Chromosome Theory of Inheritance

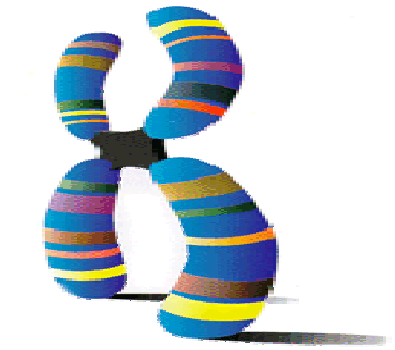
Linkage, Crossing Over

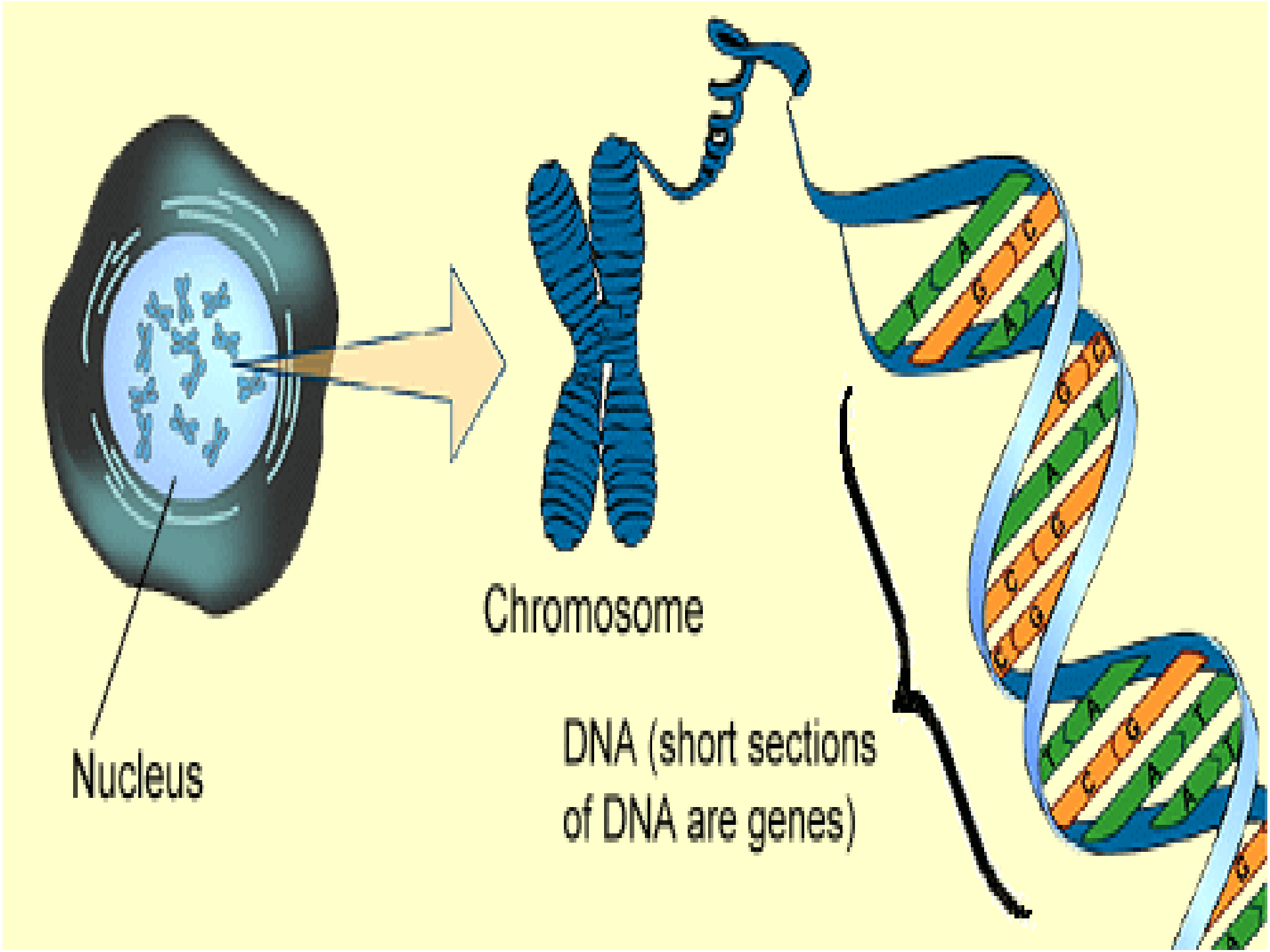
By – **Surinder Kaur**

DIET Ropar

Surinder-1998@ yahoo.in

Mob No 9988530775




Nucleus
Chromosome
DNA (short sections
of DNA are genes)

1902: Walter Sutton and Theodor Boveri

Chromosome theory of inheritance:

1. **Independently recognized that the transmission of chromosomes from one generation to the next parallels inheritance of Mendelian factors.**

2. **Mendelian factors (genes) are located on chromosomes.**

3. **Support for theory derived from study of sex chromosomes.**

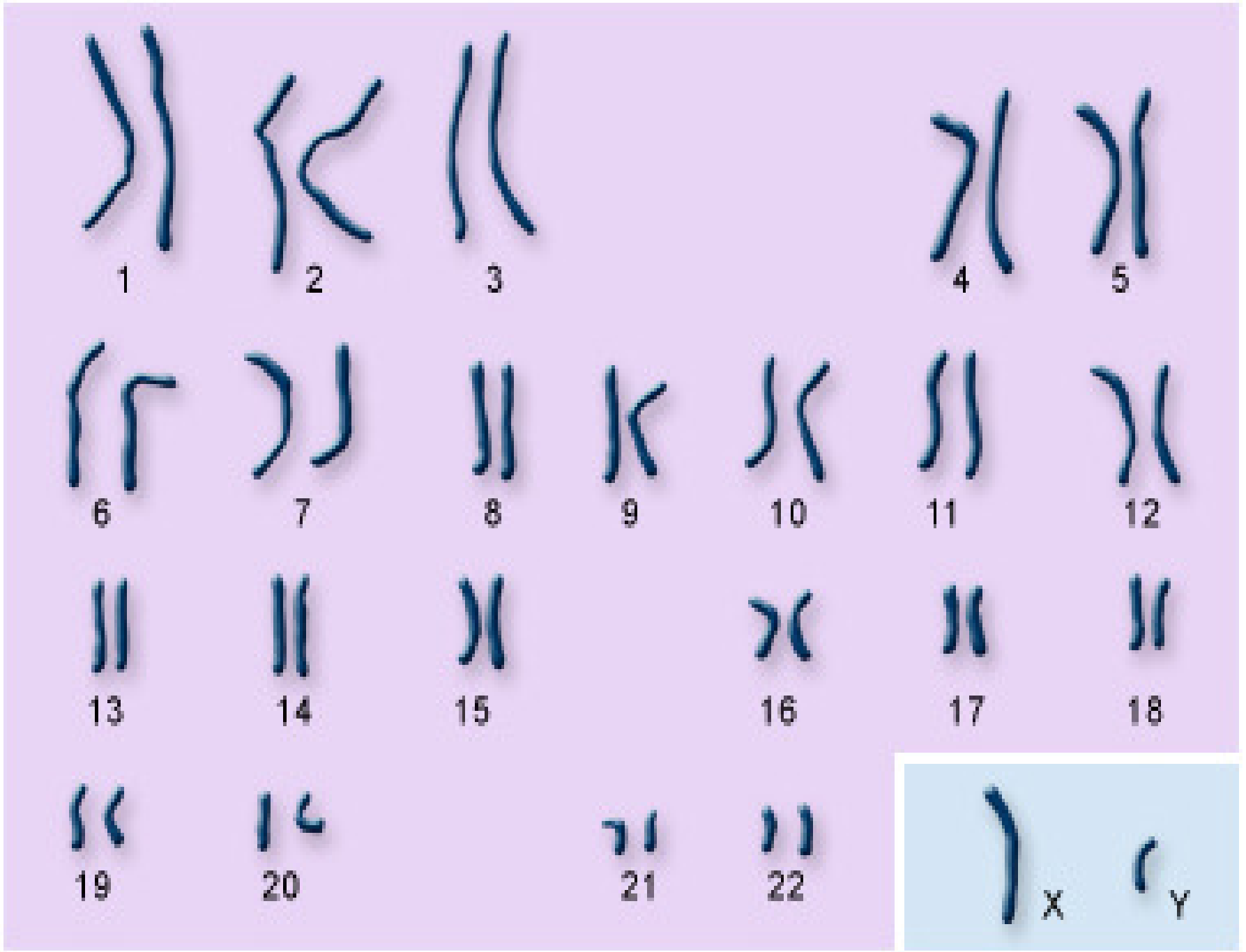
Sex chromosomes:

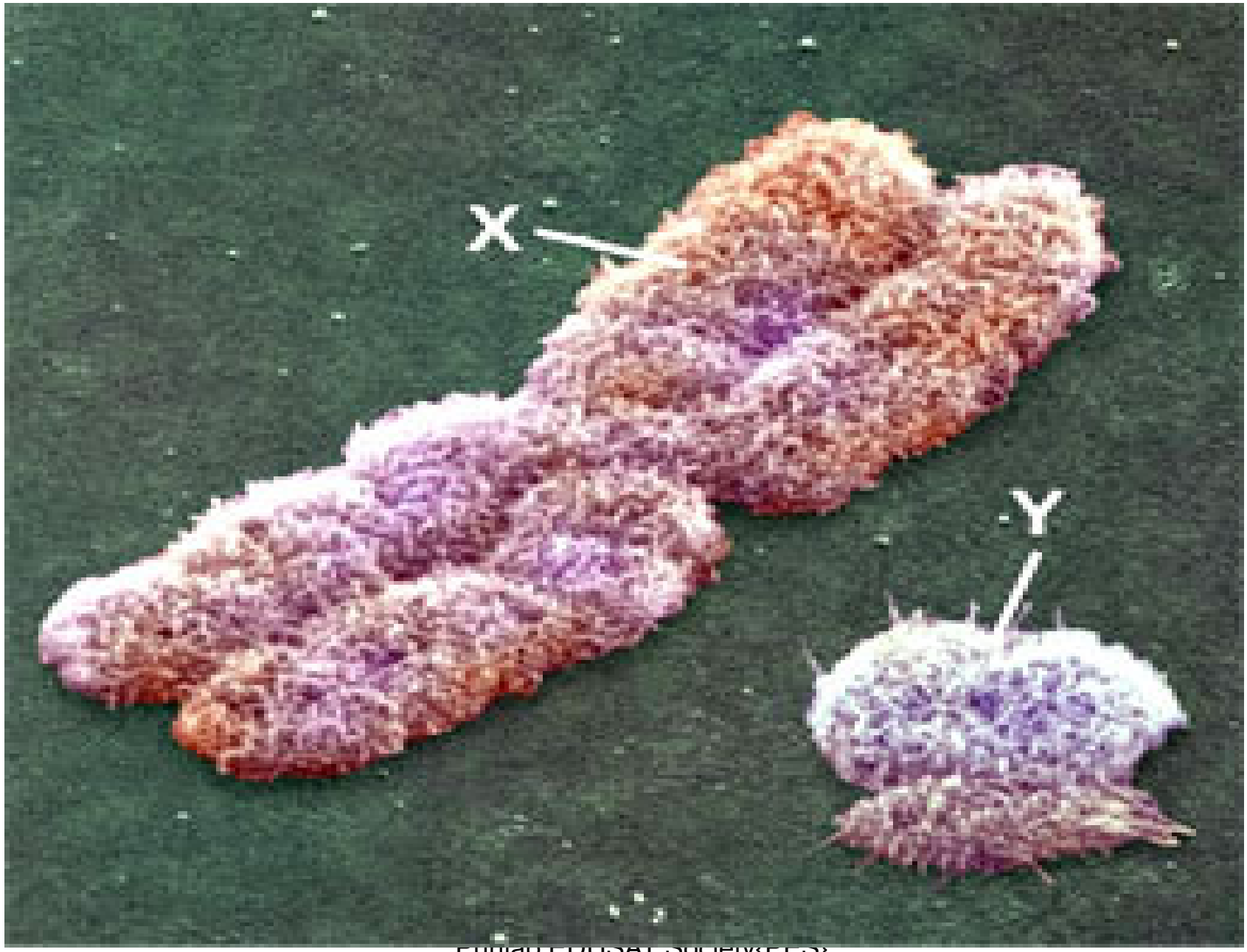
Chromosomes or group of chromosomes in eukaryotes in which the sexes are represented differently.

Typically designated X and Y (sometimes W and Z)

Autosomes:

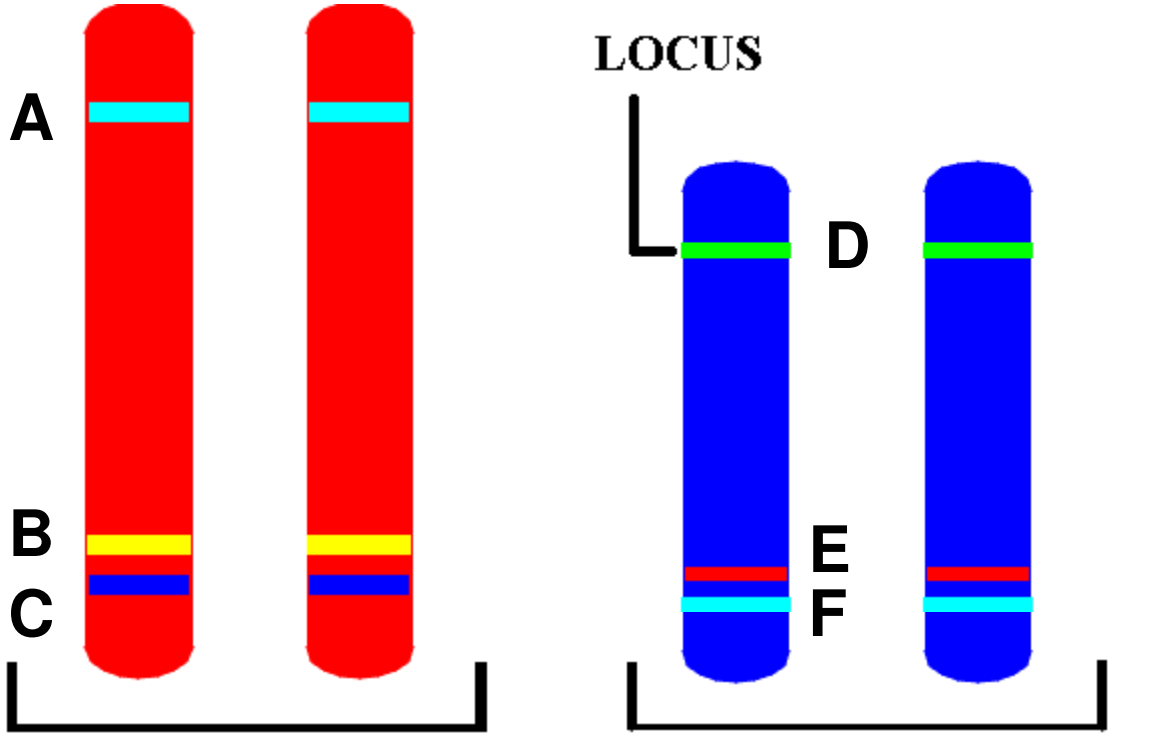
All of the other chromosomes.


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
X
Y


X
Y

Linkage

- Tendency of genes of same chromosome to remain together .
- Such genes are called – linked genes.
- Linked genes present only parental types in progeny.



HOMOLOGOUS CHROMOSOMES

A, B, C – LINKED GENES

A & D – UNLINKED GENES

Why Linkage

- Linkage refers to packaging genes onto chromosomes

- Chromosomes (and therefore linkage) are for organizing genes for their safe coordinated transmission from cell to cell, parent to offspring

- Simply put, what's easier to handle:
  - 30000 quarters (i.e., genes) OR
  - 23 bags of quarters (i.e., chromosomes)?

Some Definitions

- Complete linkage – Genes that are linked but never crossover
  - Incomplete linkage – Genes that are linked and can crossover

- Parentals – Offspring that are like the parents
  - Recombinants – Offspring with arrangements different from the parents

Unlinked genes

- Parents AABB X aabb

- Gametes AB, AB ab, ab
- F_1progeny AaBb
- T.cross AaBb X aabb
- Progeny AaBb , Aabb , aaBb , aabb (1:1:1:1)

Linked Genes

Parents $\overline{AB} / \overline{AB}$ X $\overline{ab} / \overline{ab}$

Gametes $\overline{AB}$ $\overline{AB}$ $\overline{ab}$

F_1 Progeny $\overline{AB} / \overline{ab}$

Test Cross $\overline{AB} / \overline{ab}$ X $\overline{ab} / \overline{ab}$

Gametes $\overline{AB}$ $\overline{ab}$ $\overline{ab}$

Test Cross Progeny

	ab
AB	$\overline{AB} / \overline{ab}$
ab	$\overline{AB} / \overline{ab}$

Test Ratio 1:1

FACTORS AFFECTING LINKAGE

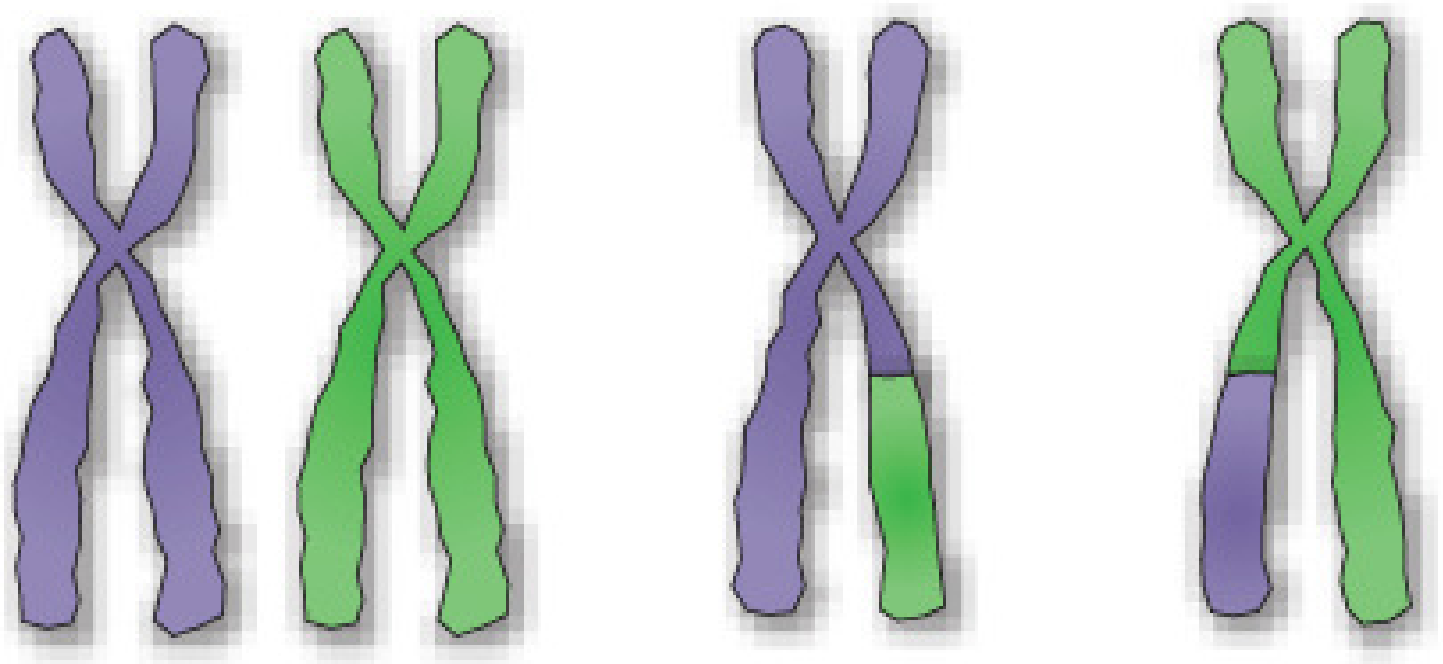
1. Age
2. Temperature
3. X-Rays

Significance of Linkage

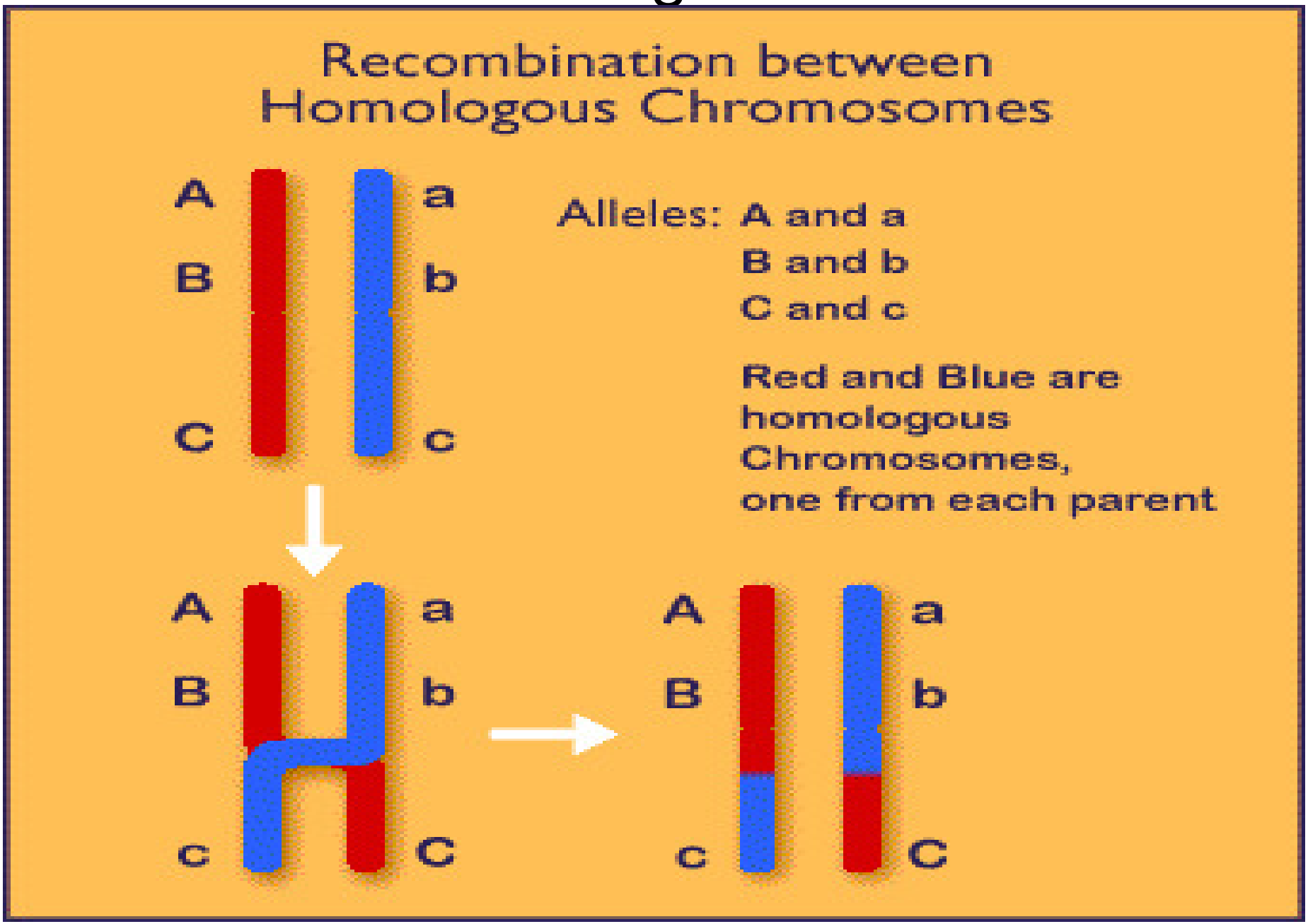
- Keeps parental / racial specific traits together.
- Valuable traits of new variety maintained.
- Disallows desirable mixing of traits.
- No. of linkage groups = No. of chromosome pairs.

This shows genes are located on chromosomes.

- **Linked genes are not inherited together every time.**
  - Chromosomes exchange homologous genes during meiosis.

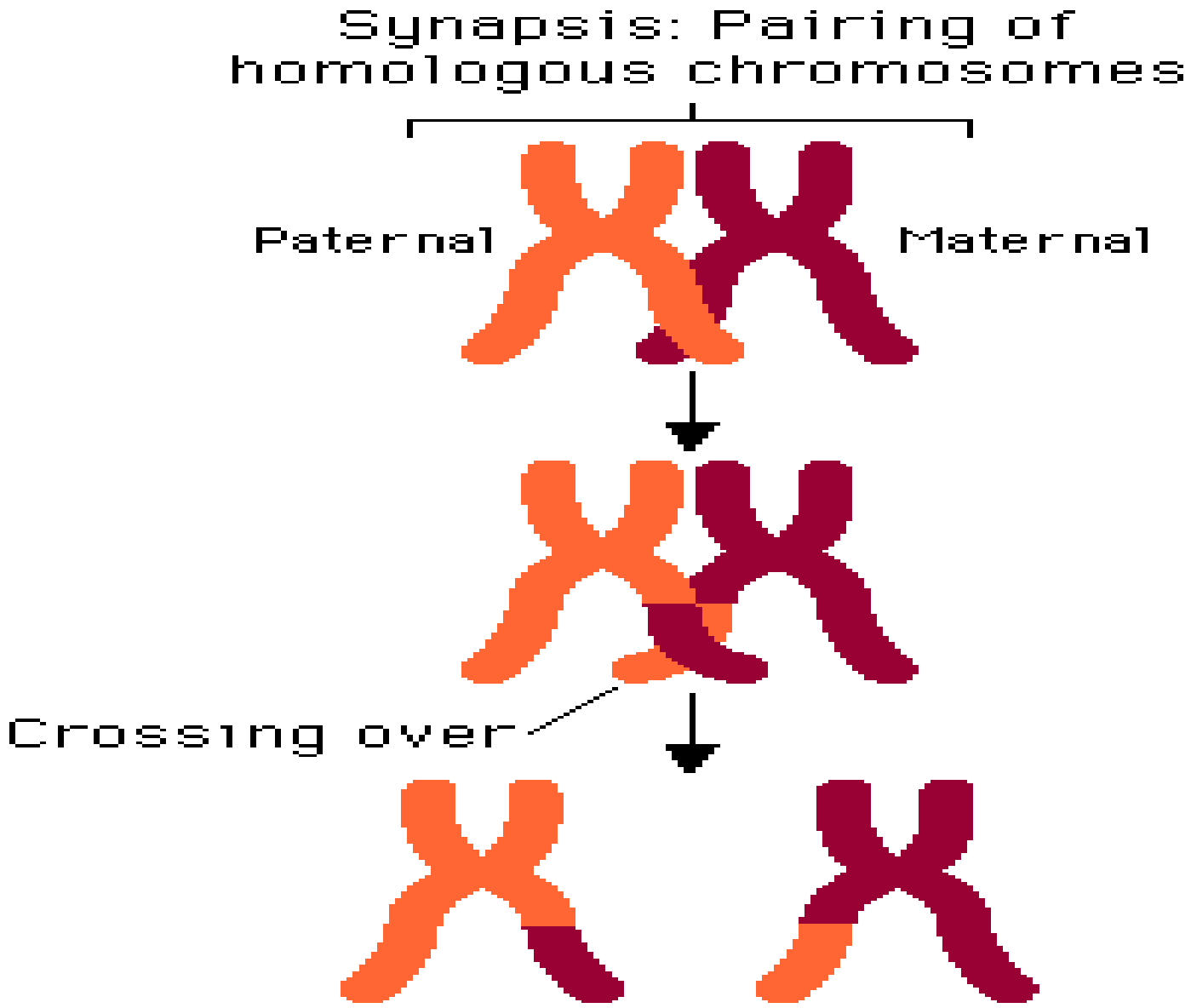


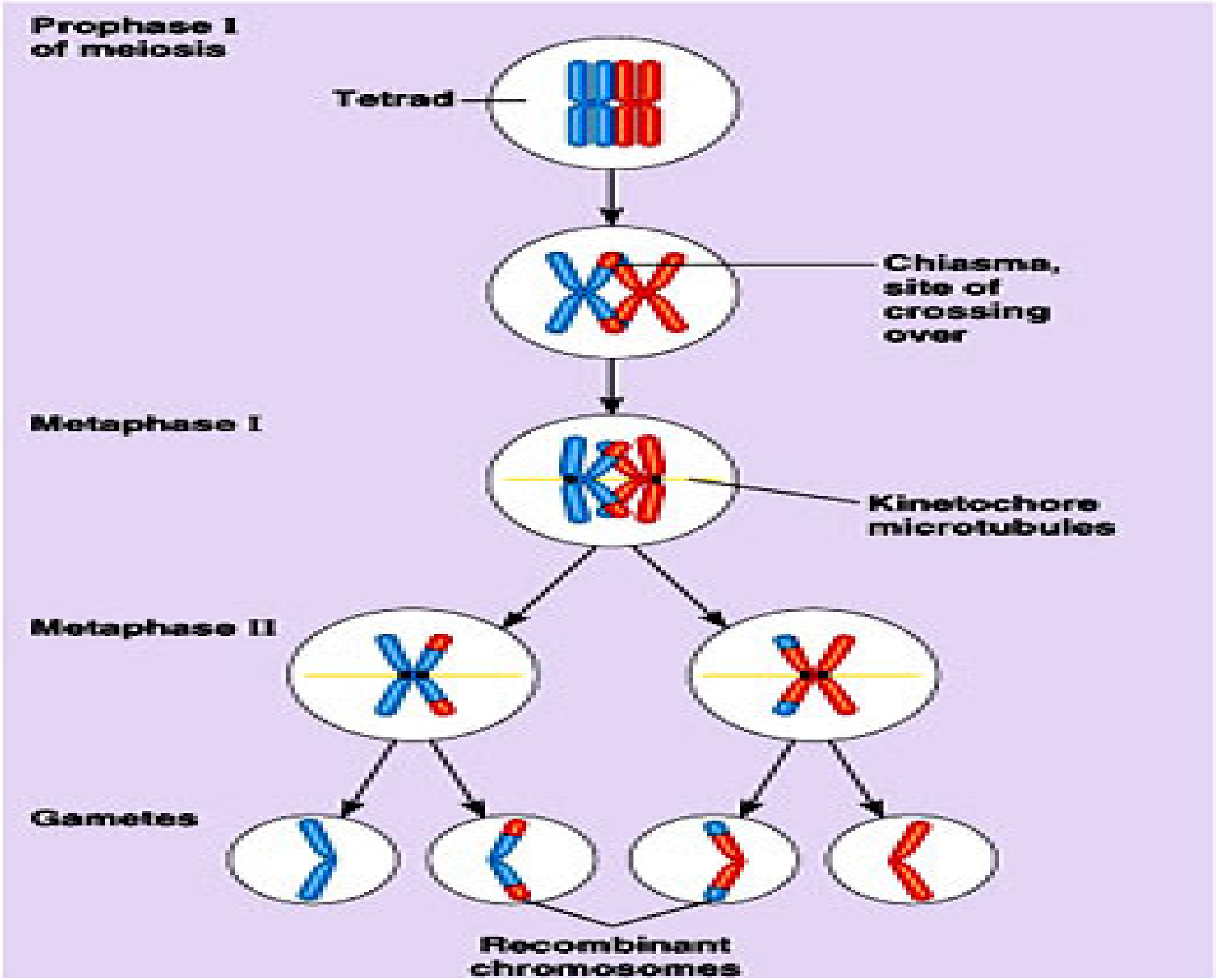
Crossing- Over



Steps of Crossing- over

- **Synapsis of homologous chromosomes – Zygotene**
- **Tetrad formation- Pachytene**
- **Crossing over- Pachytene**
- **Disjunction**


Synapsis: Pairing of homologous chromosomes
Paternal
Maternal
Crossing over


Prophase I
of meiosis
Tetrad
Chiasma,
site of
crossing
over
Metaphase I
Kinetochore
microtubules
Metaphase II
Gametes
Recombinant
chromosomes

FACTORS AFFECTING CROSS OVER

1. Temrperature
2. X-Rays
3. Chemicals
4. Age
5. Interference
6. Sex

Significance of Crossing-over

- Produces new combinations of traits.
- Forms raw material for evolution.
- Establishes concept of linear arrangement of genes.
- Helps to determine loci of genes in the chromosomes.