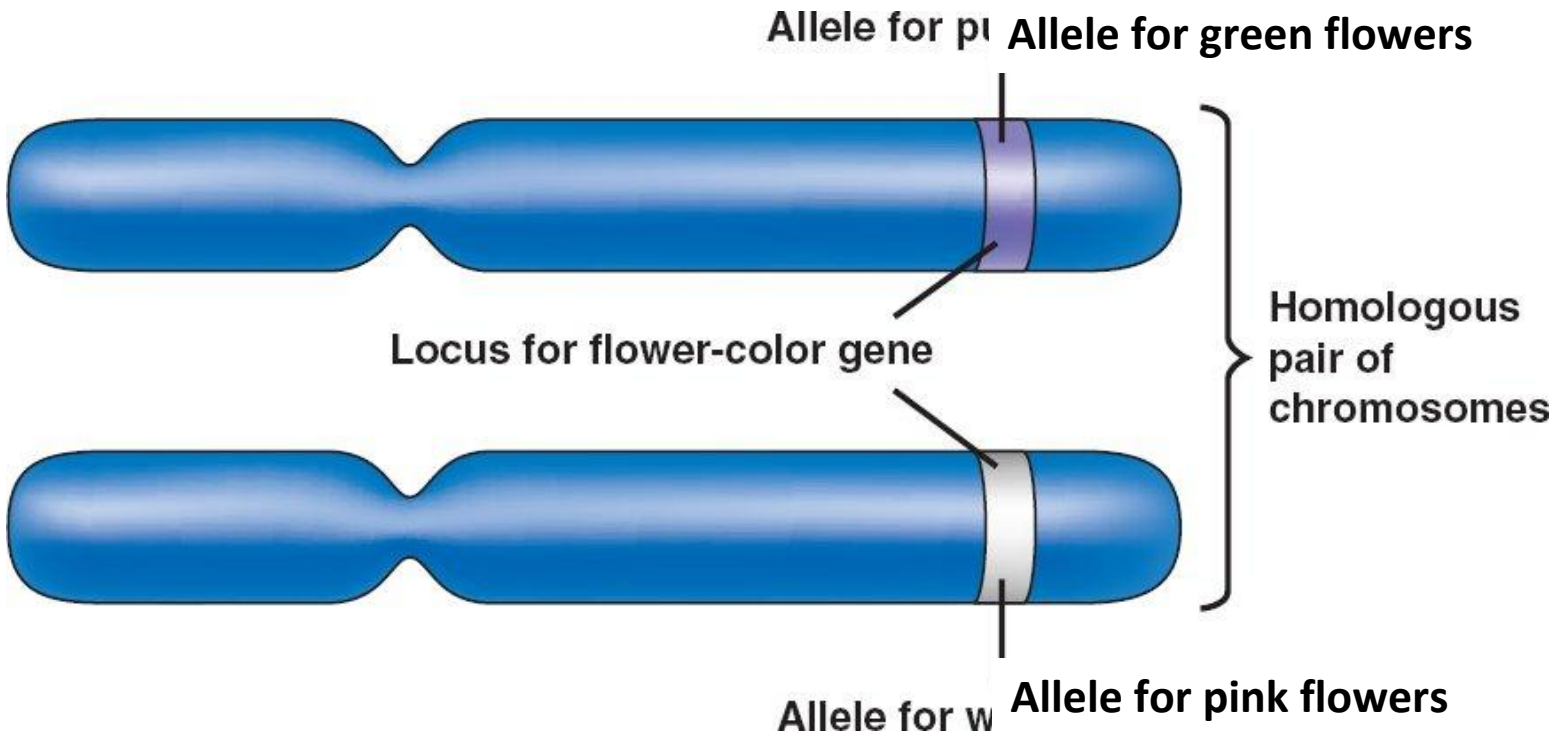
Genetics & Biotechnology

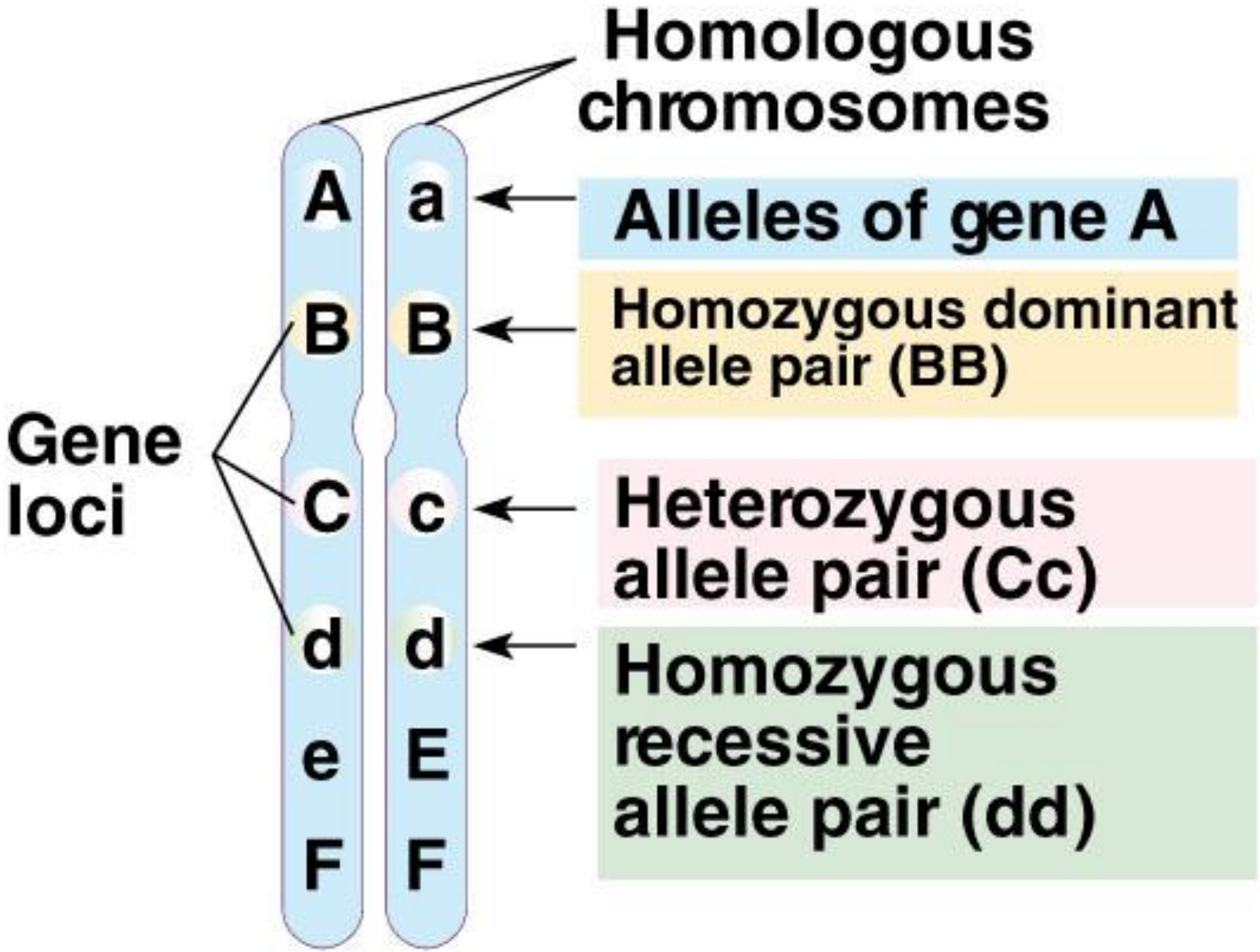
Unit 5

Vocabulary

- **Characteristic-** A quality that an organism can pass on to its offspring through its genes.
- **Clone-** An organism that is genetically identical to the organism from which it was produced
- **Codominant alleles-** Pairs of alleles that both affect the phenotype when present in a heterozygote
- **Dihybrid-** Cross involving two traits
- **Dominant allele-** An allele whose trait always shows up in the organism when the allele is present.
- **F1 generation-** The first generation of offspring obtained from an experimental cross of two organisms. offspring of P generation.
- **Genotype-** An organism's genetic makeup, or allele combinations.
- **Heterozygous-** An organism that has two different alleles for a trait
- **Homozygous-** An organism that has two identical alleles for a trait
- **Hybrids-** The offspring that result from mating between different species
- **Incomplete dominance-** A pattern of inheritance in which two alleles, inherited from the parents, are neither dominant nor recessive. The resulting offspring have a phenotype that is a blending of the parental traits.
- **Monohybrid-** A cross between individuals that involves one pair of contrasting traits
- **Offspring-** Product of reproduction, a new organism produced by one or more parents
- **P generation-** Parental generation, the first two individuals that mate in a genetic cross. Usually pure breeds.
- **Pedigree-** A diagram that shows the occurrence of a genetic trait in several generations of a family.
- **Phenotype-** An organism's physical appearance, or visible traits.
- **Polygenic-** Trait controlled by two or more genes
- **Punnett Square-** Diagram showing the gene combinations that might result from a genetic cross
- **Purebred-** An organism that always produces offspring with the same form of a trait as the parent.
- **Ratio-** A comparison of two quantities by division
- **Recessive allele-** An allele whose phenotypic effect is not observed in a heterozygote.
- **Sex-linked-** Gene located on a sex chromosome

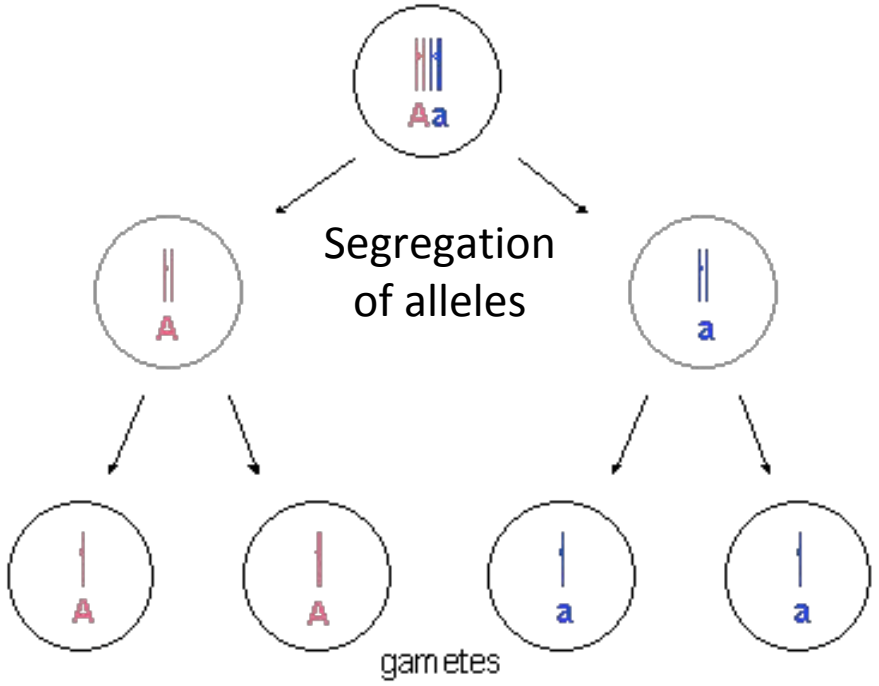


Alleles differ from one another by a few differences in DNA base sequence

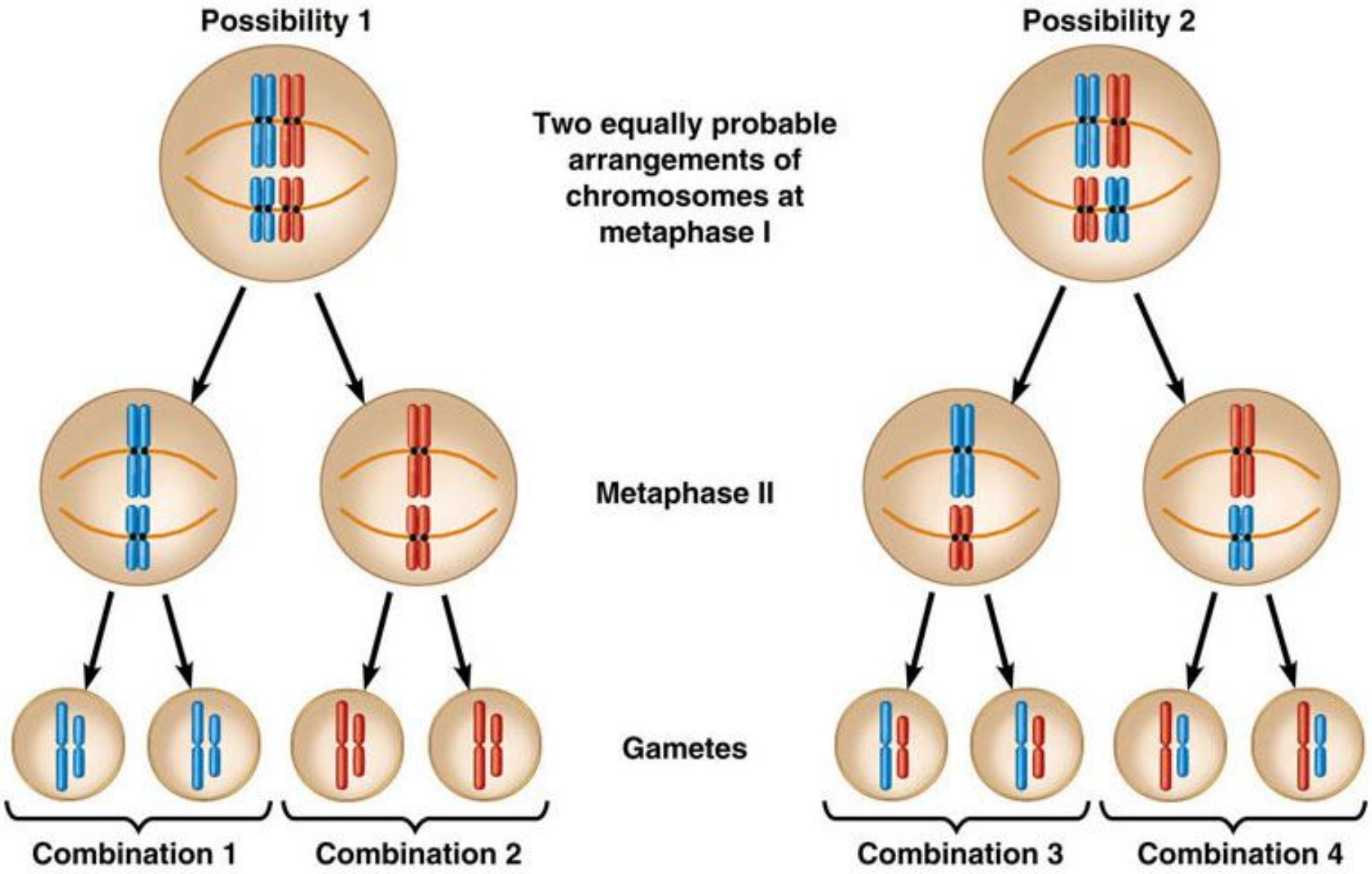

Homologous chromosomes
A
a
Alleles of gene A
B
B
Homozygous dominant allele pair (BB)
Gene loci
C
c
Heterozygous allele pair (Cc)
d
d
Homozygous recessive allele pair (dd)
e
E
F
F

Segregation

- Alleles (forms of the gene) are separated during meiosis so each gamete has only one form of the gene.
- Each parent gives one allele so the offspring has two alleles for each trait



Independent Assortment



Punnett Square & Simple Dominance

- Punnett squares are to make predictions about offspring; only **probability** of outcomes, not actual outcomes

Bb X Bb

	B	**b**
B	**BB**	**Bb**
b	**Bb**	**bb**

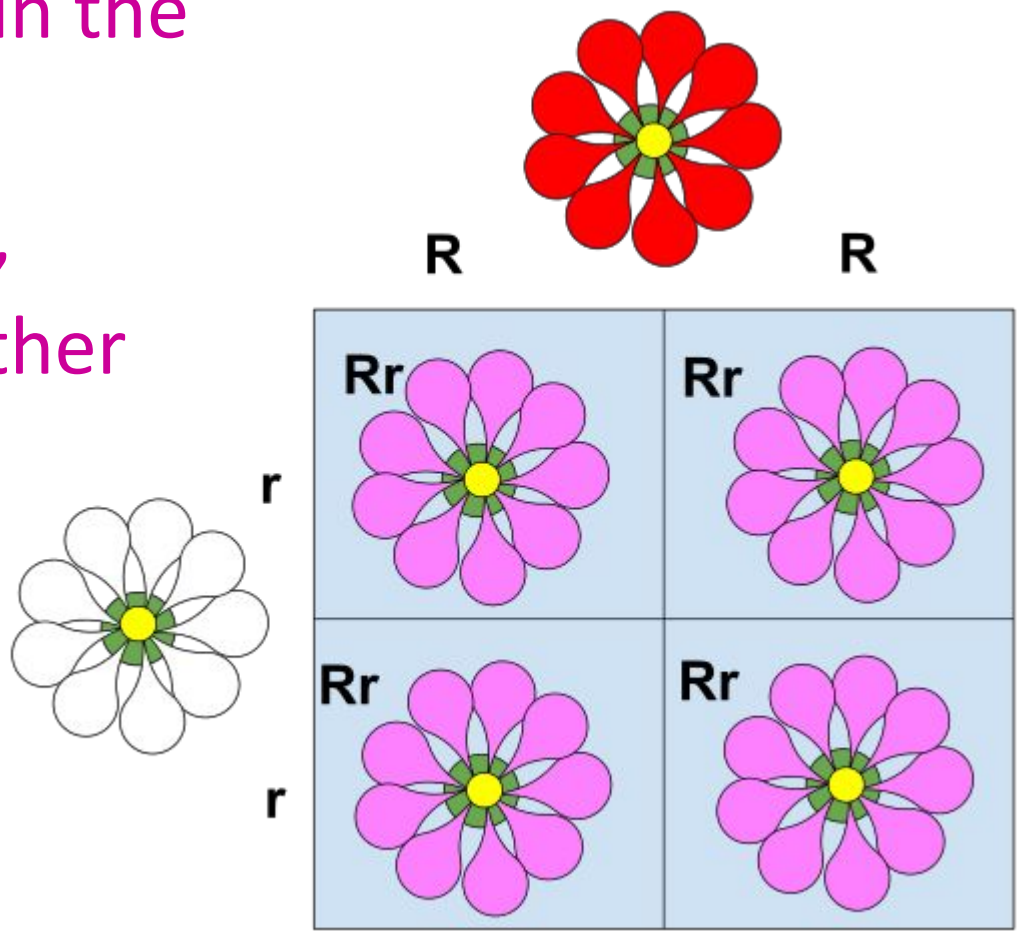
3 : 1

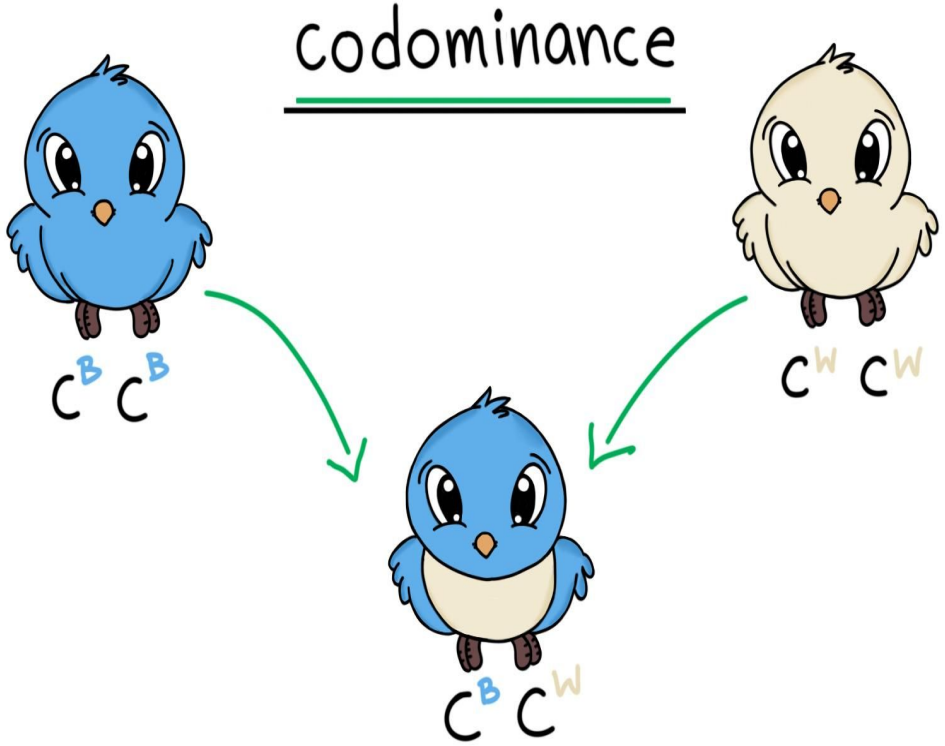
2 Factor Crosses

- Calculate and predict the phenotypic and genotypic ratio of offspring involving two unlinked autosomal genes.
- AaBB x aaBb
  - P- 1:1
  - G- 1:1:1:1
- AaBb x AaBb
  - P- 9:3:3:1
  - G- 1:2:2:4:1:2:1:2:1

Incomplete Dominance

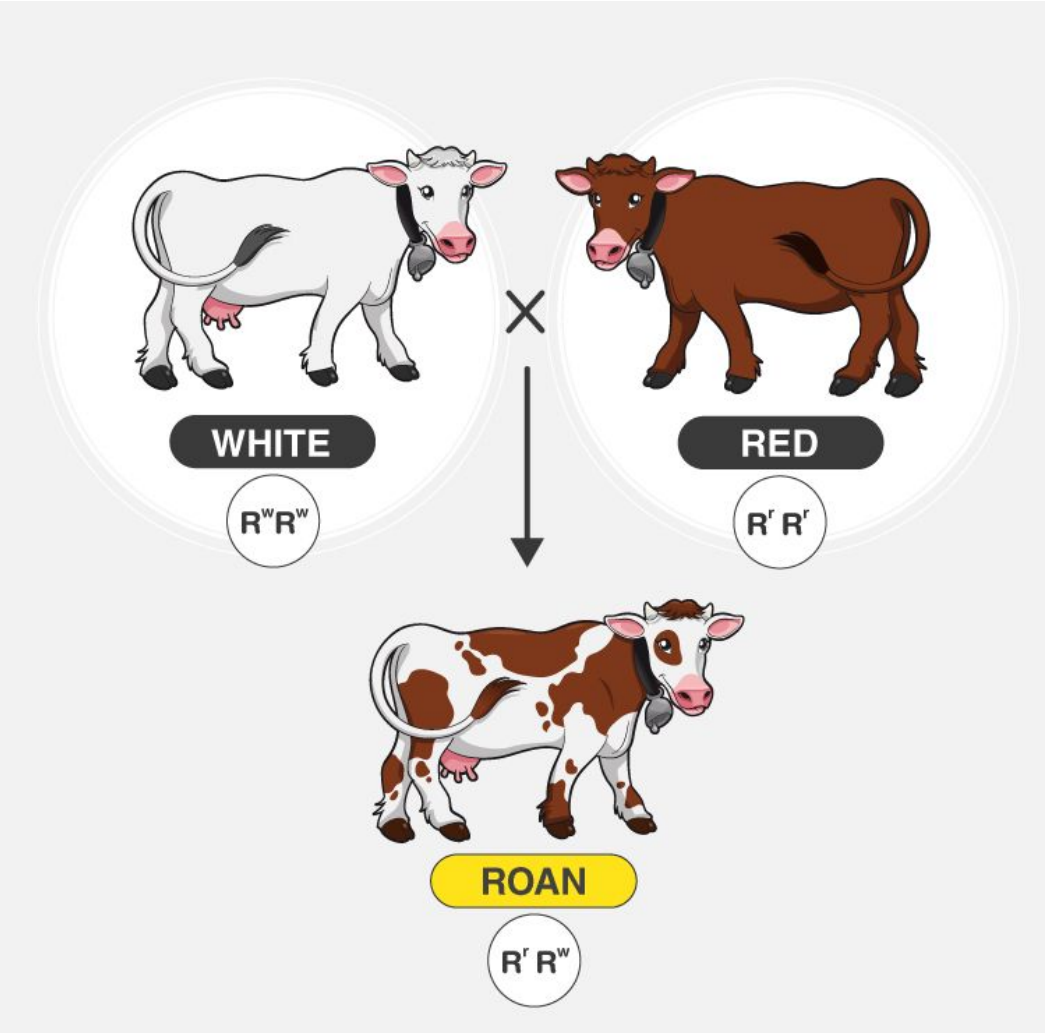
Both alleles for a trait are present in the phenotype as a blend.
An example is two alleles for color, red and white, when present together produce pink colored offspring.





Both alleles for a trait are expressed in the phenotype individually.

An example would be two alleles for color, red and white, when present together produce offspring with BOTH red and white.



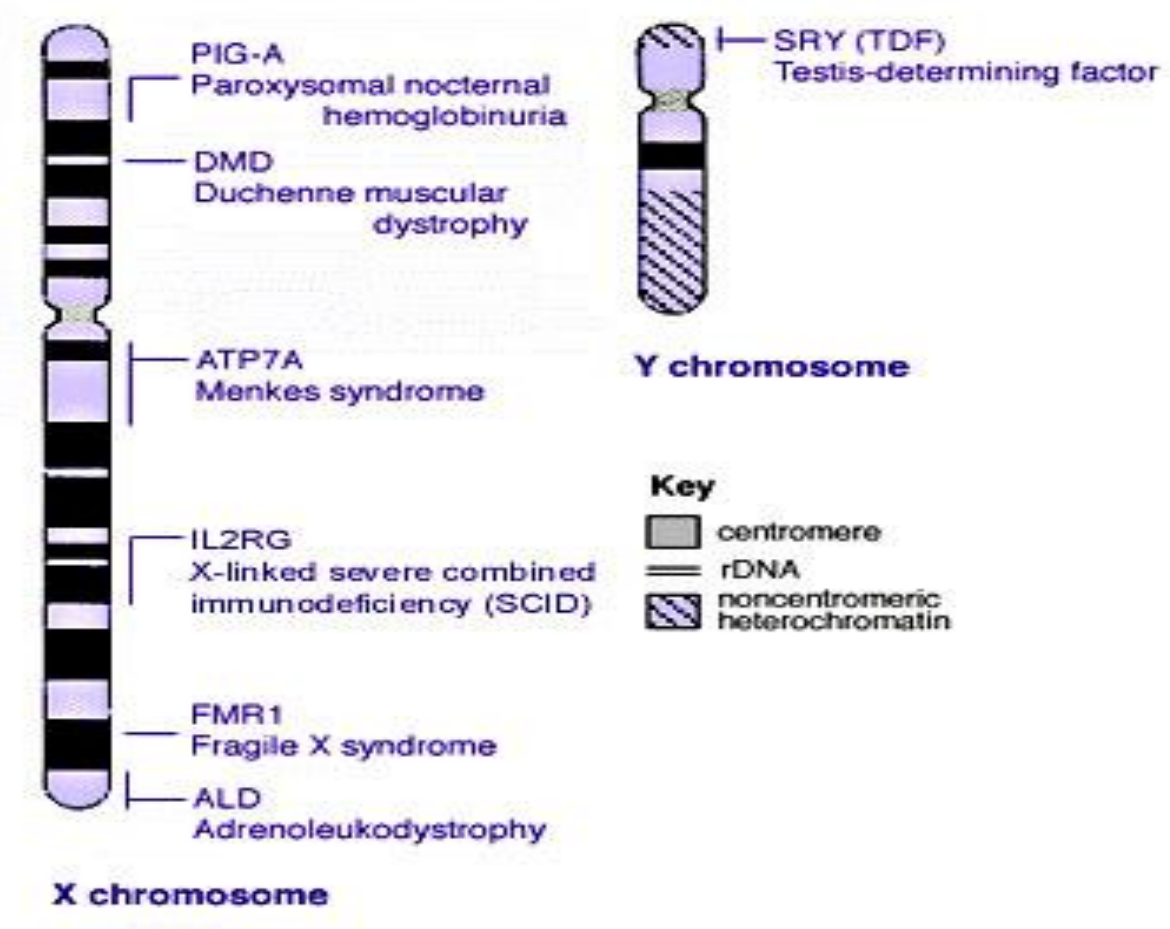
Codominance and Multiple Alleles

- Typically, there are two alleles for a trait. There are occasions in which there are more than two or multiple alleles.
- I^A and I^B blood types are codominant alleles. This means both alleles in the pair are present in a heterozygote. An individual with both I^A and I^B expresses blood type AB.
- If there are more than 2 alleles of a gene, they are called multiple alleles. ABO blood groups have a third allele: i
- I^A and I^B are codominant to one another, but dominant to i

Genotype	Blood Type
I^A i	A
I^A I^A	A
I^B I^B	B
I^B i	B
I^A I^B	AB
i i	O

Sex Linkage

- Sex linkage is a gene located on the X chromosome and usually associated with the individual's sex.
- If a gene is carried on the X chromosome, the pattern of inheritance is different in males and females. These genes are absent from the Y.
- Females may be homozygous or heterozygous (carriers) for sex linked traits as they have two X chromosomes. Males only have one X chromosome, so they express the trait if it is present on the X even if it is recessive.
- Hemophilia (X^h) and red-green color blindness (X^b) are examples.



Practice

- B is normal vision and b is color blindness.
- X^BX^b is a carrier female for color blindness. She marries a man that is color blind X^bY. What percent of children will be color blind?
    - 50%
- What percent will be carriers?
    - 25%

Practice

- H is normal and h is hemophilia
- A homozygous normal female has a child from a male that has hemophilia. What is the chance that the child will be afflicted?
    - 0%
- Be a carrier?
    - 50%

Polygenic Inheritance

- Characteristics influenced by two or more genes.
- Many traits are *discrete* or set such as blood type, but some show *continuous* variation as they change over time due to other genes' influence.
  - Skin color is determined by multiple genes that affect the pigment intensity. There are no fixed categories due to the variety of shades.
  - Wheat color varies from white to dark red and is determined by three genes.
  - Height is continuous as it changes as you grow and is not set. Also may be influenced by nutrition and environment.

Pedigrees are to trace genetic traits back multiple generations

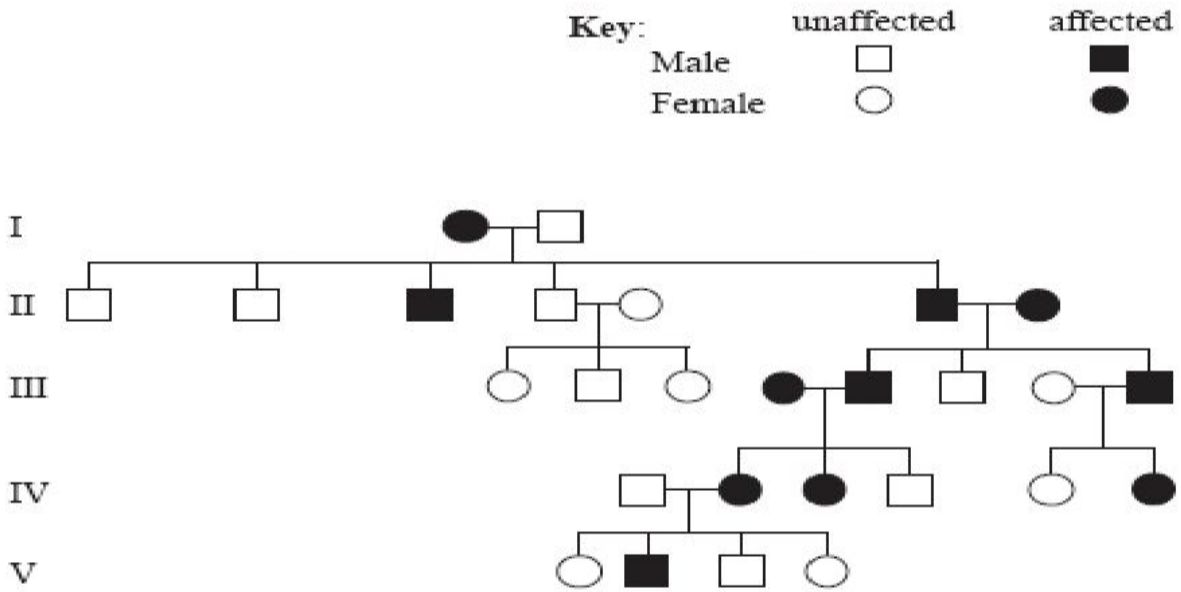
If neither parent has a condition, but a child does, the condition is caused by a recessive allele.

If both parents have a condition, but no children do, the condition is caused by a dominant allele.

If one sex (typically males) is greatly more affected then it is likely a sex-linked trait.

Practice

The pedigree chart below shows the inheritance of a genetic disease in a family. What is the nature of the allele that causes this disease?



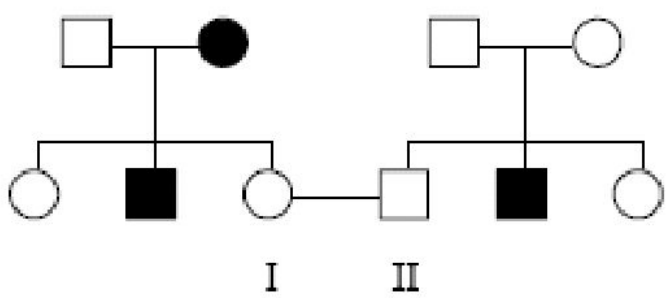
A. Dominant and sex linked

B. Dominant and non-sex linked

C. Recessive and sex linked

D. Recessive and non-sex linked

The pedigree chart below shows the inheritance of Daltonism in a family. Daltonism (red-green colour blindness) is sex linked. The allele for Daltonism is recessive to normal colour vision.



Key:

- □ Unaffected male
- ■ Affected male
- ○ Unaffected female
- ● Affected female

Persons I and II have a child. What is the chance that the child will be colour blind?

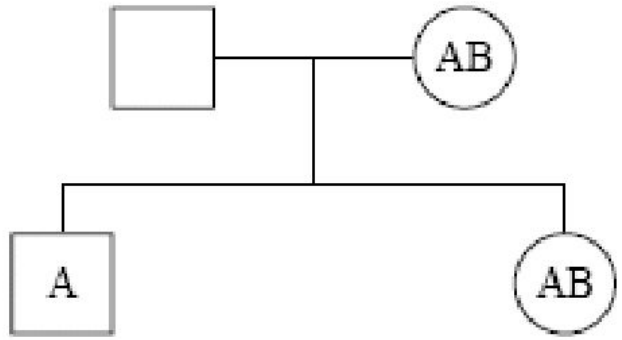
A. 0 %

B. 25 %

C. 75 %

D. 100 %

The pedigree chart below shows the blood groups of two children and their mother. What could be the blood group of the father?



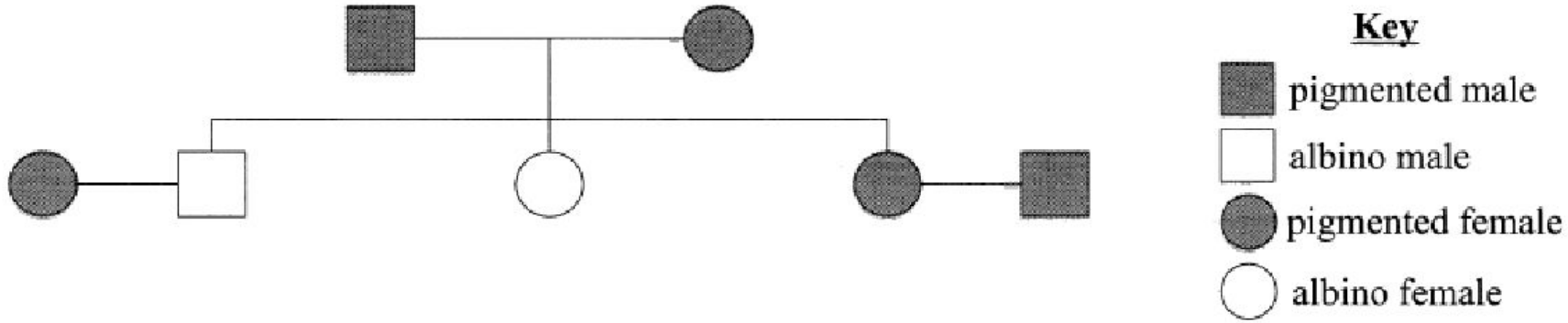
A. A only

B. A or B only

C. A, B or AB only

D. A, B, AB or O

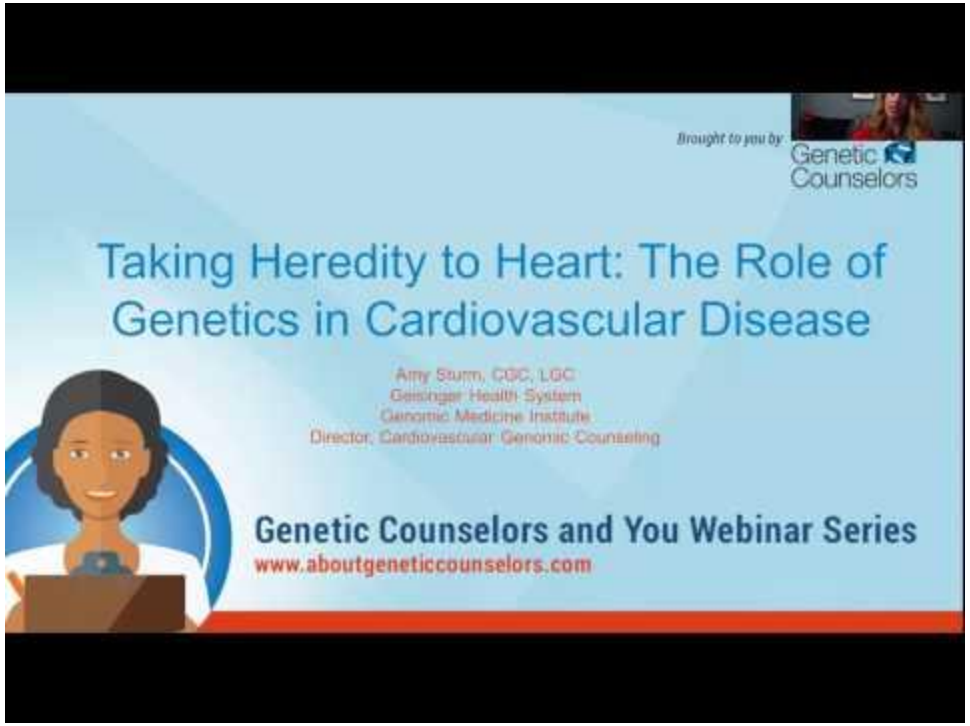
The pedigree chart below shows a family in which two albino children were born. Albino children cannot make the pigment melanin and so have unpigmented skin, hair and eyes. Albinism is not sex-linked.



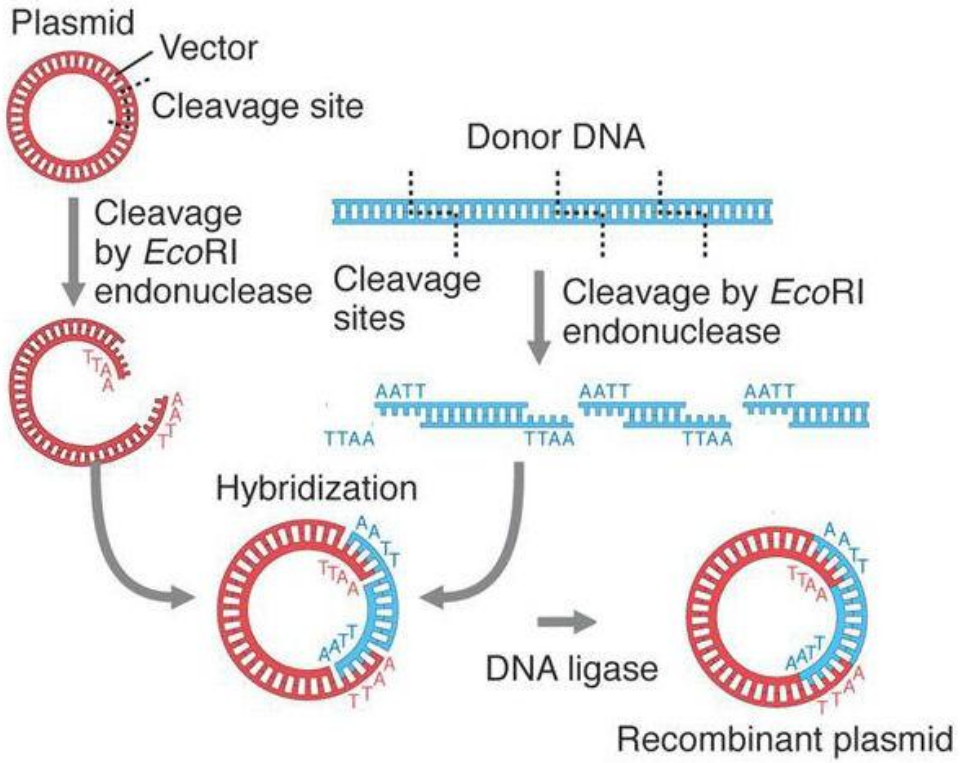
The albino son and the pigmented daughter both married members of other families in which albinism has never been found. What is the chance of their first child being albino?

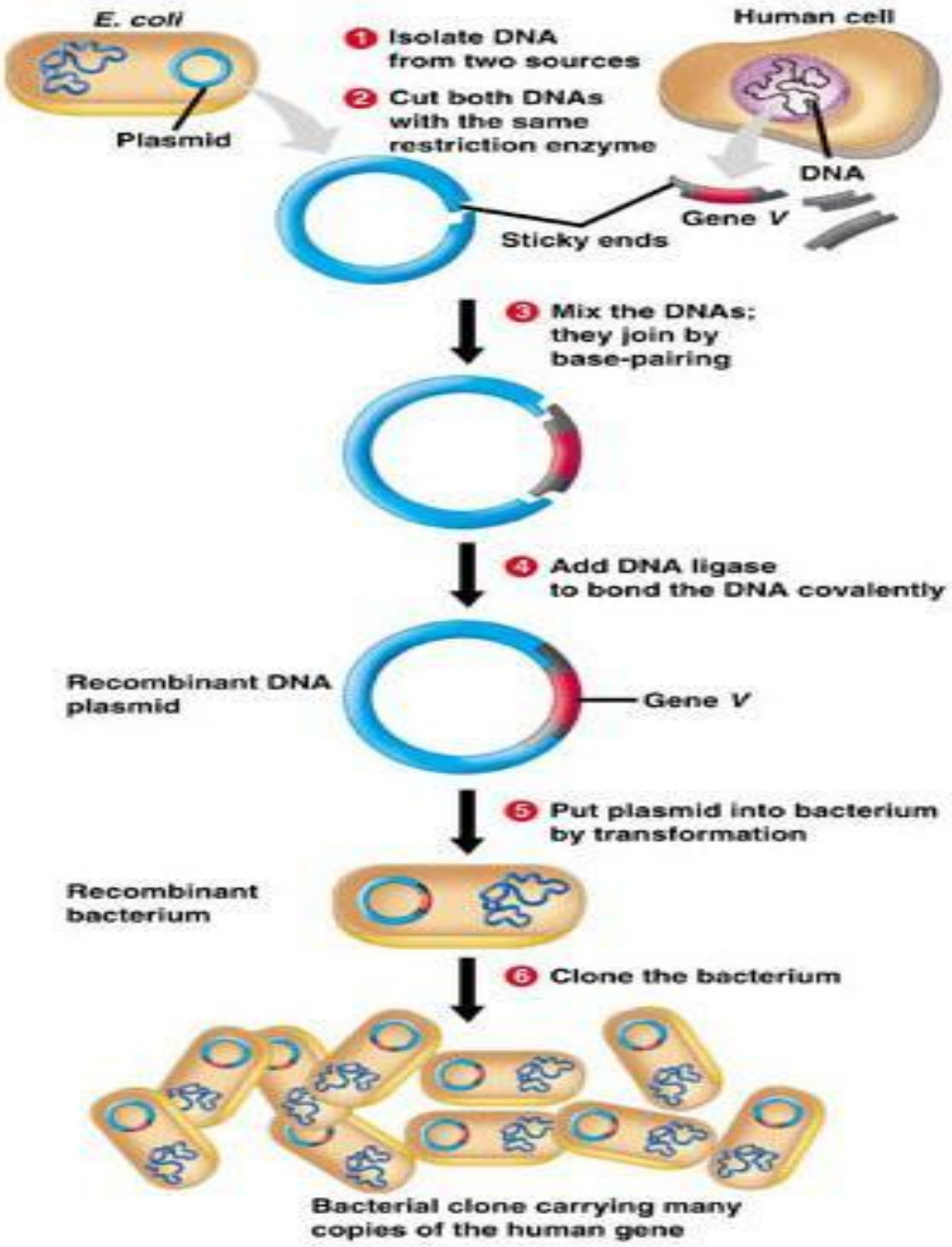
	Chance of the son's first child being albino	Chance of the daughter's first child being albino
A.	0 %	0 %
B.	25 %	0 %
C.	50 %	50 %
D.	100 %	25 %

Heredity and Heart Disease (1 hr. long!)

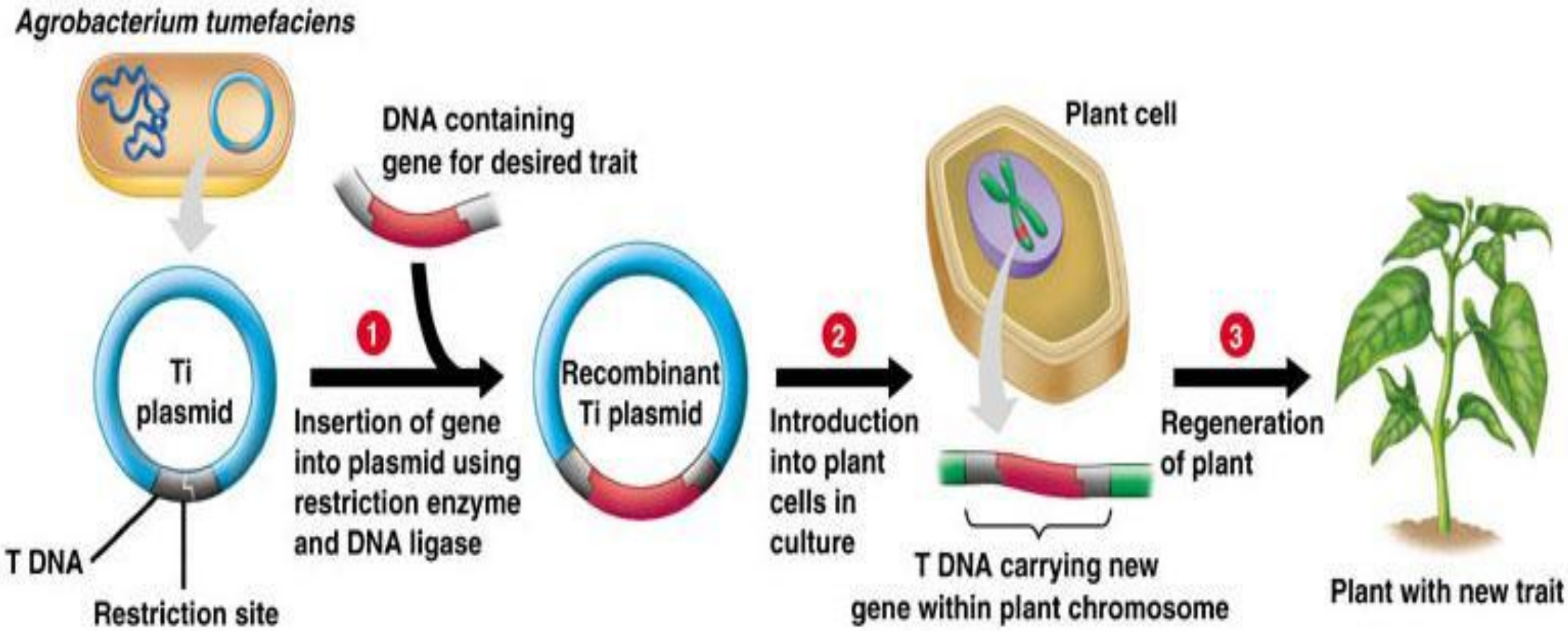


Biotechnology





Biotechnology



Medical products made from rDNA tech

Product	year	treatment
Human insulin	1982	diabetes
somatotropin	1985	Pituitary dwarfism
Hepatitis B vaccine	1986	Immunization for hepatitis B virus
Erythropoietin	1988	anemia
Interleukin-2	1989	Cancer of kidney
Whooping cough vaccine	1989	Immunization for Whooping cough
Factor VIII	1993	hemophilia

Health Benefits & Risks of Biotechnology

Health Benefits

- Increased nutritional value
- Natural allergens and toxins can be removed
- Possibility of putting vaccines in crops

Health Risks

- Protein inserted could cause allergic reaction or be toxic
- Antibiotic resistance genes used as markers could spread to bacteria and they would be resistant
- Mutation of genes could cause unexpected problems

Environmental Benefits & Risks of Biotechnology

Environmental Benefits

- Less insecticide used if a gene to make the toxin can be transferred to the plants
- Less fuel used by machinery due to reduced need for plowing and spraying
- Improved shelf life of fruit and vegetables

Environmental Risks

- Non-target organisms could be affected
- Herbicide resistant plants could spread pollen to other crops making them also resistant
- Decreased biodiversity