Al-Farabi Kazakh National University (KazNU)

Faculty of Biology and Biotechnology

DISCIPLINE: «Modern Problems of Plant Genetics»

Lecture 2

Challenging Features of Plant Genomes.

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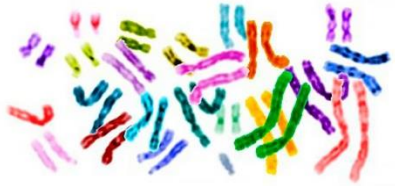
***Purpose of the lesson*:**
Acquaintance with the major achievements and problems in plant genomics.

Plan of the lesson:

1. **Modern problems of plant genetics.**
2. **Agriculture and Plant Genomes**
3. **Challenges for sustainable agriculture production.**
4. **Major achievements in plant pan-genomics.**



- **MODERN PROBLEMS OF PLANT GENETICS**

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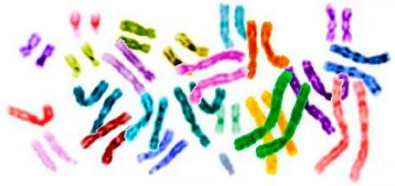


- **The plant kingdom has amazing diversity and importantly provides a variety of resources and food energy intake for humans (Food and Agriculture Organization of the United Nations, 1995).**
- **The estimated number of land plant species is approximately 391,000, and their genomes are unusually diverse and complicated with genome sizes that vary dramatically from approximately 60 Mb to 150 Gb.**

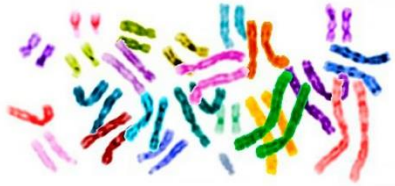
- **Polyploidization events and variations in the amounts of repetitive DNA have played important roles in influencing the different sizes of plant genomes, which are vital to plant speciation and evolution.**

- **The dynamics of transposable elements, along with self-incompatibility, have long been recognized as significant evolutionary forces that contribute to plant genome changes.**

- **MODERN PROBLEMS OF PLANT GENETICS**

- **All of these properties, high repetitive DNA content, high degree of heterozygosity, and polyploidy, make it technically challenging and time-consuming to generate high-quality plant genome assemblies.**

- **High-quality reference genome sequences are the prerequisite and basis for promoting fundamental and applied research in plants and animals. Triggered by developments in computing power, sequencing technologies, and assembly methods, the genomes of more than 700 plants species, from non-vascular to flowering, have been released in the past 20 years (Sun et al., 2021)**



- **Agriculture and Plant Genomes**

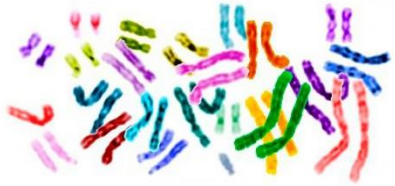
- **We grow about 200 crops for food, feed, or fiber, and almost all were introduced to the U.S.; they were modified genetically to be adapted to climate and consumer desires.**
- **Clearly, genomics can help in issues related to food safety, food quality, and food diversity.**

- **Genomics provides objectivity in breeding as never before possible; it allows hypothesis testing of quantitative genetics applications in plant improvement.**

- **Agriculture and Plant Genomes**

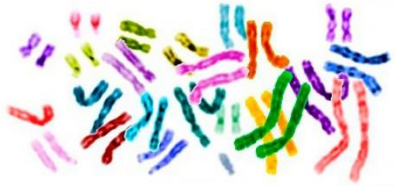
- **Among these are the applications of (i) DNA markers into cultivar identification, seed purity analysis, germplasm resource evaluation, heterosis prediction, genetic mapping, cloning and breeding; and (ii) gene expression data in supporting the description of crop phenology, the analytic comparison of crop growth under stress versus non-stress conditions, or the study of fertilizer effects. Besides, various purposes of using transgenic technologies in agriculture, such as generating cultivars with better product quality, better tolerance to biotic or abiotic stress.**

- **CHALLENGES FOR SUSTAINABLE AGRICULTURE PRODUCTION.**



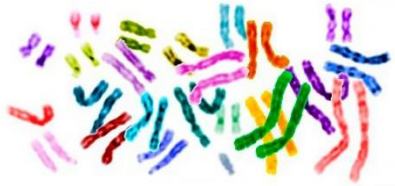
- **To entail a comprehensive system-centered technology that integrates innovative farming approaches, long-term sustainable agronomic practices, and value-added climate-resilient crops, genomic-based technologies offer, for this task, solid foundational tools and genetic tools insights for shaping the future agriculture.**

- **Major achievements in plant pan-genomics.**



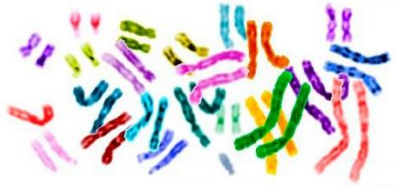
- **A PANGENOME is information about the complete set of genes of a taxon, among which one can distinguish a set of universal genes common to all representatives of the taxon and variable genes that are partially or completely specific to its representatives.**

- **Pan-genomes for major crops, such as maize, rice, wheat, and soybean, have been constructed based on high-quality genomes of multiple samples, which has led to great progress in studies into the evolution of plant genomes and the identification of key genes associated with important agronomic traits.**



- **MAJOR ACHIEVEMENTS IN PLANT PAN-GENOMICS**
- **These studies have shown that the construction of a pan-genome can eliminate deviations from a single reference genome as much as possible and can present a nearly full view of the diversity within a species.**

- **Grain species**
- **Major grain species include rice, wheat, maize, soybean, millet, barley, oats, and sorghum, which are indispensable sources of energy in the human diet (Bansal et al., 2016).**



- **MAJOR ACHIEVEMENTS IN PLANT PAN-GENOMICS**

- **Because of their importance, a major focus of plant pan-genome research has been to obtain a full view of the genetic variations within each of these grain species. The first plant pan-genome based on high-quality genomes was released in 2014 for wild soybean, which provided a potentially rich resource for improving the genetic diversity of cultivated soybean that was lost during domestication**

- **Control questions:**

- **Modern problems of plant genetics.**
- **Agriculture and Plant Genomes**
- **Challenges for sustainable agriculture production.**
- **Major achievements in plant pan-genomics.**


GOOD LUCK!