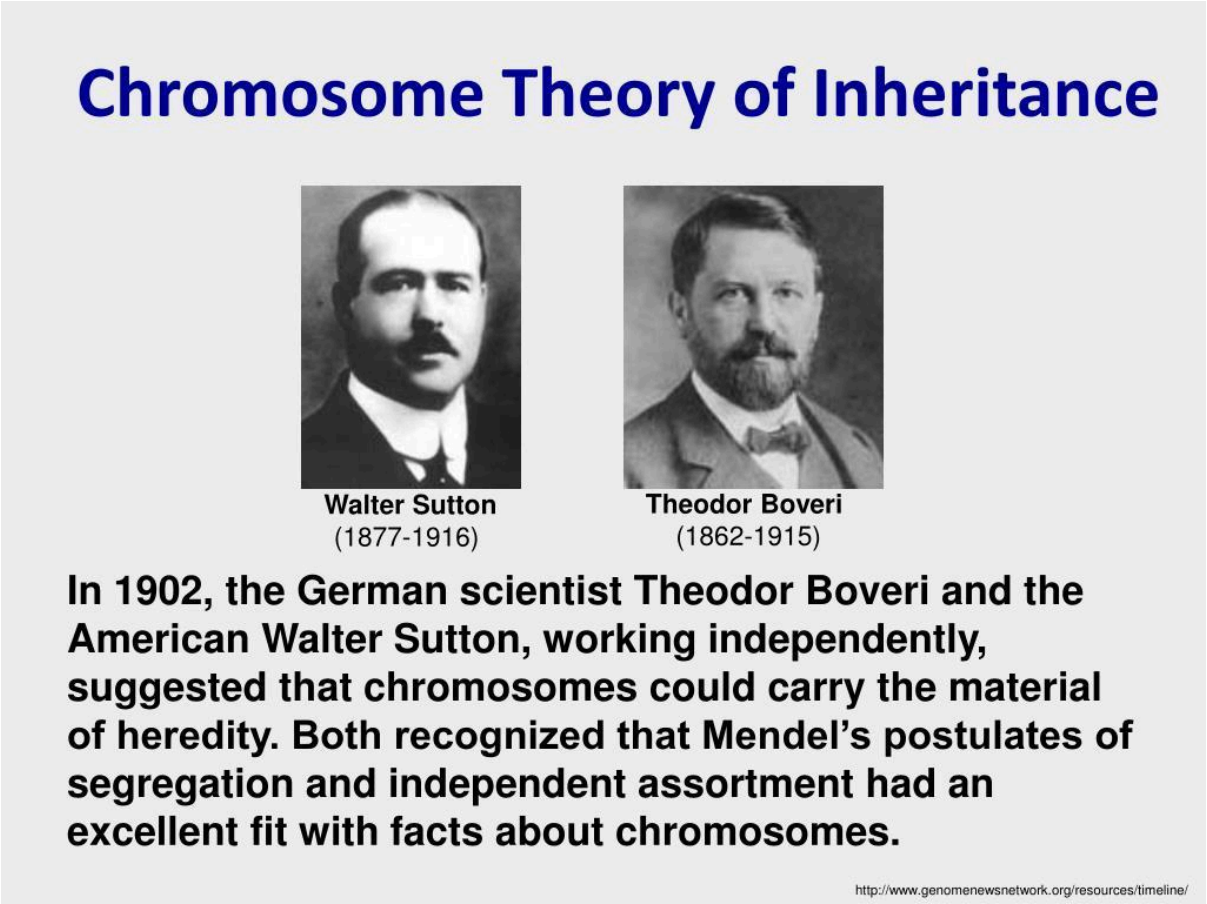
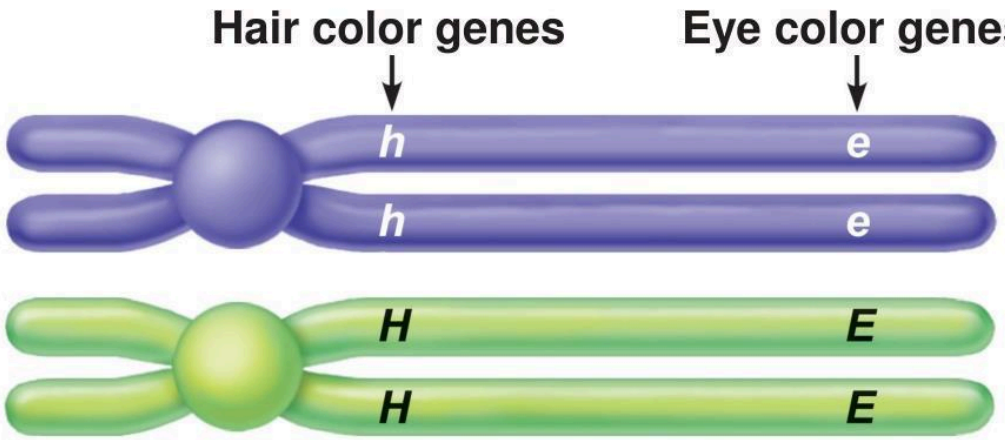
Chromosome Theory of Inheritance

1. Introduction

The Chromosome Theory of Inheritance explains that genes are located on chromosomes, and the transmission of chromosomes from parents to offspring is responsible for the inheritance of characters.

The theory was independently proposed by Walter Sutton and Theodor Boveri in 1902–1903. It is also known as the Sutton–Boveri theory.





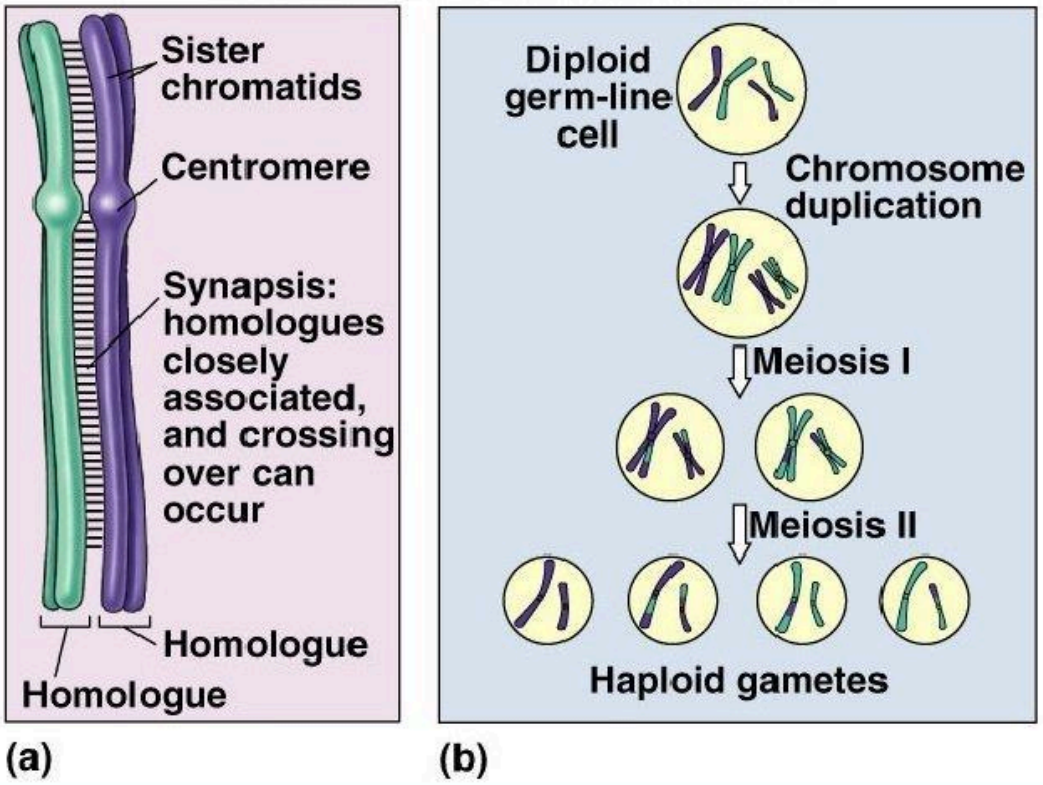
Homologous chromosomes synapse during prophase of meiosis I. Each chromosome consists of two sister chromatids.

H Allele for brown hair
h Allele for blond hair
E Allele for brown eyes
e Allele for blue eyes
Paternal chromosome
Maternal chromosome
Homologous pair

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Figure 29.3 (1 of 4)

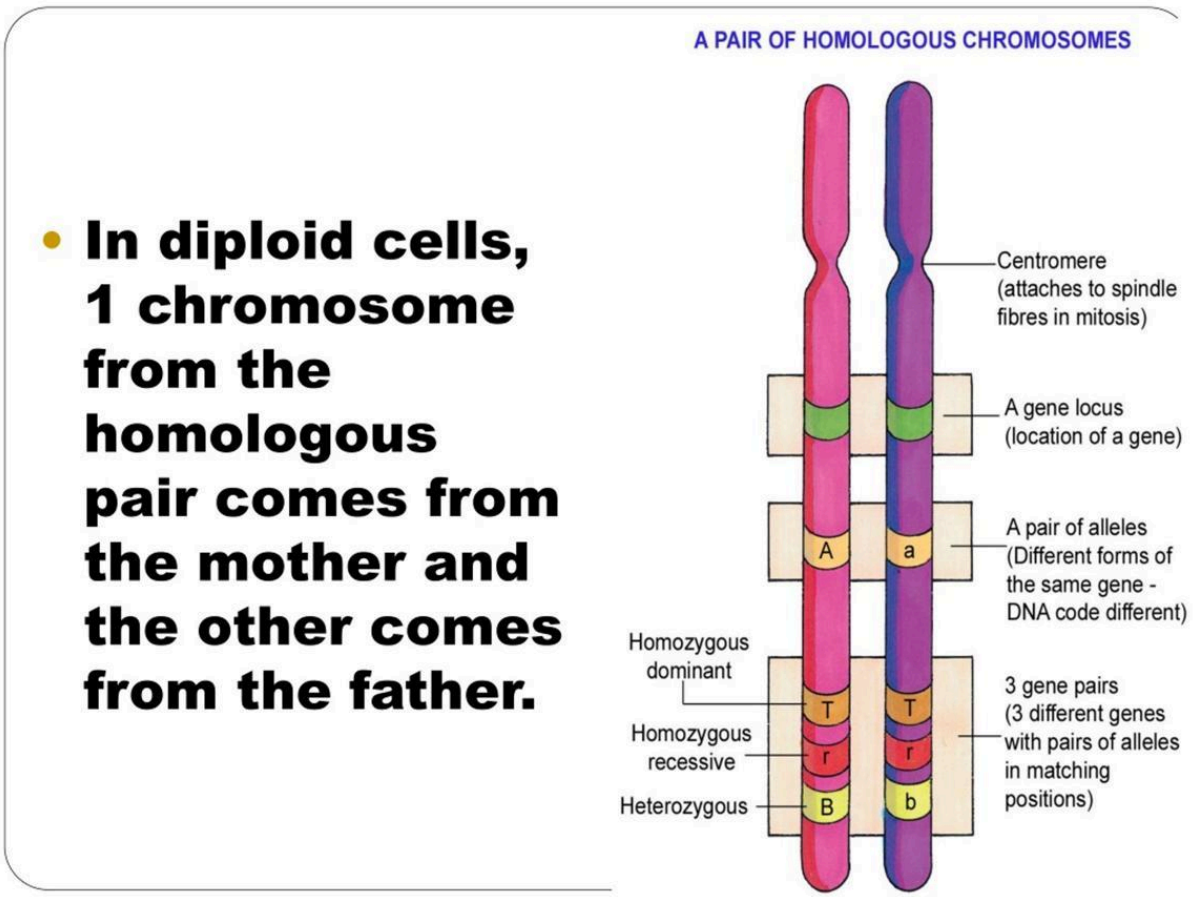
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2. Main postulates of the theory

1. Genes are located on chromosomes. Chromosomes carry hereditary information from one generation to the next.
2. Chromosomes occur in pairs in diploid organisms. One chromosome of each homologous pair is inherited from the mother and the other from the father.
3. Genes occupy specific positions, called loci, on chromosomes.
4. During meiosis, homologous chromosomes separate, so each gamete receives only one chromosome from each homologous pair.
5. Different pairs of chromosomes generally assort independently during meiosis, explaining Mendel's law of independent assortment.
6. At fertilisation, the maternal and paternal chromosome sets unite, restoring the diploid chromosome number.
7. Chromosomes carry many genes, and genes on the same chromosome may show linkage.

3. Relationship between genes and chromosomes



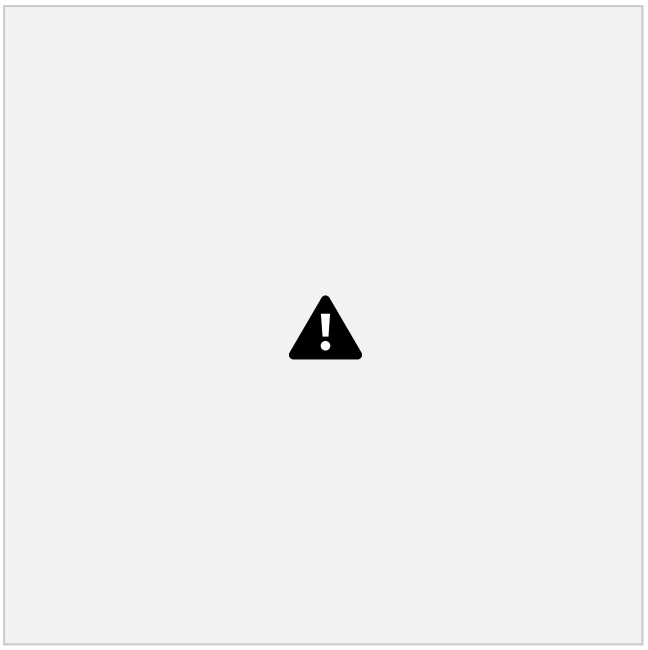
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- Chromosome: A DNA–protein structure that carries genes.

- Gene: A DNA sequence that contributes to a functional product or influences a heritable characteristic.
- Locus: The specific position of a gene on a chromosome.
- Homologous chromosomes: A pair of chromosomes carrying the same genes at corresponding loci, though their alleles may differ.
- Alleles: Alternative forms of the same gene.

For example, a gene may have alleles A and a. A diploid individual can have genotype AA, Aa, or aa.

4. How meiosis supports the theory



Interphase
DNA copies once before meiosis while chromatin stays uncondensed.
Give feedback

The behaviour of chromosomes during meiosis closely parallels Mendel's laws of inheritance.

Chromosomal event	Genetic significance
Separation of homologous chromosomes in meiosis I	Explains segregation of alleles
Independent orientation of different chromosome pairs	Explains independent assortment

Crossing over between homologous chromosomes	Produces new combinations of alleles
Fusion of male and female gametes	Restores diploid chromosome number

Example: An individual with genotype Aa produces gametes carrying either A or a, usually in equal proportions, assuming normal segregation and no transmission distortion.

5. Experimental evidence

A. Sutton's observations

Walter Sutton studied meiosis in grasshoppers and observed that chromosomes occur in pairs, separate during gamete formation, and are restored to pairs after fertilisation.

He recognised the similarity between chromosome behaviour and Mendel's factors.

B. Boveri's observations

Theodor Boveri studied sea urchin embryos and showed that normal development depends on the correct combination of chromosomes. His work supported the idea that individual chromosomes have distinct hereditary roles.

C. Morgan's experiments

Thomas Hunt Morgan studied Drosophila melanogaster (fruit fly).

- He demonstrated sex-linked inheritance of white eye colour.
- His experiments provided strong evidence that genes are carried on chromosomes.
- Alfred Sturtevant, working in Morgan's group, developed the first genetic linkage map in 1913 using recombination frequencies.

6. Significance

- Established the chromosomal basis of Mendelian inheritance.
- Explained segregation and independent assortment.
- Provided the foundation for linkage and crossing-over studies.
- Helped explain sex determination and sex-linked inheritance, such as haemophilia and red–green colour blindness.
- Laid the groundwork for modern genetics, genetic mapping and the study of chromosomal abnormalities.

7. Limitations and refinements

The original theory was later refined by discoveries that:

- Genes located on the same chromosome can be linked and may not assort independently.
- Crossing over can separate linked genes.
- Mutations and chromosomal rearrangements can alter hereditary information.
- Mitochondria and chloroplasts have their own DNA, allowing certain forms of non-Mendelian inheritance.

8. Quick revision

Year: 1902–1903

Scientists: Walter Sutton and Theodor Boveri

Central idea: Genes are located on chromosomes, whose behaviour during meiosis and fertilisation explains inheritance.

Key association: Mendel’s laws correspond to chromosome segregation and independent assortment.

Important examination point: Sutton and Boveri proposed the theory; Morgan’s fruit-fly experiments provided strong experimental evidence for the chromosomal location of genes.