Method of improving quality of crops

Disclaimer

All the content material provided here is only for teaching purpose.

INTRODUCTION

- Increased crop yield is required for food security
- Changing climate is the major obstacle
- Conventional methods of plant breeding is age-old technique
- Modern techniques are designed with the help of modern scientific tools

What are the modern scientific tools?

- Mutation Breeding
- Polyploidy Breeding
- Hybridization
- Biotechnological Methods

BRIEF HISTORY

- Gregor Mendel is consider to be the founder of Modern Science of Genetics
- 1856-1863 he established the rules of heredity
- He was working with *Pisum sativum*
- He observed 7 distinct traits

MUTATED GENE = NEW SPECIES?

- Hugo De Vries claimed – if a gene is a changed, it would create a new species
- He chose *Drosophila* flies for experiment
- He tried to create mutant flies by using x-ray, acids and other toxic chemicals
- He concluded – something had spontaneously changed in the red eyed flies, thus it has changed to white

What is mutation?

- A permanent alteration in the DNA sequence which results in an unusual sequence, rarely seen
- It may involve duplication of large sections of DNA through genetic recombination

What are the causes of mutation?

-Spontaneous mutation
    Tautomerism
    Depurination
    Deamination
    Slip strand mispairing
-Mutations due to error prone replication by pass of naturally occurring DNA damage
-Errors introducing during DNA repair
-Induced mutations caused by mutagens
    due to chemicals
    due to physical agents

DIFFERENT TYPES OF MUTATION

- By effect on structure
- By effect on function
- By effect on fitness
- By impact on protein sequence

BY EFFECT ON STRUCTURE

Small scale mutation
- point mutation
- silent mutation
- missense mutation
- nonsense mutation
- insertions
- deletions

Large scale mutations
- amplifications
- deletion of large chromosomal regions

BY EFFECT OF FITNESS

- Loss of function
- Gain of function
- Lethal mutation

BY EFFECT OF FITNESS

- A harmful or deleterious mutation
- A beneficial or advantageous mutation
- A neutral mutation
- A nearly neutral mutation
- Conditional mutation

BY IMPACT ON PROTEIN SEQUENCE

- Frameshift mutation
- Nonsense mutation
- Missense mutation
- Neutral mutation
- Silent mutation

ACHIEVEMENTS :

1. Disease resistance for leaf spot, blast disease, leaf blight in high yielding dwarf variety of paddy IR-8.
2. Jagannadh variety of paddy.
3. Hardiness in Swedish variety of barley.
4. Primex variety of White Mustard.
5. Aruna variety of Castor.
6. Sharbati, Sonor variety of Wheat.

LIMITATIONS OF MUTATION :

1. Most of the induced mutations are undesirable and even some are lethal.
2. A large number of plants have to be tested in order to get desirable mutations.
3. Mutant variety is subjected to prolonged testing in order to ensure the true breeding nature of mutagenic trait.

POLYPLOIDY

- Presence of more than two sets of chromosomes in a cell or organism is known as polyploidy
- It is also called numerical mutation

VARIATION IN CHROMOSOME NUMBER

TYPE	CHARACTERS
EUPLOIDY	Numerical changes in the entire genome
(a) Monoploidy	Only set of gamete (x)
(b) Haploidy	Only the haploid (gametic) set of genomes (n)
(c) Diploidy	Two sets of genomes (2x)
(d) Polyploidy	More than 2 sets of genomes (3x onwards)
(i) Triploidy	3x
(ii) Tetraploidy	4x
(iii) Pentaploidy	5x
(iv) Hexaploidy	6x

VARIATION IN CHROMOSOME NUMBER

TYPE	CHARACTERS
ANEUPLOIDY	Change in the number of a one or a few chromosomes
(a) Hypoploidy	Loss of chromosomes from the diploid set
(i) Monosomy	Loss of one chromosome from the diploid set (2n - 1)
(ii) Nullisomy	Loss of one chromosome pair from the set (2n - 2)
(b) Hyperploidy	Additional presence of chromosomes along with the diploid set
(i) Trisomy	Addition of one chromosome to the set (2n + 1)
(ii) Tetrasomy	Addition of one pair of chromosomes (2n + 2)

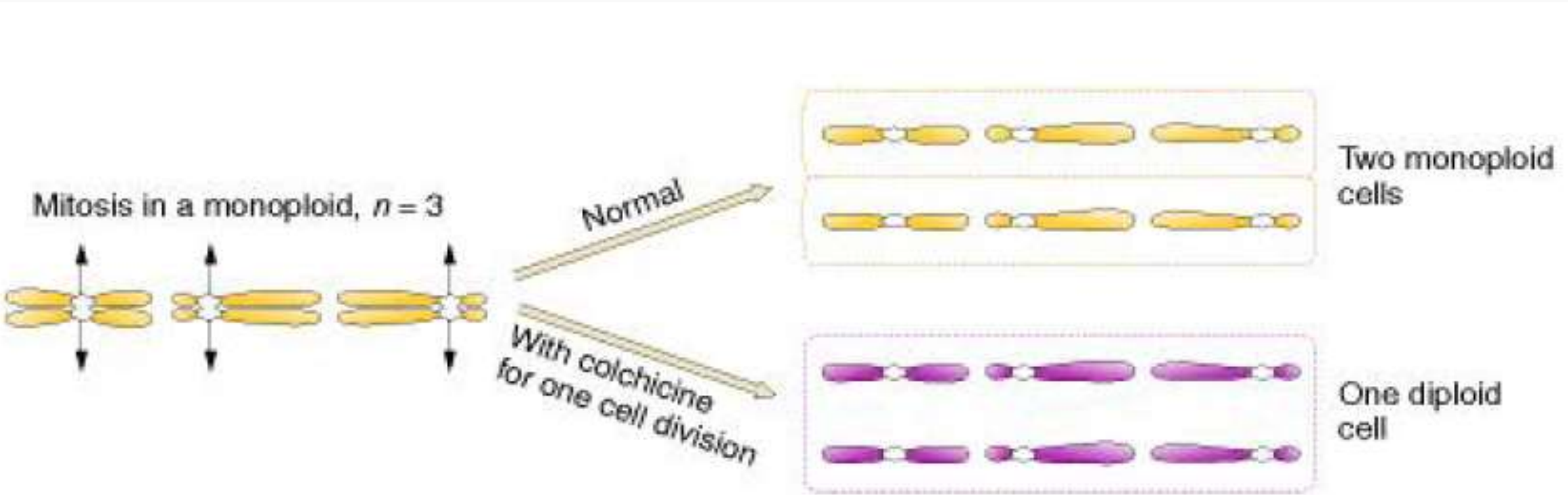

Figure a. the use of colchicine to generate a diploid from a monoploid. Colchicine added to mitotic cells during metaphase and anaphase disrupts spindle-fibre formation, preventing the migration of chromatids after the centromere is split. A single cell is created that contains pairs of identical chromosomes that are homozygous at all loci.

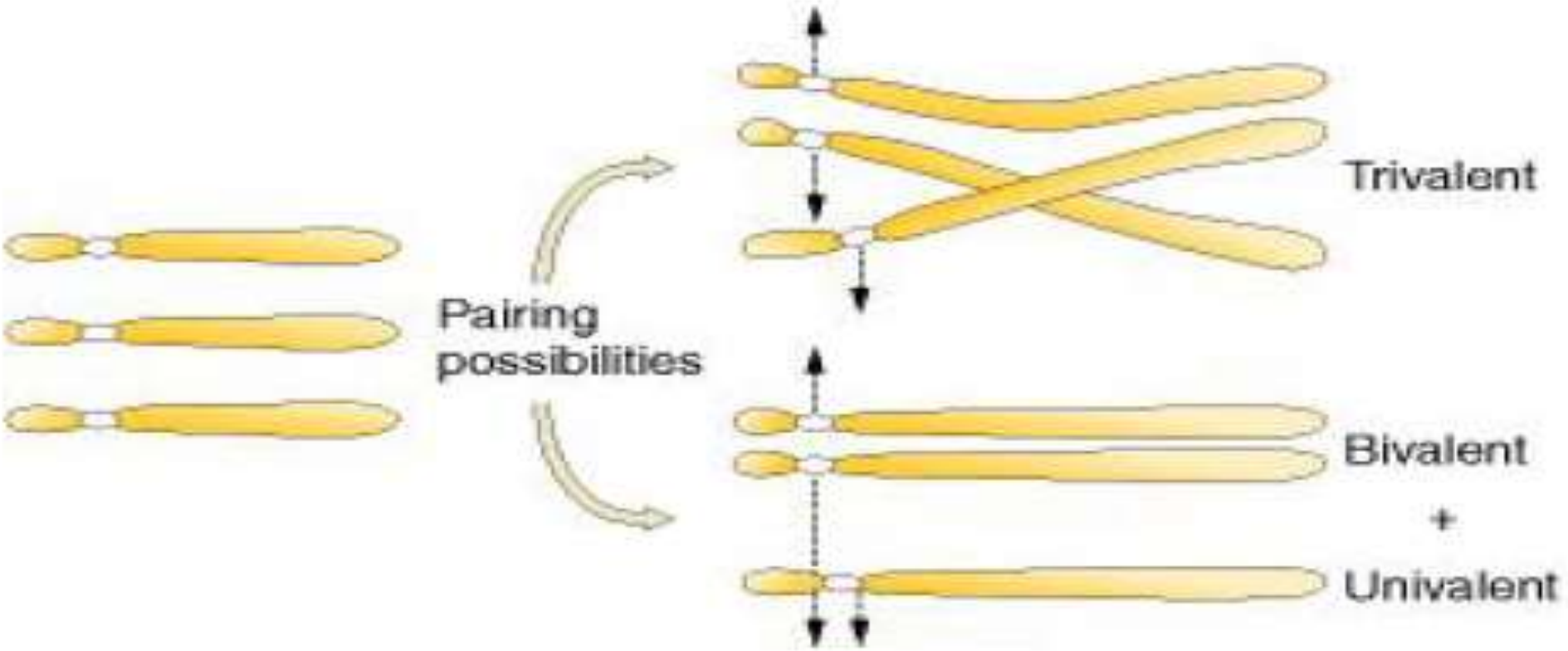

Figure b. two possibilities for the pairing of three homologous chromosomes before the first meiotic division in a triploid. Notice that the outcome will be the same in both cases : one resulting cell will receive two chromosomes and the other will receive just one. The probability that the latter cell can become a functional haploid gamete is very small, however, because to do so, it would also have to receive only one of the three homologous chromosomes of every other set in the organism.

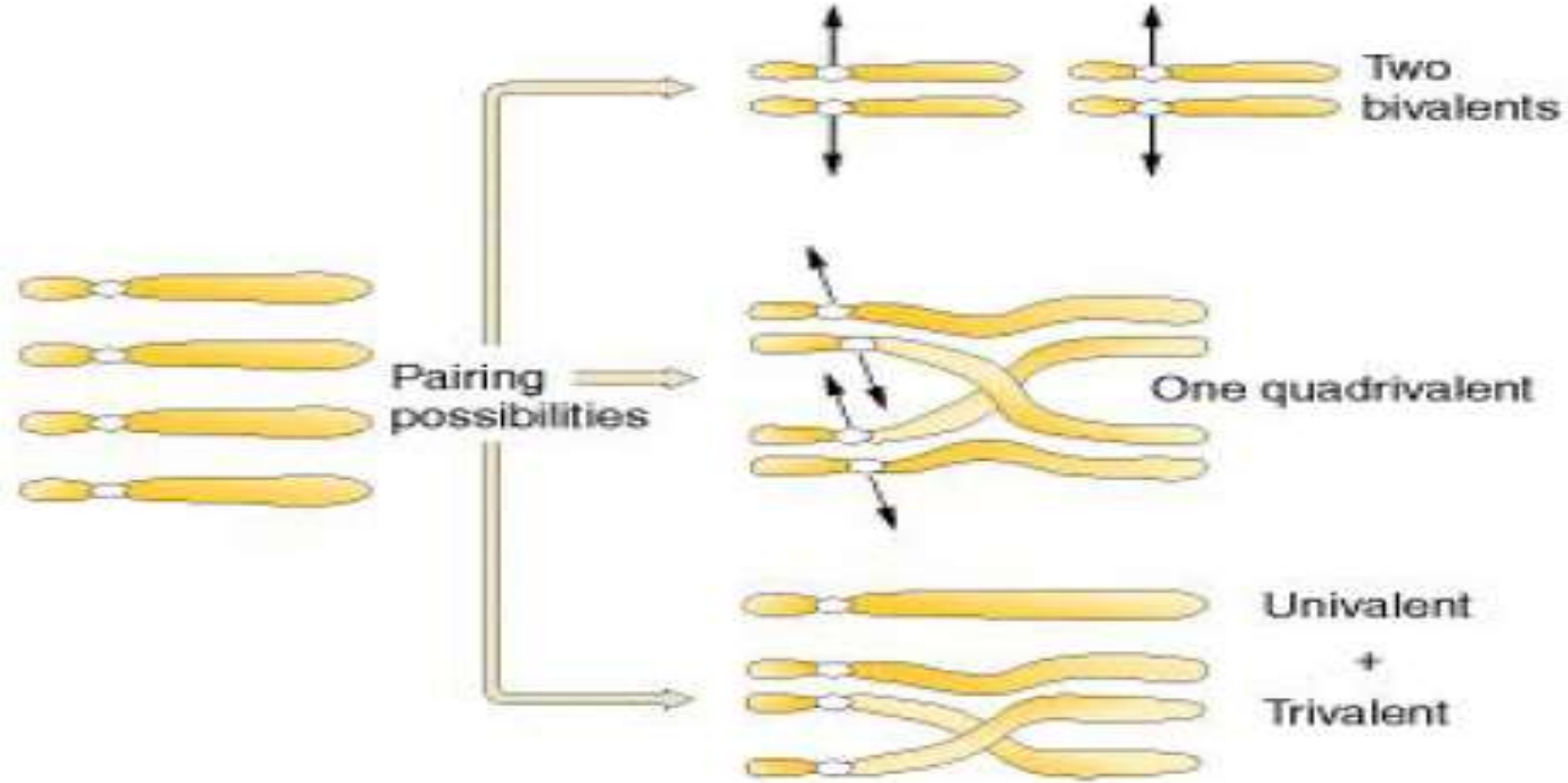

Figure c. meiotic pairing possibilities in tetraploids. The four homologous chromosomes may pair as two bivalents or as a quadrivalent. Both possibilities can yield functional gametes. However, the four chromosomes may also pair in a univalent-trivalent combination, yielding nonfunctional gametes. A specific tetraploid can show one or more of these pairings.

INDUCTION OF POLYPLOIDY

Cell generation
- Physical agents
  - Temperature shocks
  - Centrifugation
  - X-rays
- Chemical agents

MECHANISM OF POLYPLOIDY

Cytological Mechanism

- Meiotic nuclear restitution
- Chromosome doubling
- Pre-meiotic or Post-meiotic failure

Chromosomal doubling during meiosis

Polyspermy

ALTERNATIONS ASSOCIATED WITH POLYPLOIDY

- Changes in genetic composition
- Changes in the physiological mechanism
- Structural composition
- Vigor

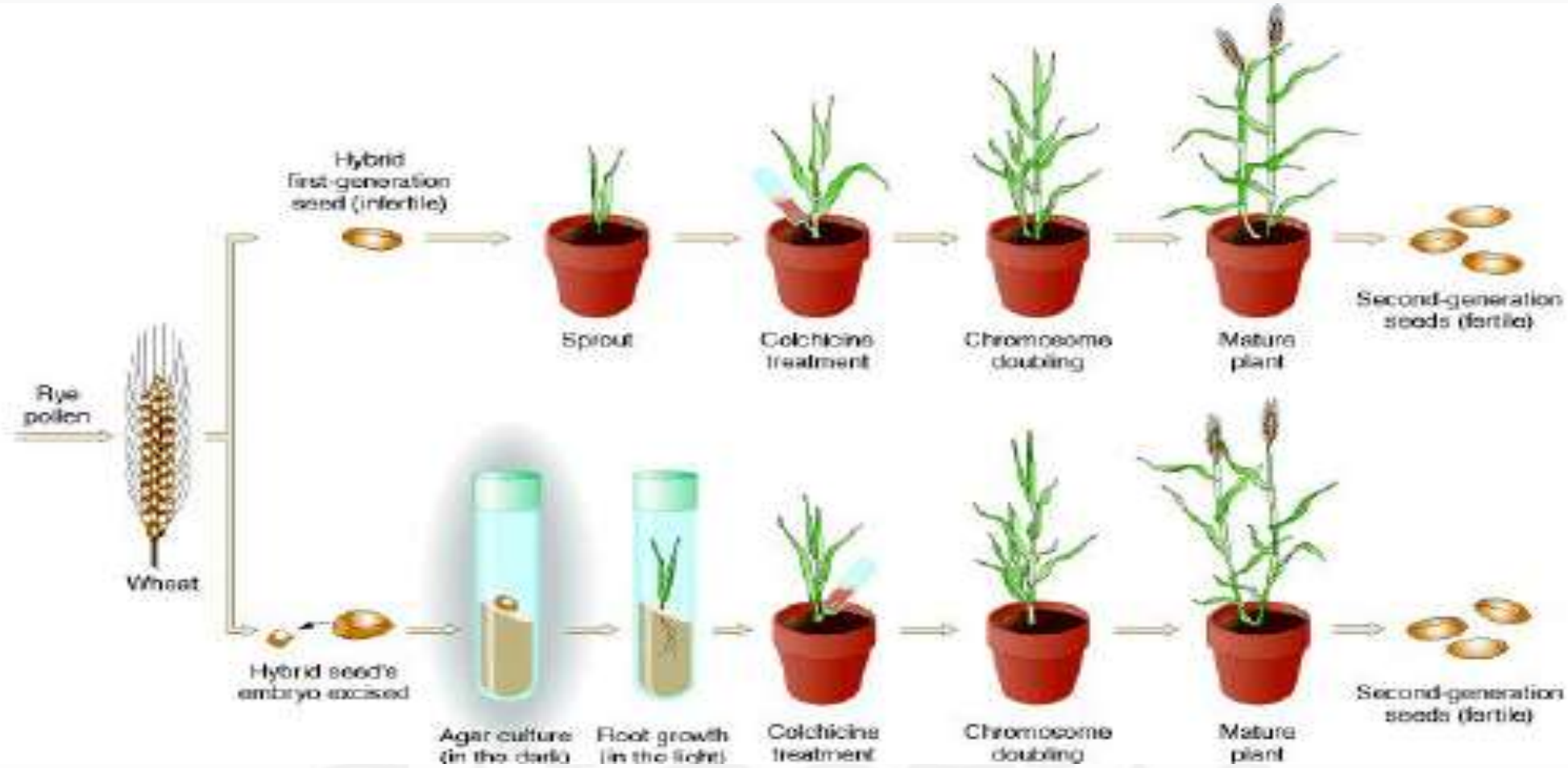

Figure d. techniques for the production of the amphidiploid *Triticale*. If the hybrid seeds does not germinate, then tissue culture may be used to obtain a hybrid plant.

Gossypium herbaceum

(Old world cotton; 2n=26; 13 bivalents

x

Gossypium raimondii

(American or upland cotton, 2n=26; 13 bivalents

↓

F1 hybrid

(2n=26, 26 univalents)

↓

Colchicine

New wold cotton

(Gossypium hirsurum)

(2n=52; 26 bivalents)

AIMS AND OBJECTIVES

1. To increase the yield of various types of plant products.
2. To improve the quality of product such as size, shape, color, taste, nutritional value, storing ability of grains, vegetables, fruits, etc. and many other features such as high sugar content, high protein content in pulses, long and fine fiber in fiber crops, fruit size in fruit crops.
3. To develop varieties resistant to diseases, insects, drought, floods, frost, alkaline and saline conditions.
4. To produce early mature crops for crop rotation purpose.
5. To change the growth habit and agronomic characteristics of plants and to produce dwarf varieties, winter hardiness in certain situations and tolerance to moisture and salt stress.
6. Suitability of crops for easy harvesting, adaptability to wide regions are some of the other objectives.

CONCLUSION

The last few years have seen the release of the first genome sequences for model plant species and the more genetically simple crops. Exploitation of these sequence data and associated tools for functional genomics has led to rapid progress in understanding the roles of individual genes, particularly in plant development and defense pathogens.

One negative factor is that random mutagenesis is much more likely to generate loss of function mutations rather than conferring improved or new properties on the targeted gene and thus will only be an appropriate strategy in a proportion of cases.

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