plant Breeding

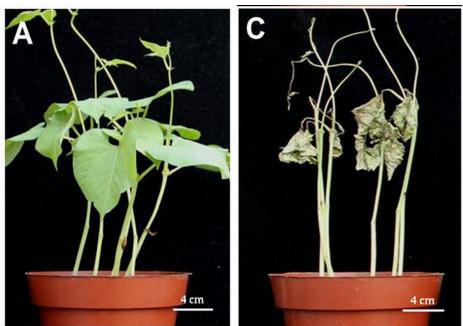
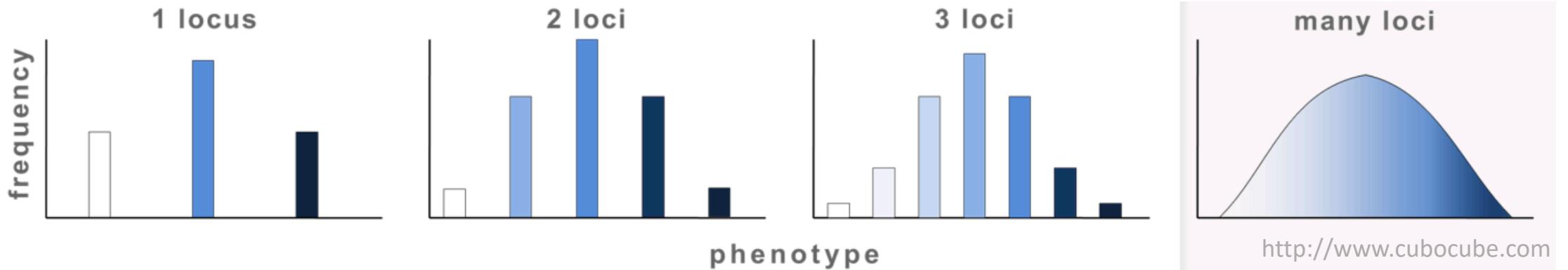


Marker Assisted Selection

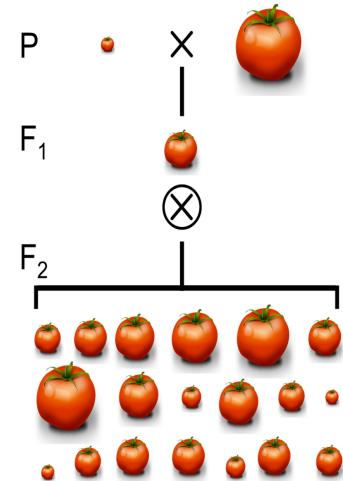


Lema 2018

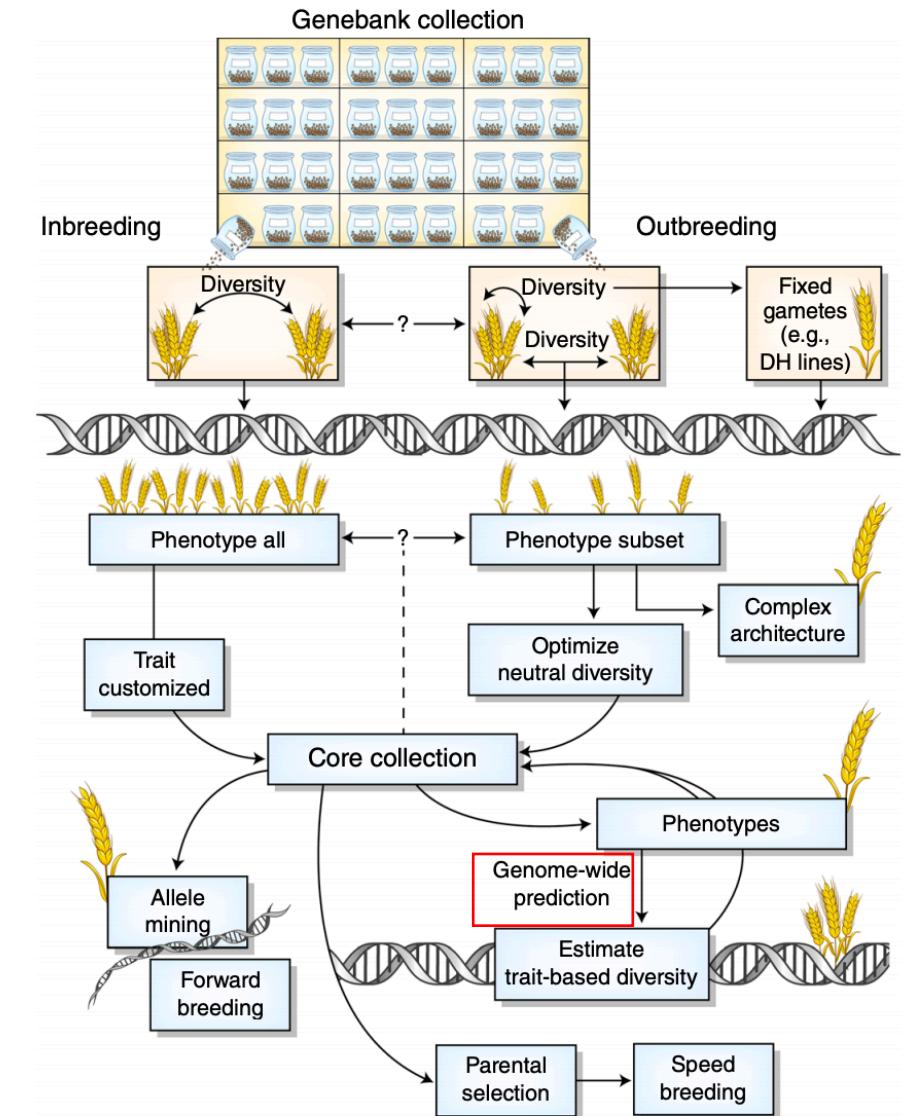
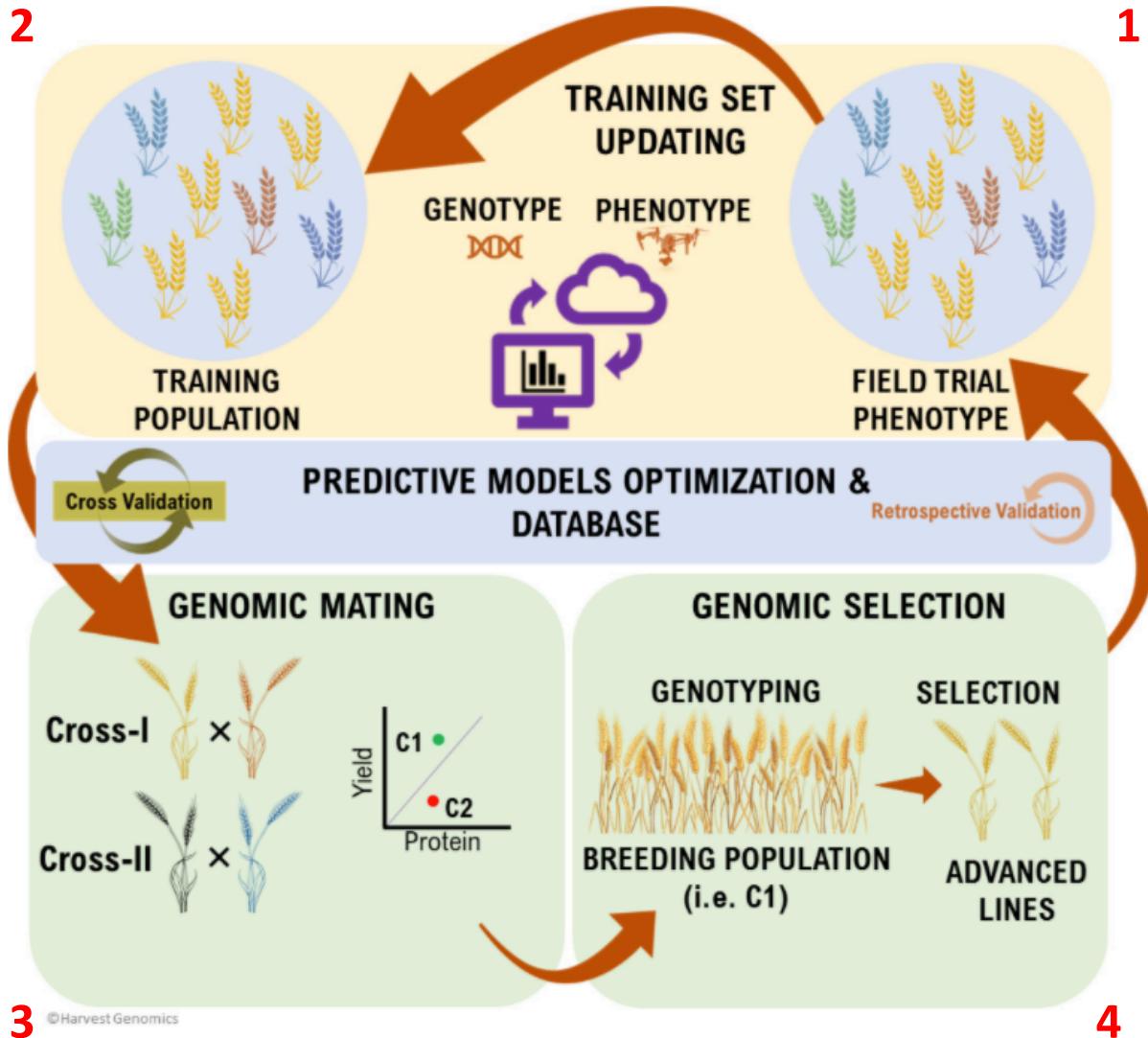
What happens in quantitative traits?



Chen et al 2017



Genomic Selection Workshop



Genomic Selection Workshop

The molecular basis of genetics

The molecular basis of genetics:

- Genome
- Chromosomes
- Genes (alternative splicing)
- Mitosis and meiosis
- Crossing over
- DNA sequencing
- Genotyping by sequencing (GBS)



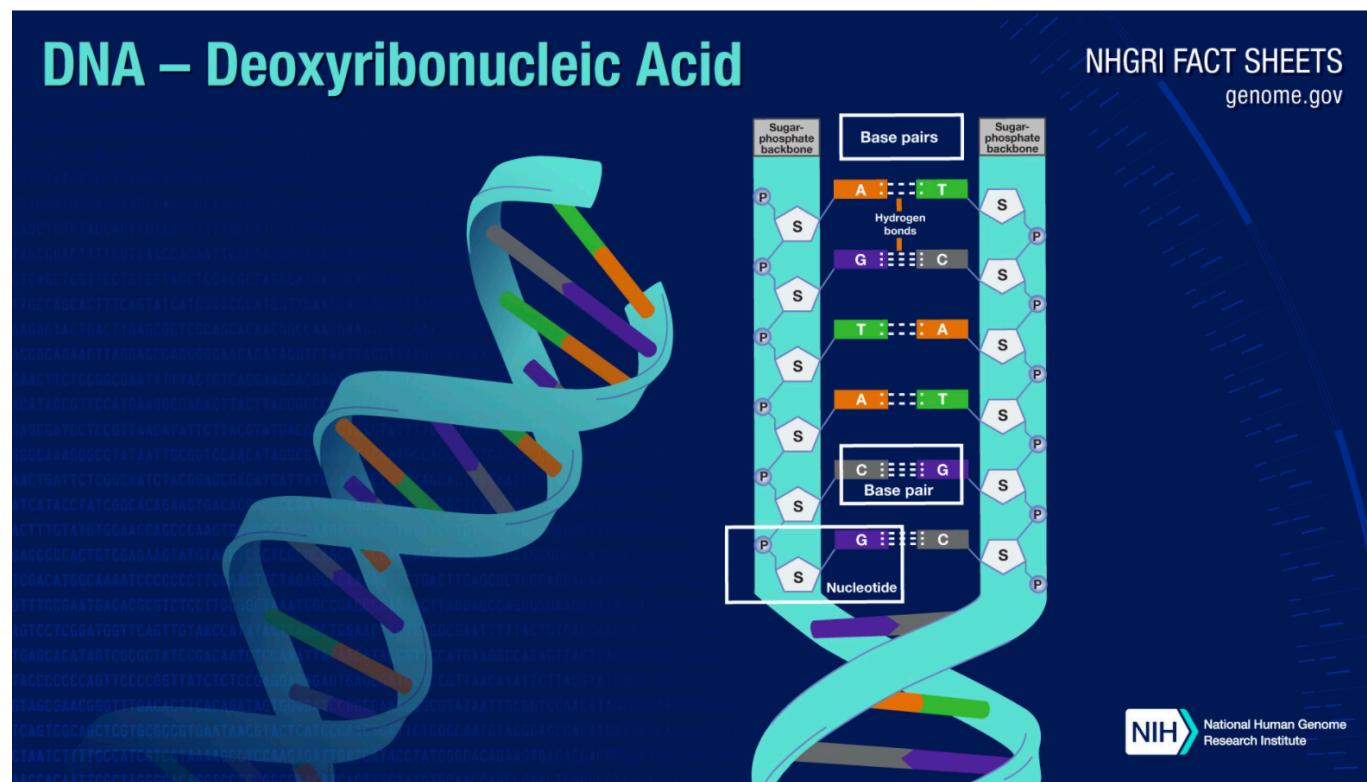
greenhousegrower.com

Genome

Deoxyribonucleic acid (DNA) is a molecule that contains the genetic instructions for the development, functioning, growth and reproduction of nearly all living organisms.

DNA is made of four chemical units, called nucleotide bases (adenine (A), thymine (T), guanine (G), and cytosine (C)).

A - T
C - G



Genome



Phaseolus vulgaris genome

~540 Millions bases!



Image Credit: fotohunter / Shutterstock

Genome



Phaseolus vulgaris genome

~540 Millions bases!

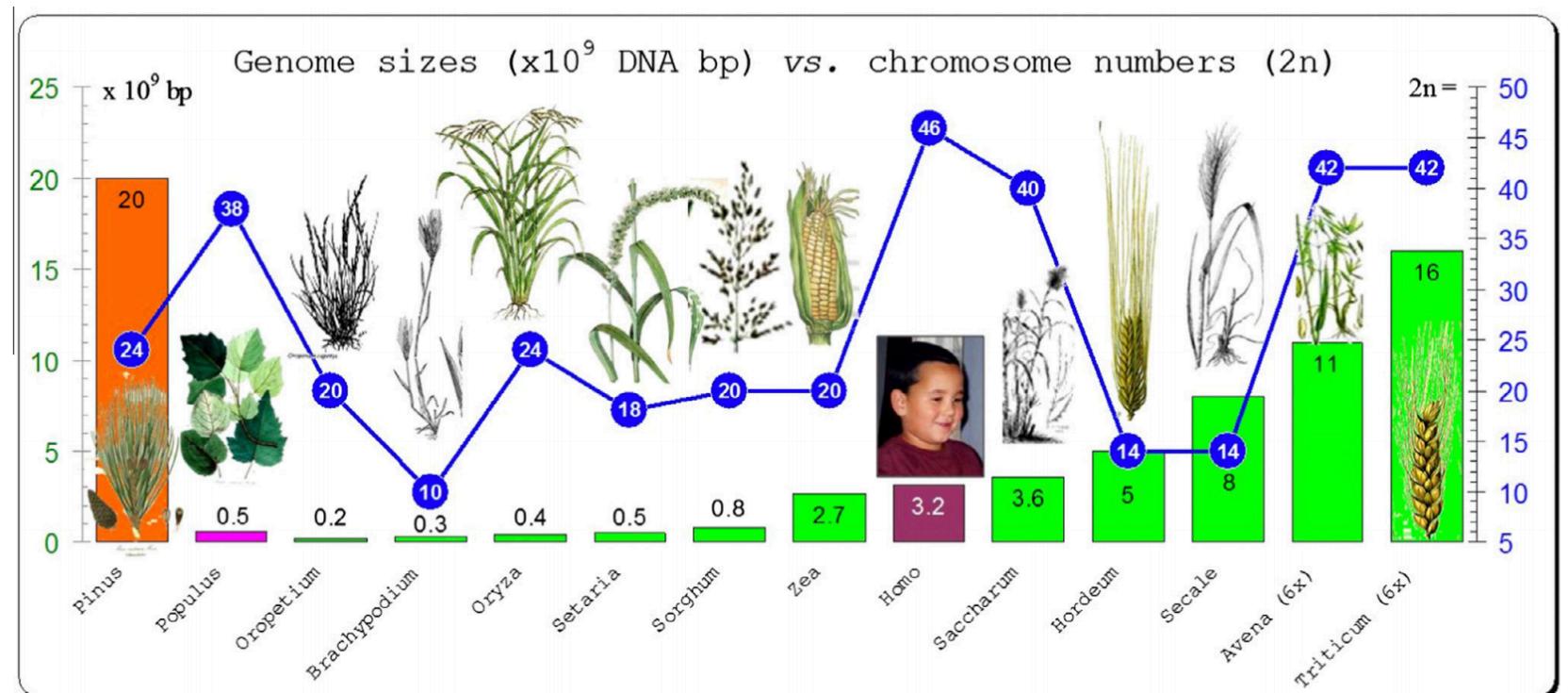
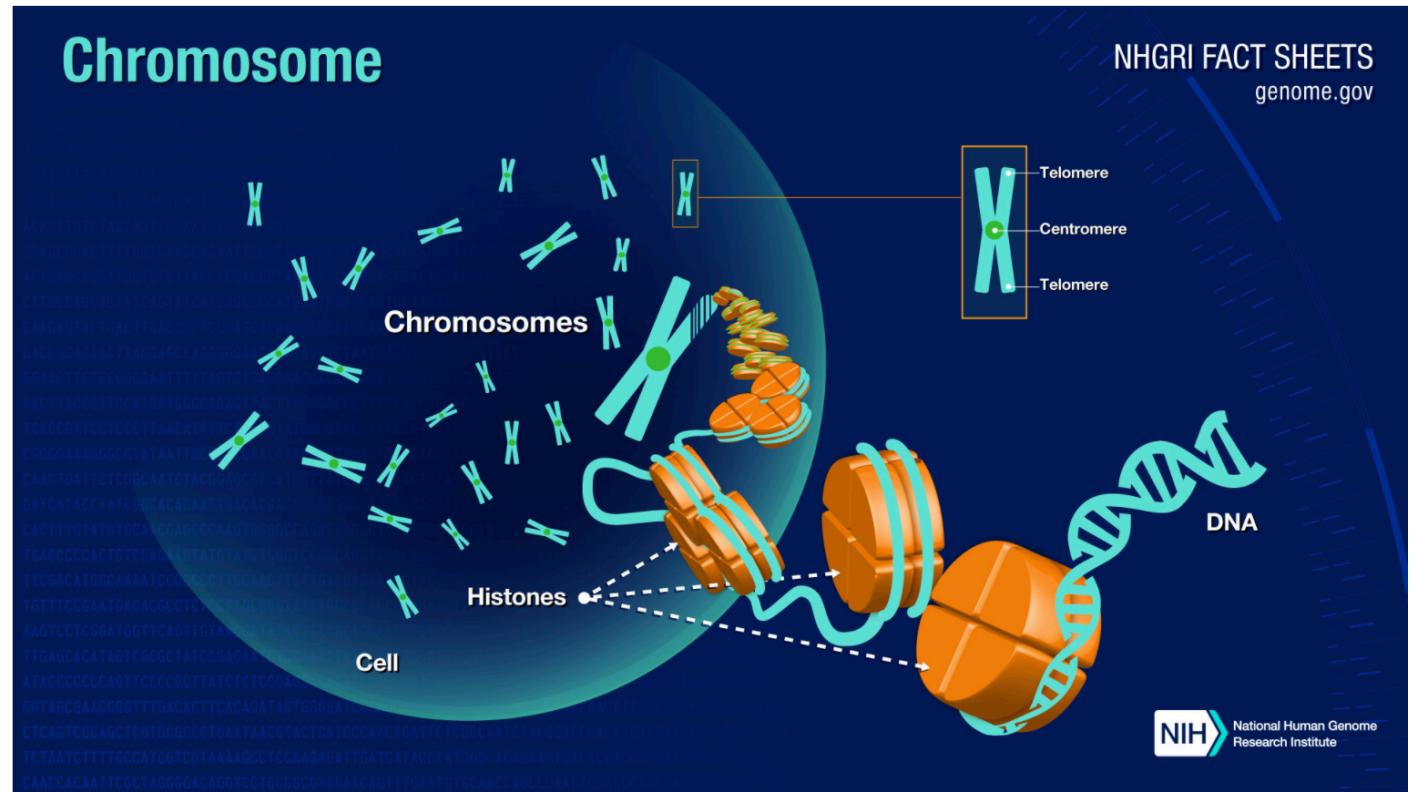


Figure 1 Sizes of plant genomes. Sizes (bp) vs. chromosome numbers ($2n$) of plant genomes from different taxa and compared to human genome size (3.2×10^9 bp).

Chromosomes

Chromosomes contained part of the genetic material (DNA).

Chromosomes keeps DNA wrapped around proteins called **histones** which bind to and condense the DNA molecule to maintain its integrity.

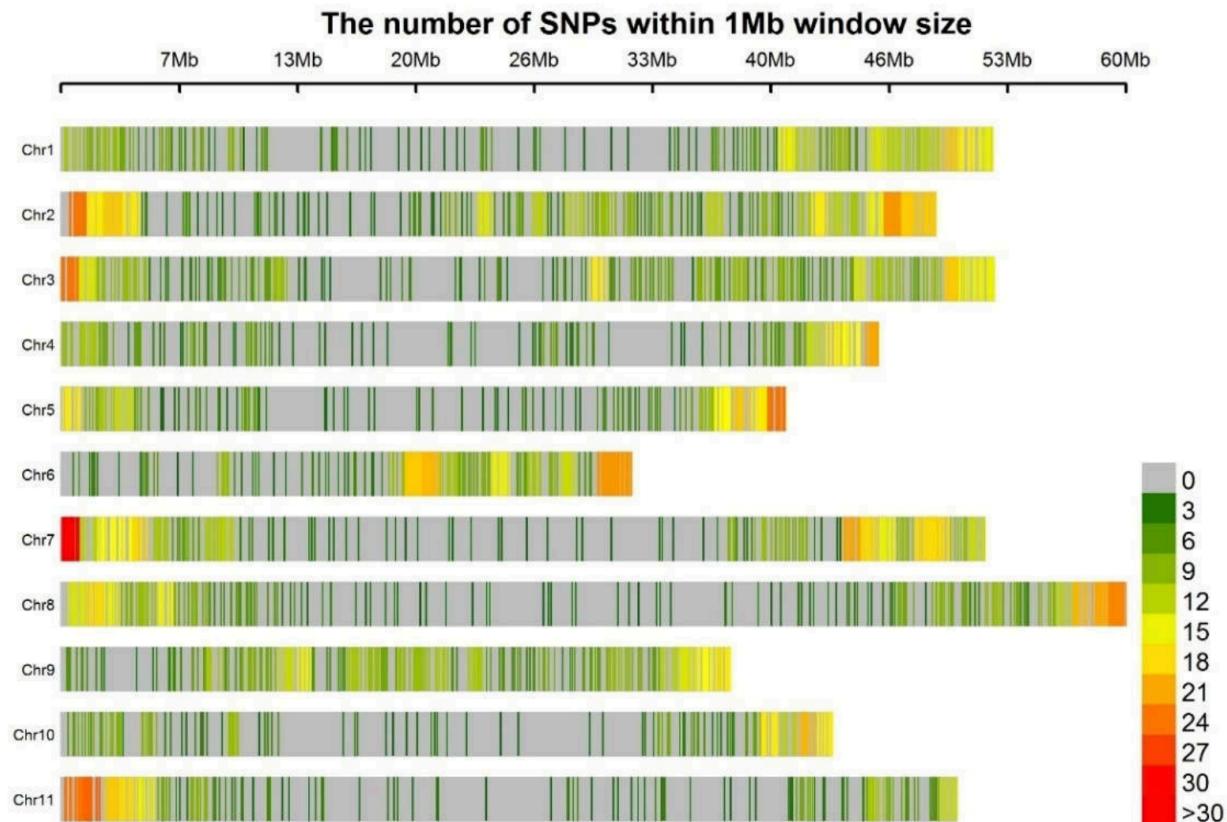


Chromosomes



Phaseolus vulgaris genome

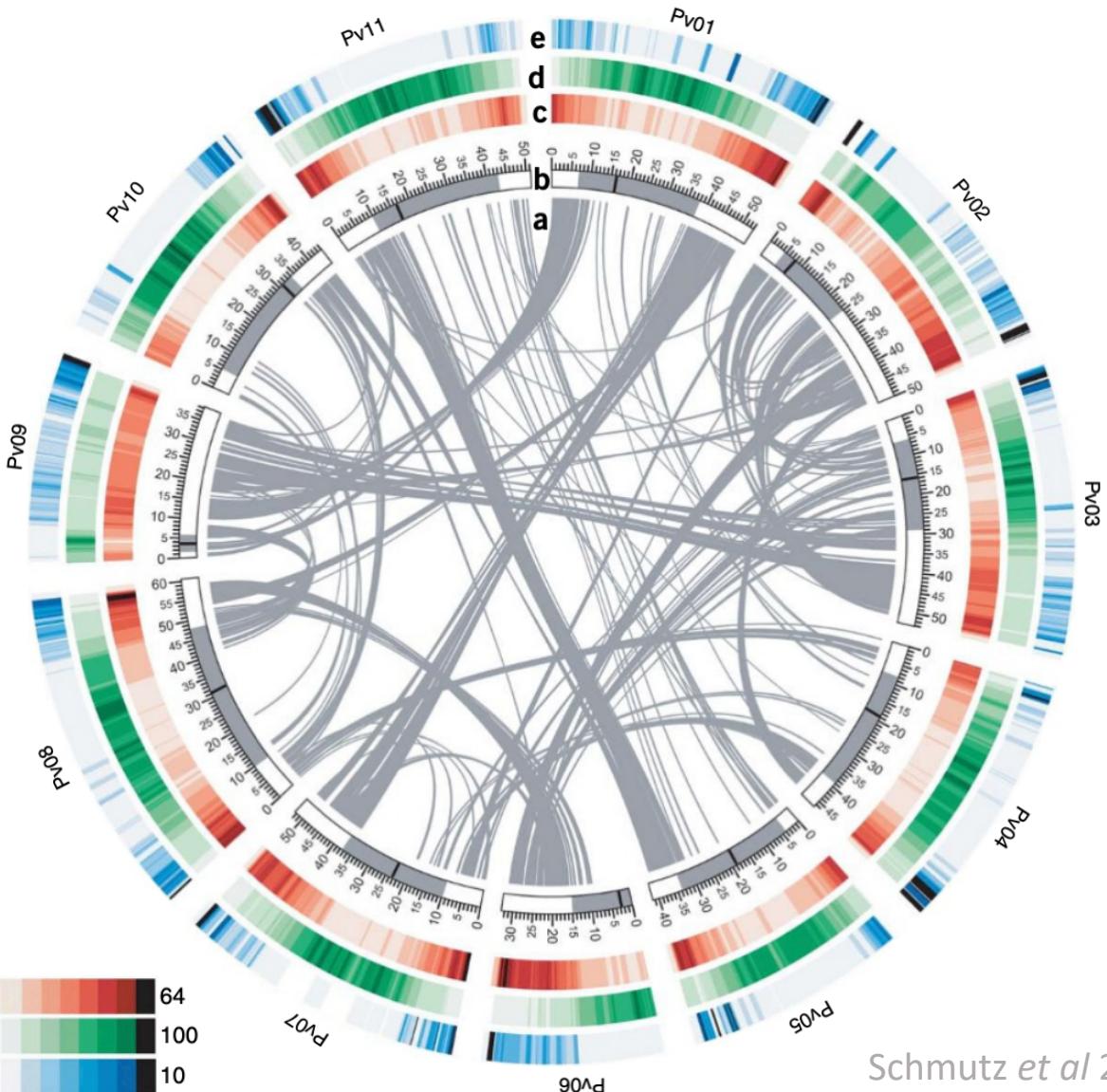
11 chromosomes



Chromosomes



Gene density (genes/Mb)
Repeat density (%)
Recombination rate (cM/Mb)

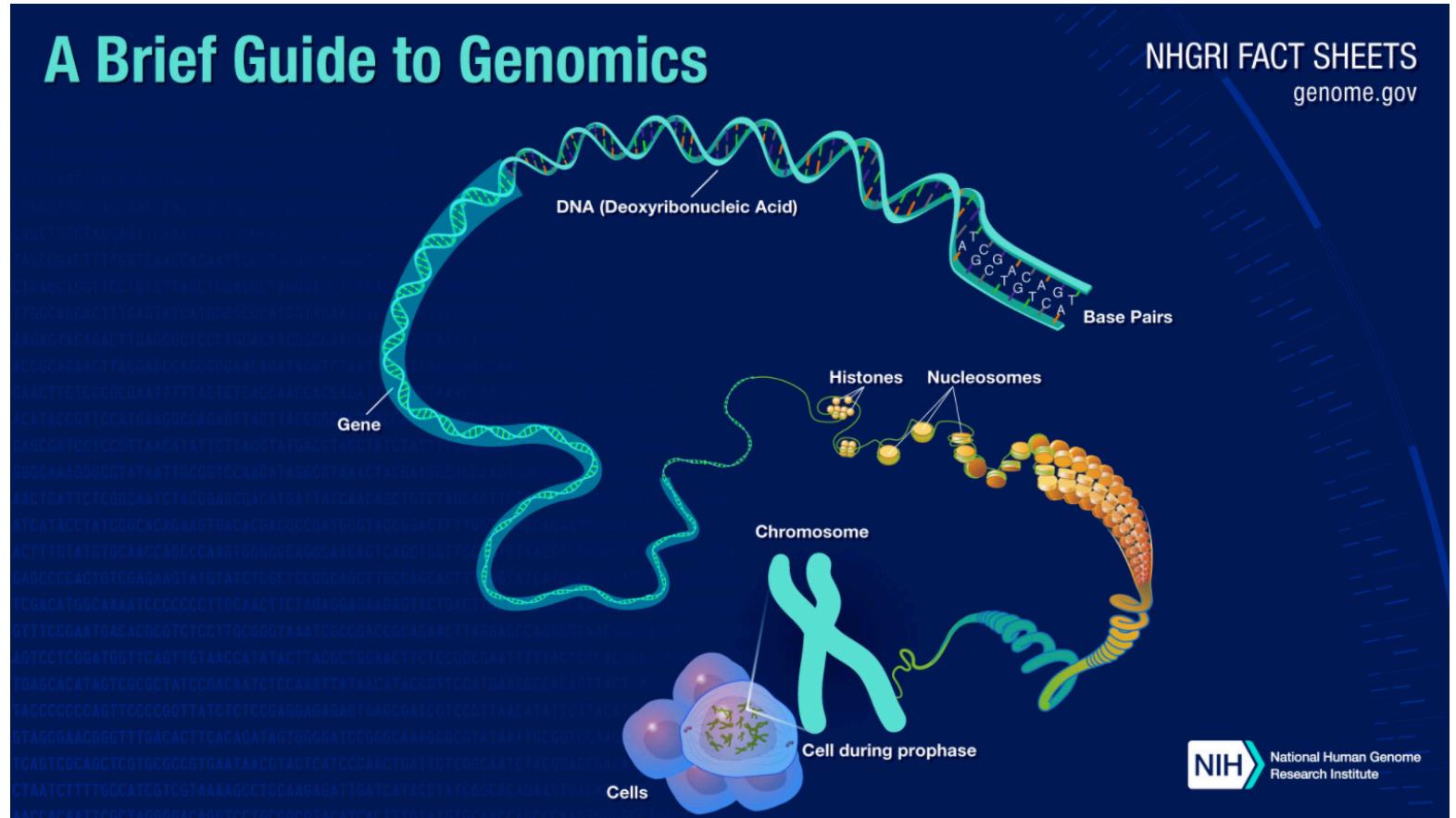


Schmutz et al 2014

- (a) Gray lines connect duplicated genes.
- (b) Centromeric and pericentromeric regions in black and gray.
- (c) Gene density in sliding windows of 1 Mb.
- (d) Repeat density in sliding windows of 1 Mb
- (e) Recombination rate

Genes

The gene is the basic physical unit of inheritance and contain the information needed to specify traits.

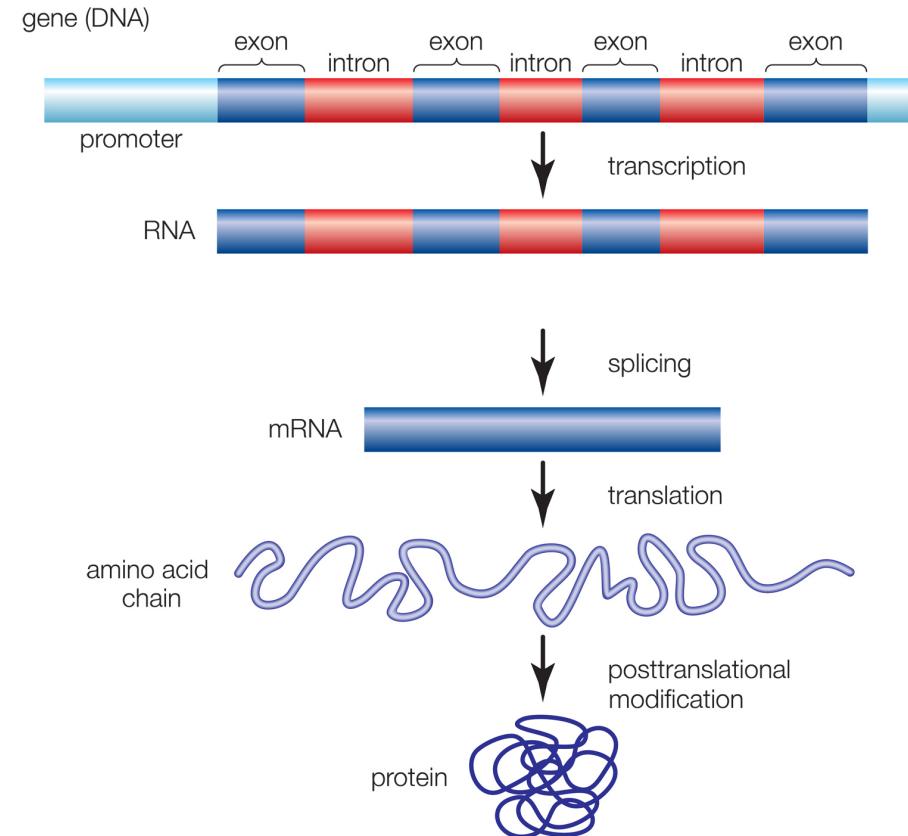


Genes

Promoter: sequence of DNA needed to turn a gene on or off.

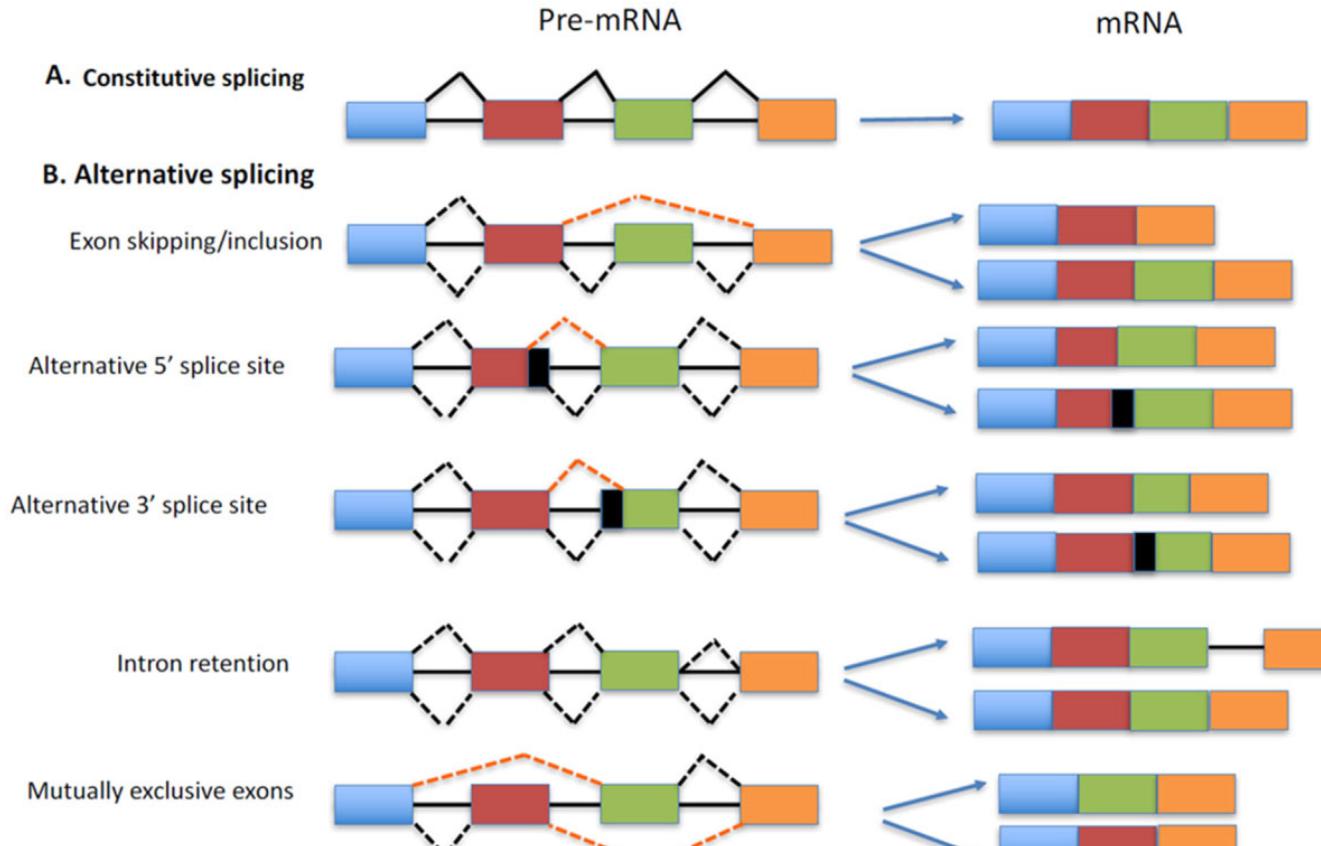
Exons: parts of the gene sequence that are expressed in the protein.

Introns: parts of the gene sequence that are not expressed in the protein.



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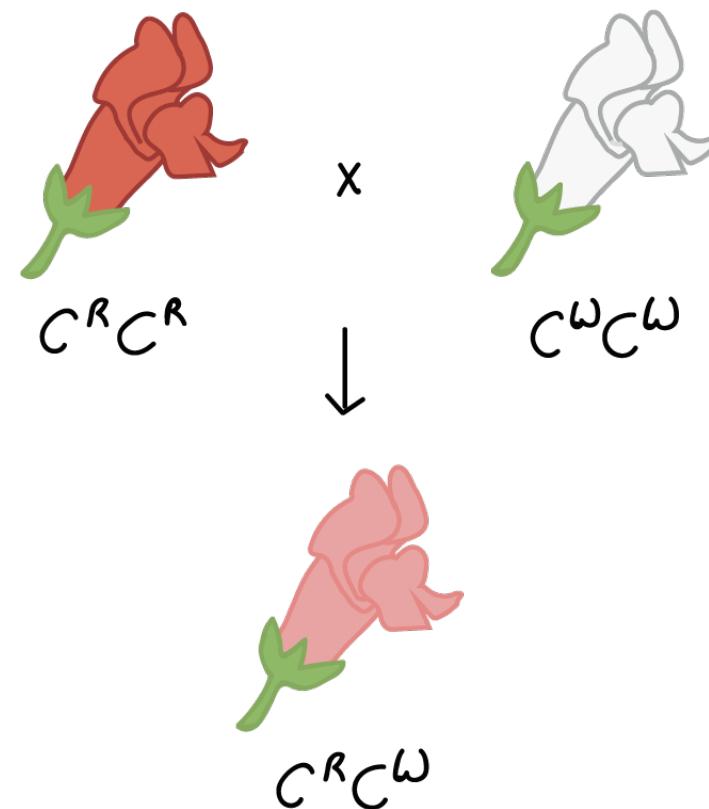
Genes



Sen 2018

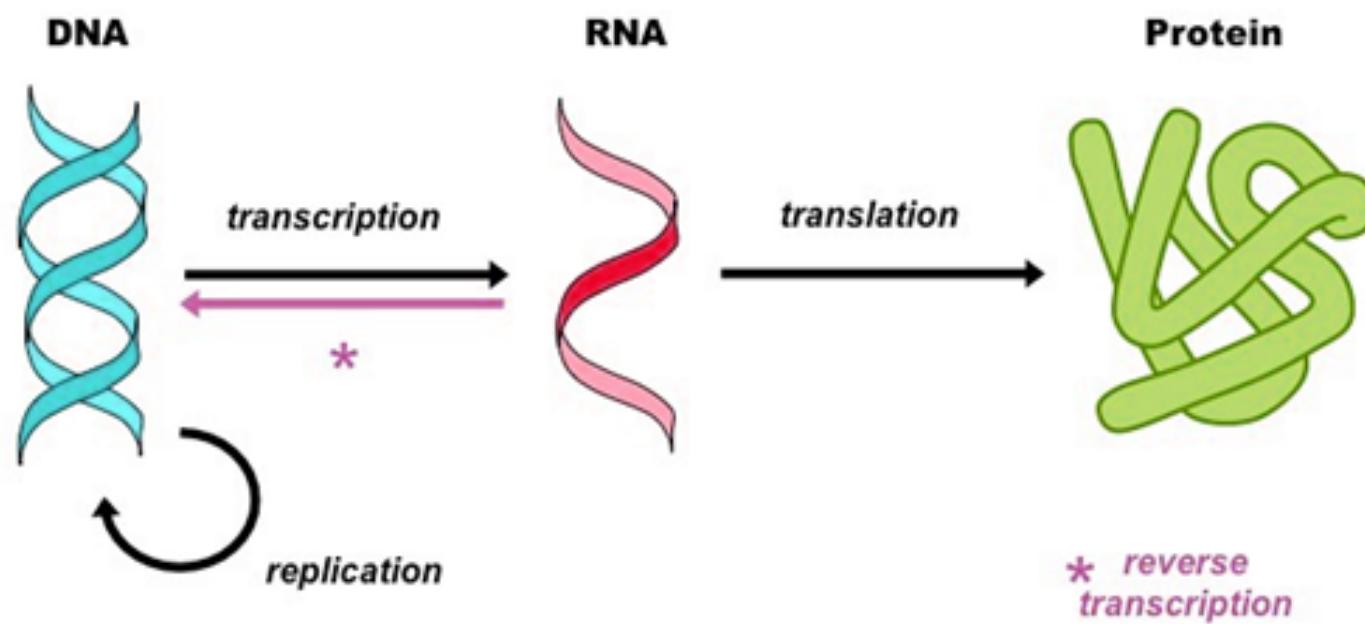
Alleles

- An allele is one of **two or more versions** of a gene.
- If the two alleles are the same, the individual is homozygous for that gene.
- If the alleles are different, the individual is heterozygous.
- The use of the allele also refers to variation among non-coding DNA sequences.



Central dogma

CENTRAL DOGMA



Genes



Phaseolus vulgaris

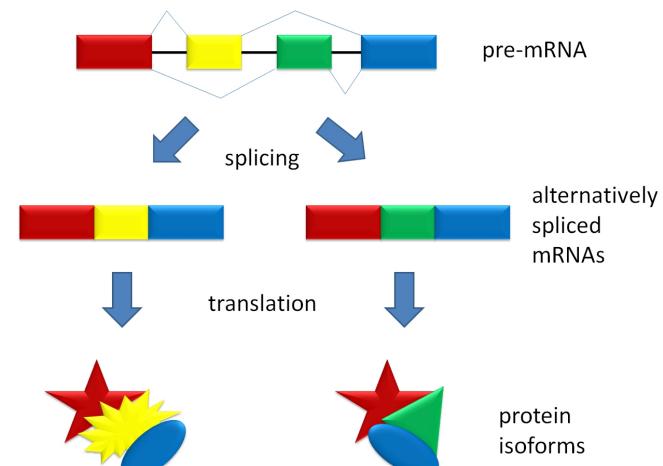
Loci

27,433 total loci containing 36,995 protein-coding transcripts

Alternative Transcripts

$36,995 - 27,433 = 9,562$ total alternatively spliced transcripts

Schmutz *et al* 2014



Mitosis

The mitosis occurs in the somatic cells, and it is meant for the multiplication of cells.

- Development and growth
- Cell replacement
- Regeneration
- Asexual reproduction

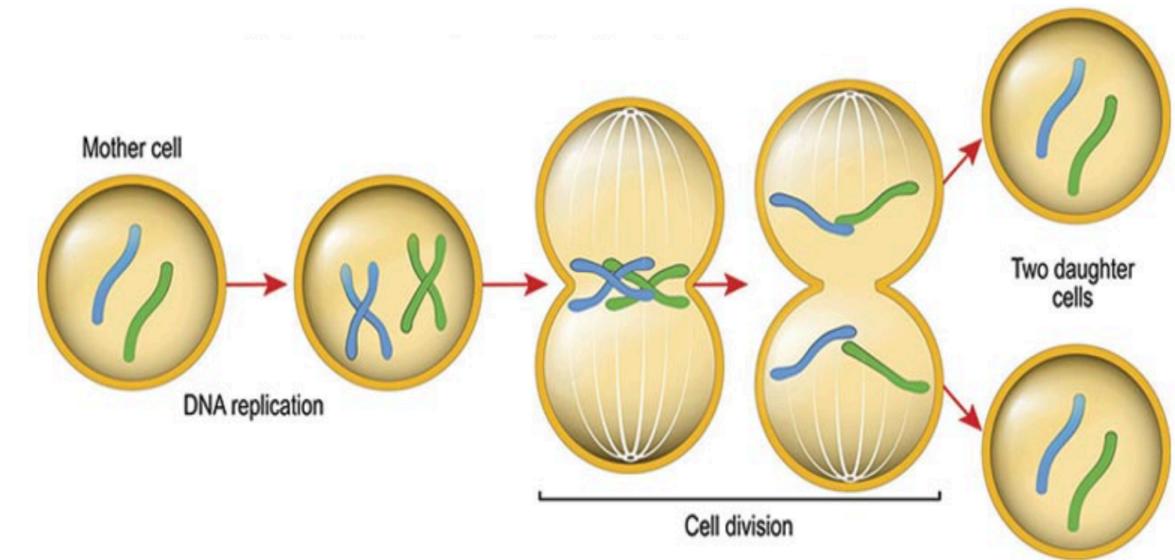


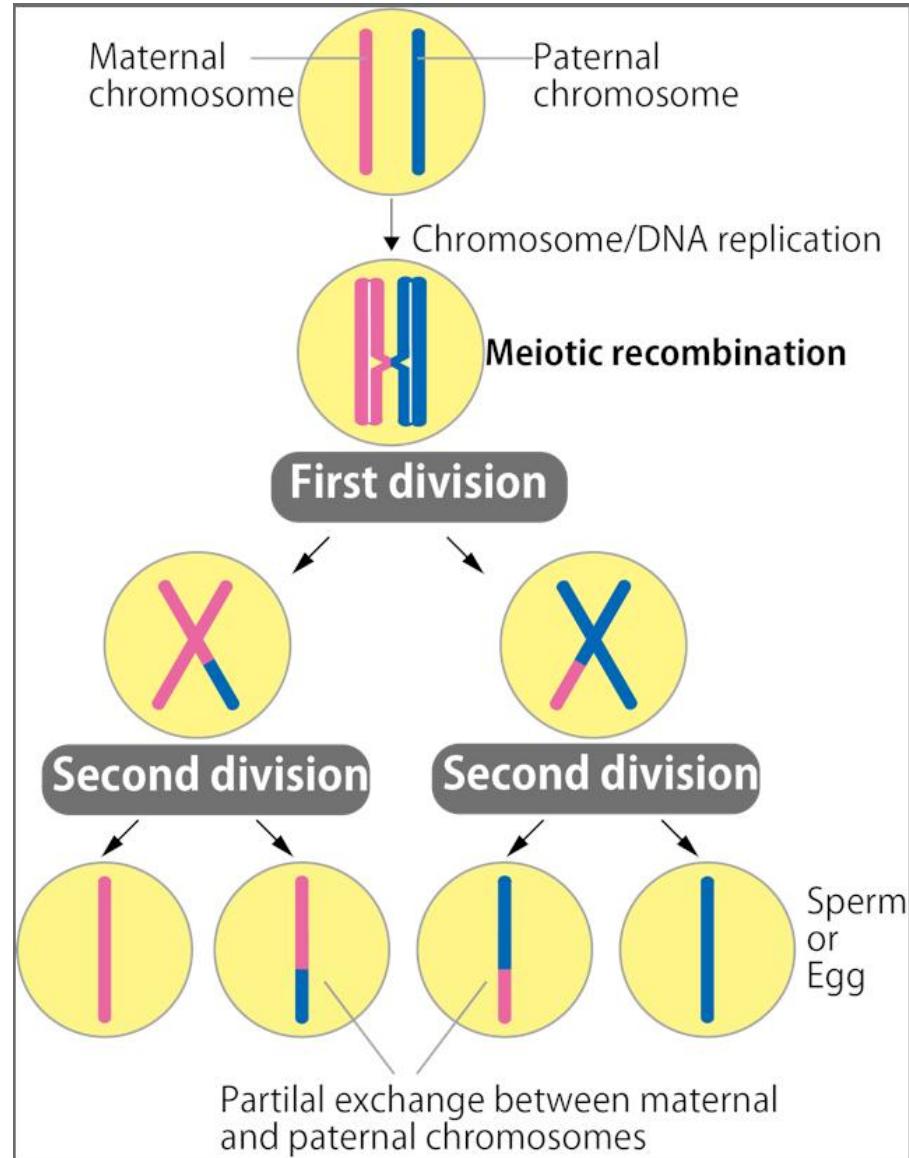
Image Source: [Biology Wise](#).

Meiosis

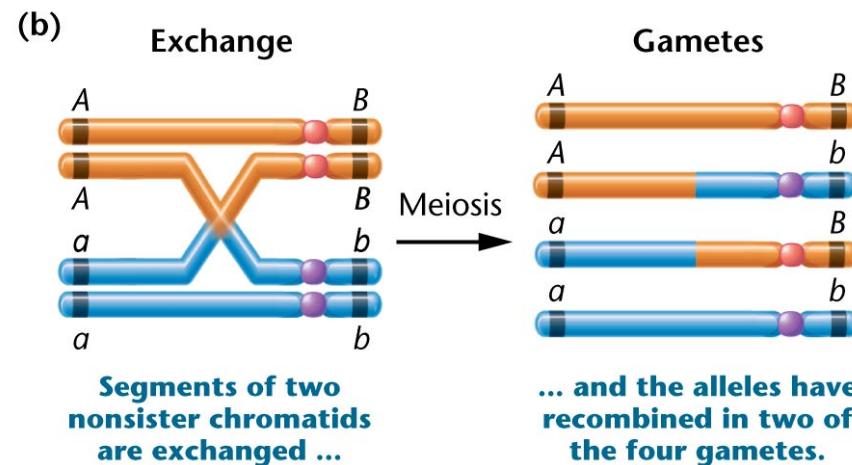
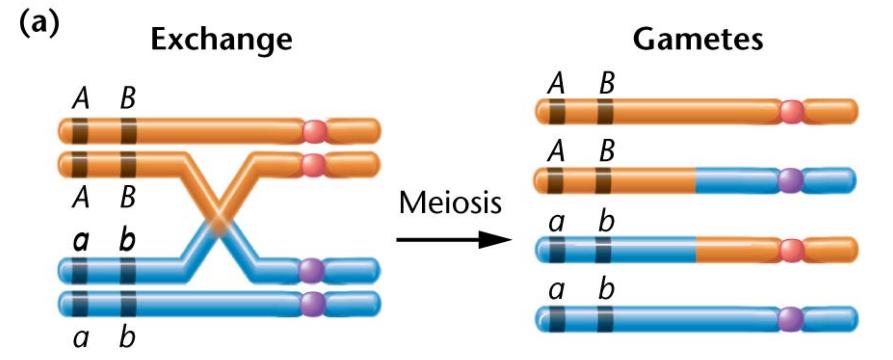
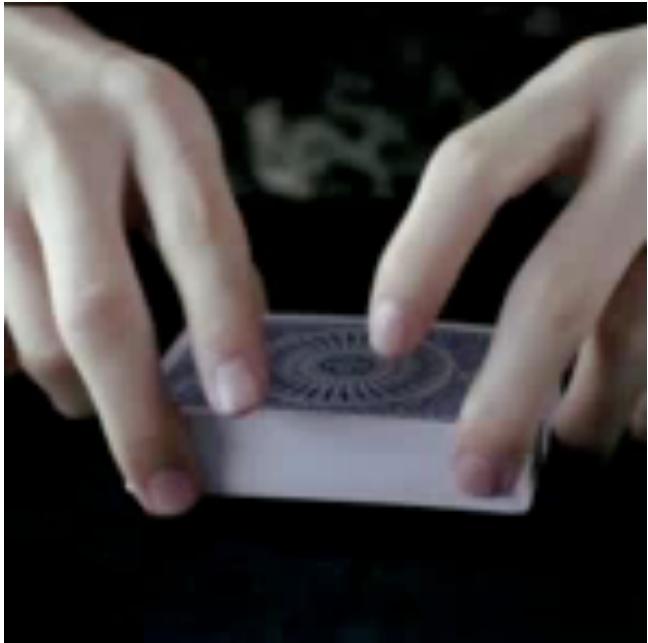
During meiosis, diploid cells undergo DNA replication, followed by two rounds of cell division in germ cells, producing four haploid sex cells.

Meiosis maintains genetic continuity from generation to generation and gives rise to genetic variation in gametes through:

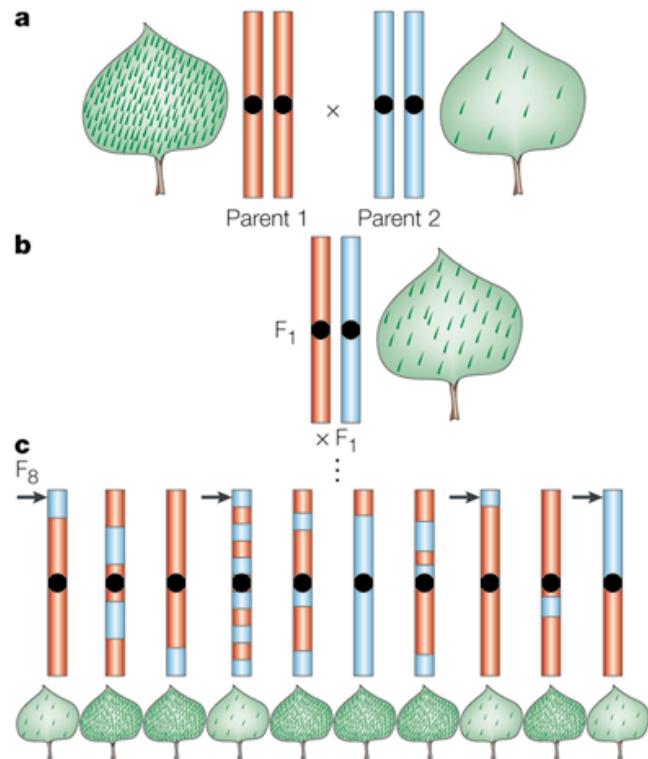
- Crossing over of homologous chromosomes.
- Unique combinations of maternal/paternal chromosomes.



Crossing Over

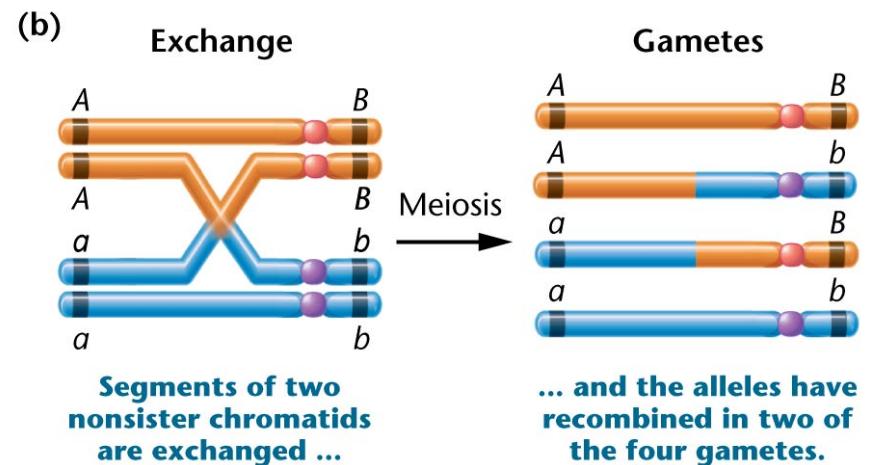
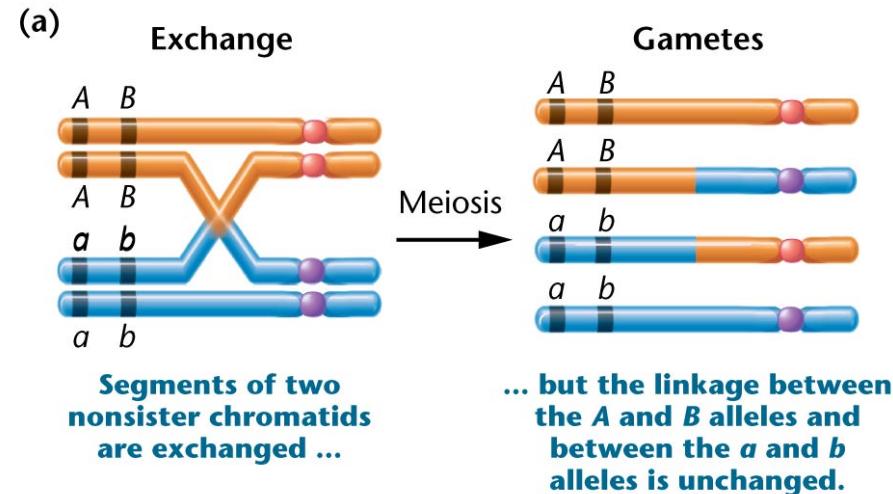


Crossing Over



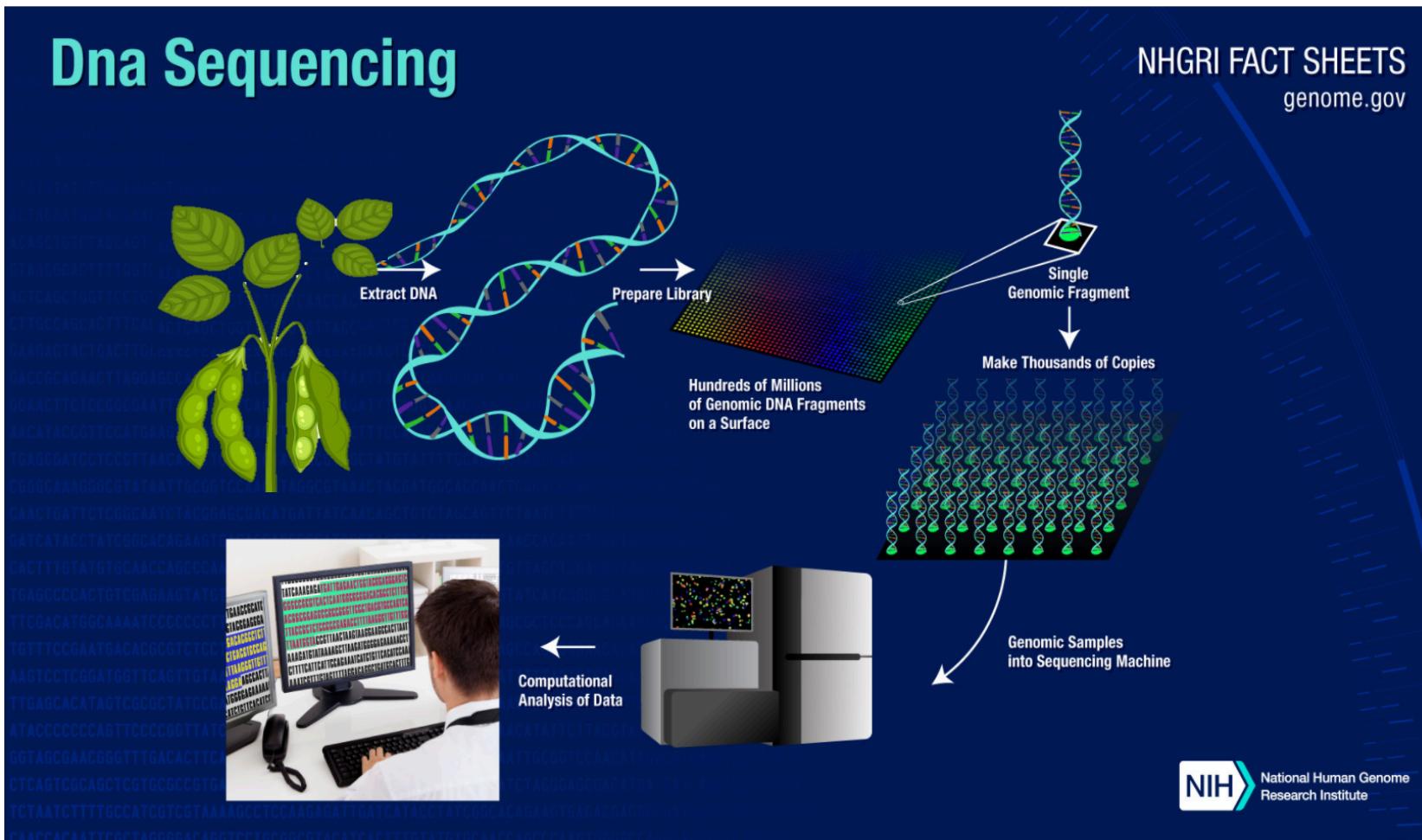
Nature Reviews | Genetics

Mauricio 2001

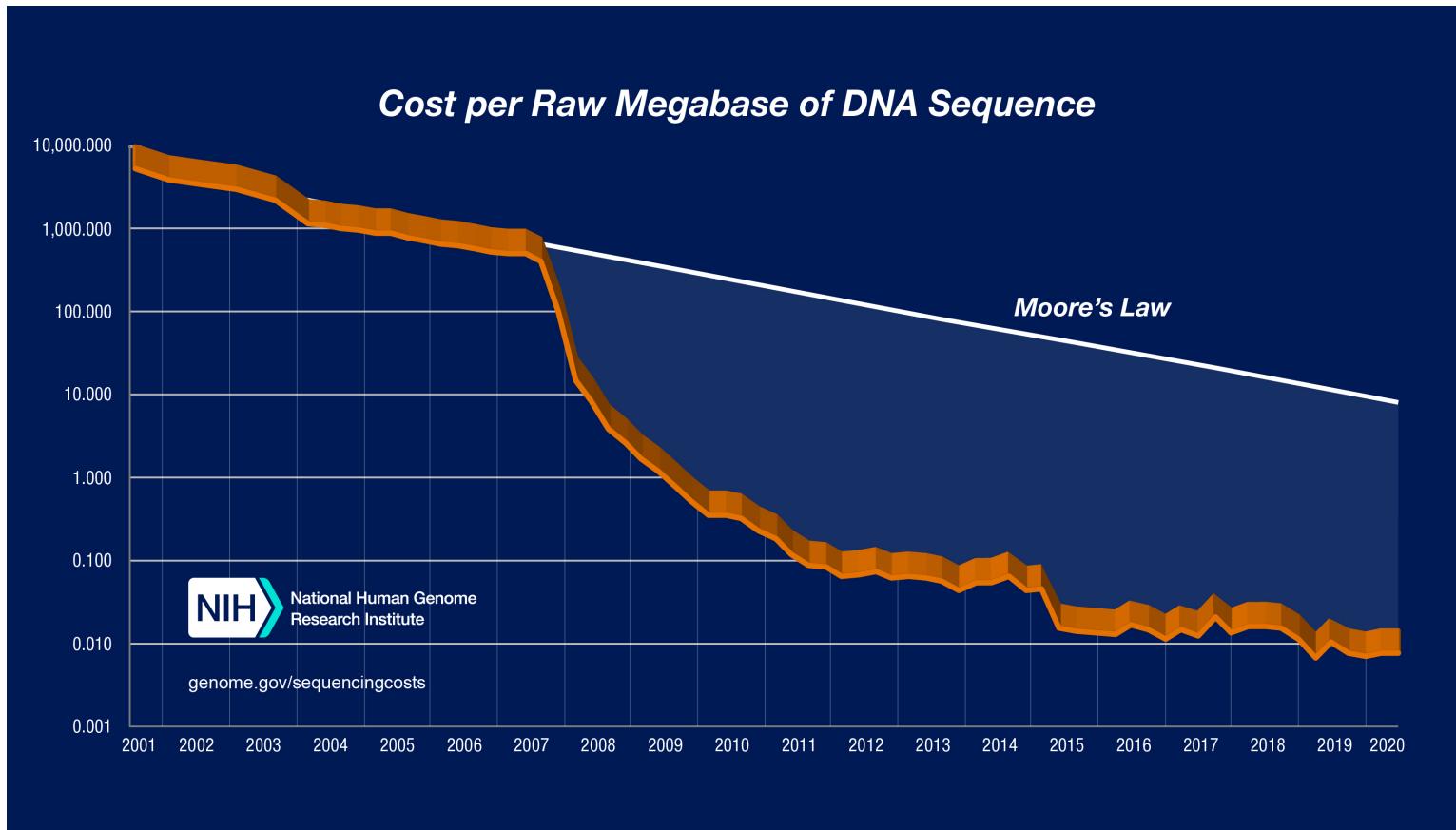


<https://quizlet.com/>

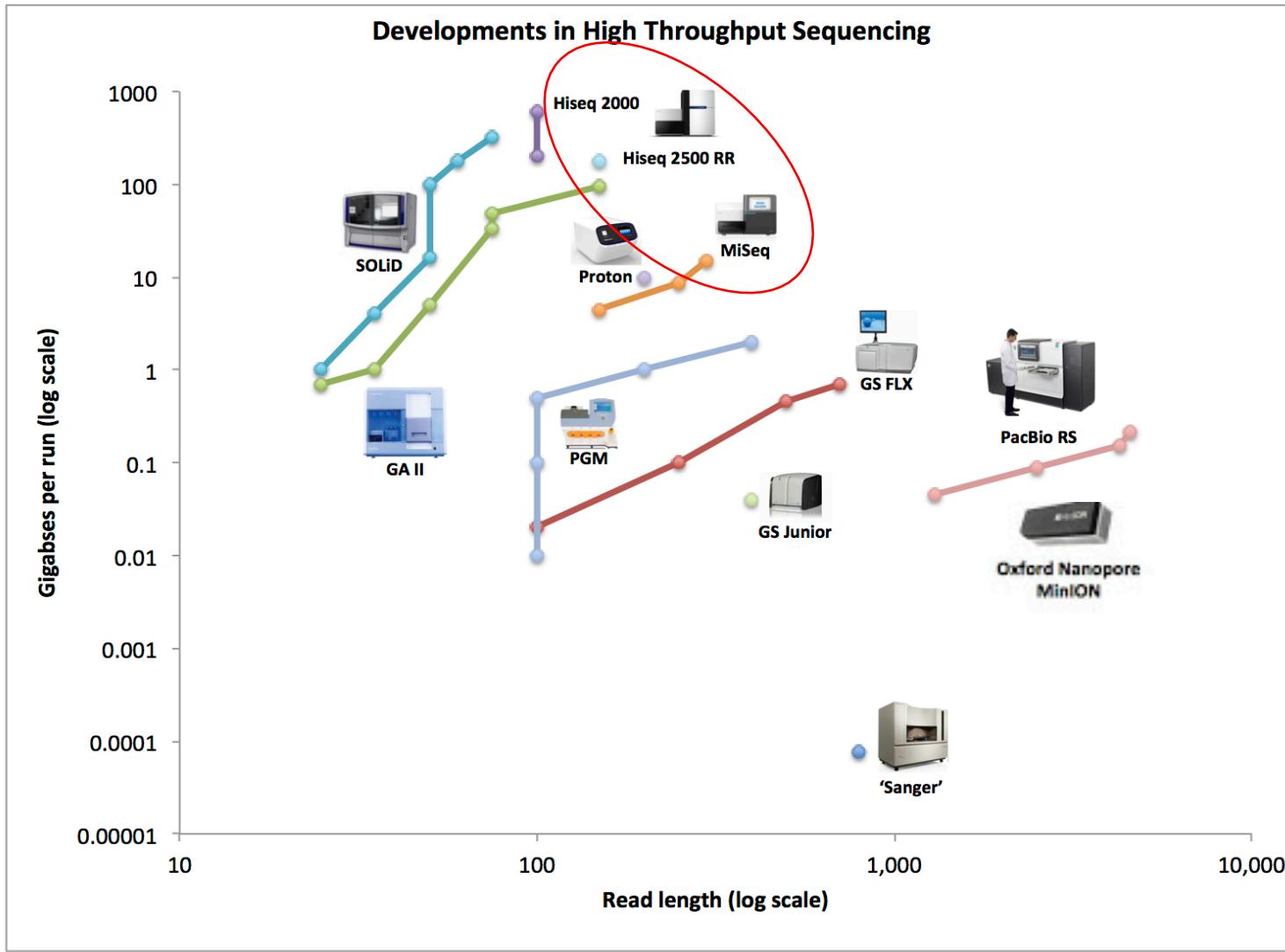
DNA Sequencing



DNA Sequencing



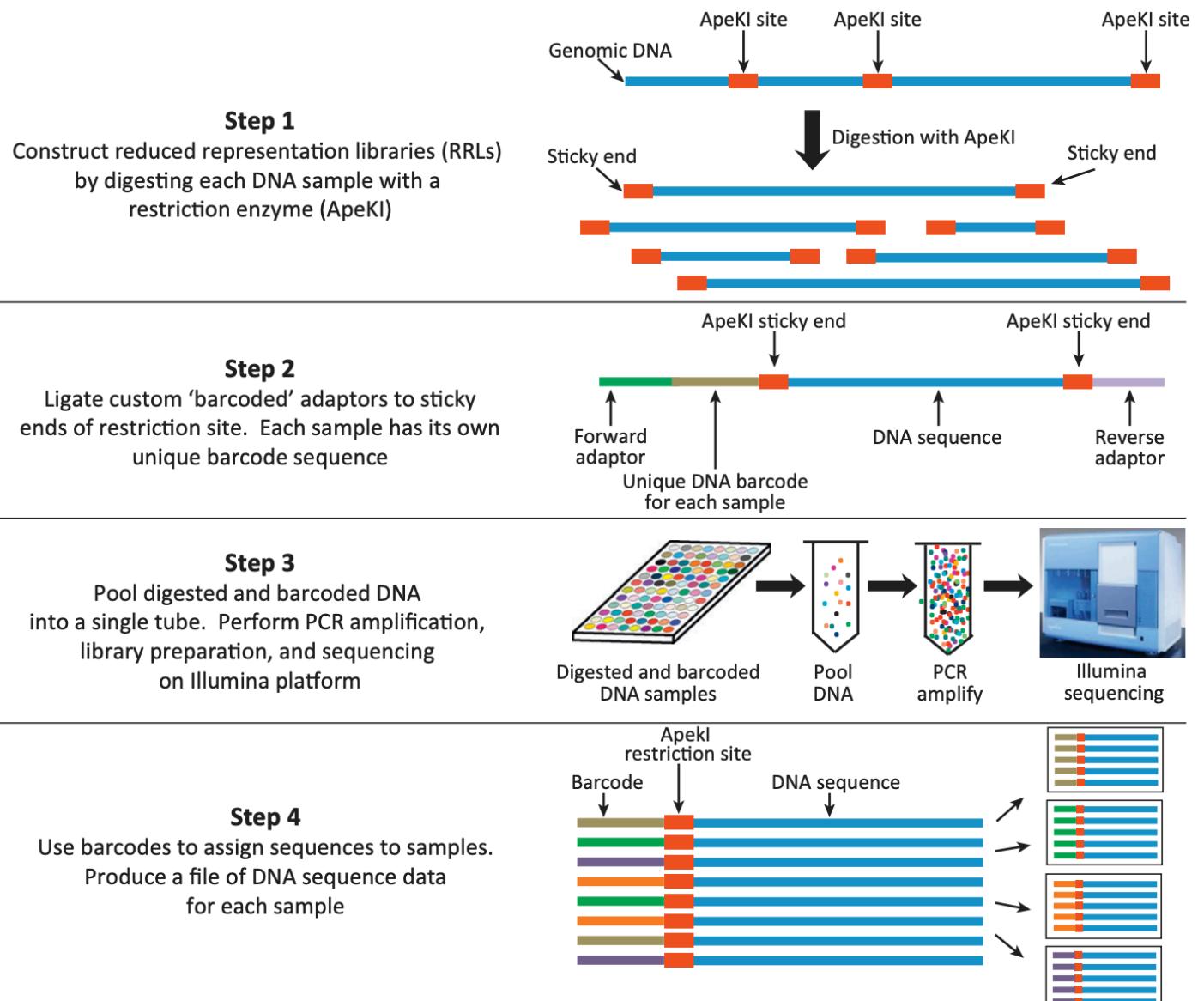
DNA Sequencing



Genotyping-by-Sequencing (GBS)

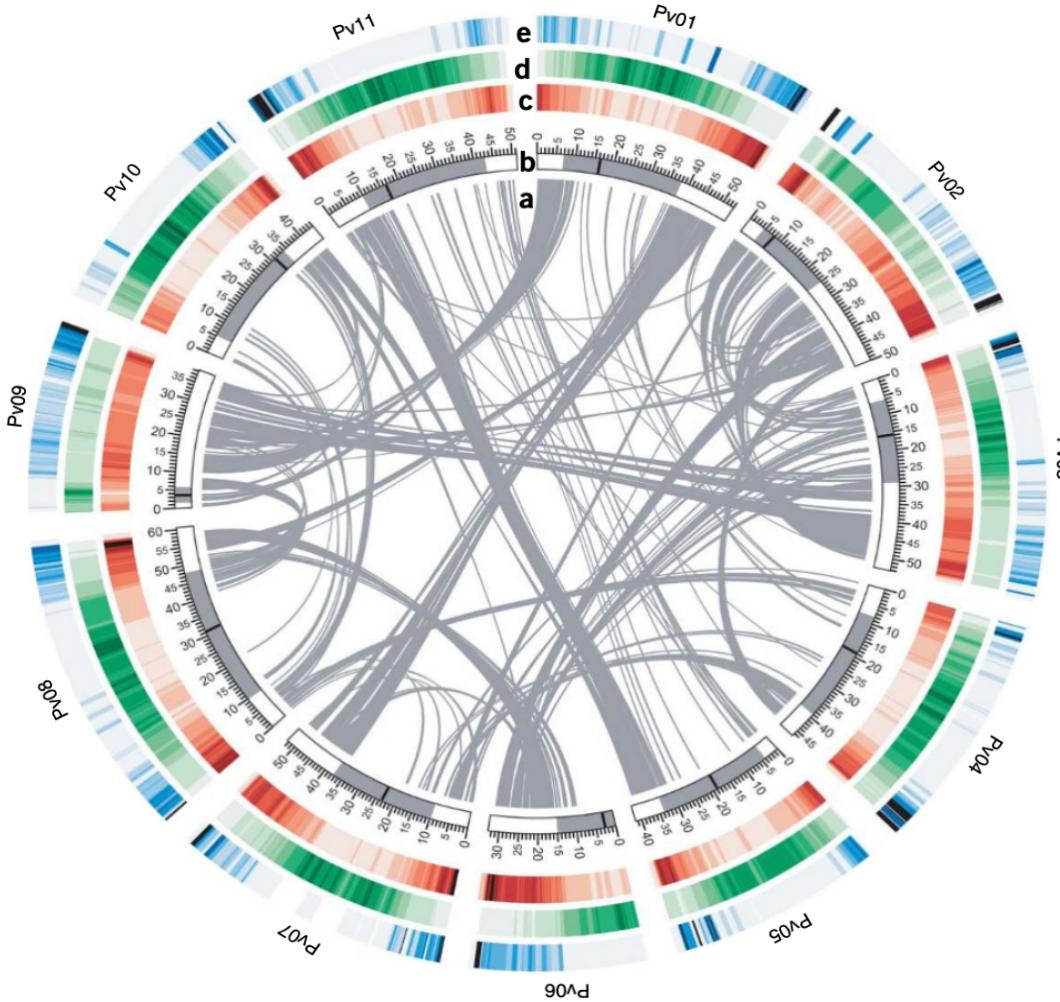
This approach is simple,
quick, specific, highly
reproducible, and may
reach important regions
of the genome

Elshire *et al.* 2011



Review

- Big picture of GS
- Genome
- Chromosomes
- Genes (alternative splicing)
- Mitosis and meiosis
- Crossing over
- DNA sequencing
- GBS



Genome
~537.2 Mb

Loci
27,433 total loci containing
36,995 protein-coding
transcripts

Alternative Transcripts
9,562 total alternatively
spliced transcripts



As of release v13, Phytozome hosts 224 assembled and annotated genomes!

The screenshot shows the Phytozome 13 website interface. At the top, there is a navigation bar with links to JGI Home, JGI Data Portal, Login, Tools, Projects, Genomes, and Cart. Below the navigation bar, a banner reads "Welcome to Phytozome". There are two tabs: "Overview" (selected) and "Release Notes". A section titled "Recent Genome Releases" lists the following genomes:

Genome	Common name	Release Date
Hydrangea quercifolia 'HQ6' v1.1	Oakleaf Hydrangea	Feb 3, 2021
Zostera marina v3.1	common eelgrass	Feb 3, 2021
Phaseolus acutifolius Frijol Bayo v1.0	tepary bean	Nov 6, 2020
Phaseolus acutifolius W6 15578 v2.0	tepary bean	Nov 6, 2020
Poncirus trifoliata v1.3.1	hardy orange	Oct 30, 2020
Joinvillea ascendens v1.1	'Ohe	Oct 30, 2020
Acorus americanus v1.1	American sweet flag	Oct 30, 2020

Below this, a paragraph describes Phytozome as a hub for plant genomics, mentioning its integration of 224 genomes from 128 species. It also notes the presence of both the 54 Brachypodium and Archaeplastida species.

The right side of the page features a search interface with two numbered steps:

1. Choose genomes by selecting from tree or type genus/species/common name. A dropdown menu shows "0 genomes selected".
2. find genes by keyword, search by BLAST, get standard data files, build custom data sets.

A list of genomes is displayed, with the Phaseolus genus highlighted by a red box:

- Glycine max Lee v1.1 (RST, JGI)
- Glycine soja v1.1 (RST, JGI)
- Lotus japonicus Lj1.0v1 (UNRST, EXT)
- Lupinus albus v1 (UNRST, EXT)
- Malus domestica v1.1 (RST, EXT)
- Medicago truncatula Mt4.0v1 (UNRST, EXT)
- Phaseolus acutifolius v1.0 (RST, EXT)
- Phaseolus acutifolius WLD v2.0 (RST, EXT)
- Phaseolus lunatus V1 (RST, EXT)
- Phaseolus vulgaris v2.1 (RST, JGI)
- Phaseolus vulgaris UI111 v1.1 (RST, JGI)
- Prunus persica v2.1 (UNRST, JGI)
- Trifolium pratense v2 (RST, EXT)
- Vigna unguiculata
 - Vigna unguiculata v1.1 (UNRST, COWPEAPAN, JGI)
 - Vigna unguiculata v1.2 (RST, COWPEAPAN, JGI)
 - Vigna unguiculata CB5-2 v1.1 (RST, COWPEAPAN, JGI)
 - Vigna unguiculata Sanzi v1.1 (RST, COWPEAPAN, JGI)
 - Vigna unguiculata Suvita2 v1.1 (RST, COWPEAPAN, JGI)
 - Vigna unguiculata TZ20 v1.2 (RST, COWPEAPAN, JGI)

<https://phytozome-next.jgi.doe.gov/>