Concept of Gene
(Multiple Alleles)

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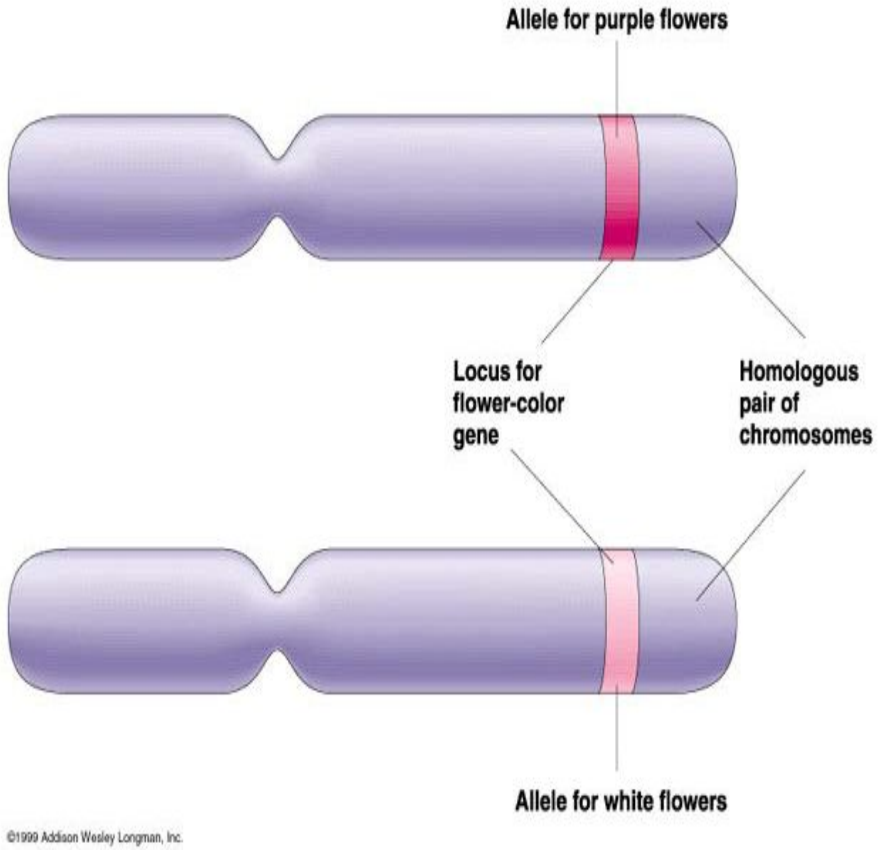
Multiple Alleles

- Multiple alleles can be defined as series of forms of a gene situated at the same locus of homologous chromosomes affecting same character.
- Multiple alleles are different forms of the same gene that is the sequence of the bases is slightly different in the genes located on the same place of the chromosome (As shown in the figure).
- Each individual will only have two alleles for a trait but there are several alleles to choose from.
- The number of possible genotypes in a series of multiple alleles is ½ n (n+1), n = no of alleles



Important Features of Multiple Alleles

1) Multiple alleles always belong to the same locus and one allele is present at a locus at a time in a chromosome.

2) Multiple alleles always control the same character of an individual.

3) Wild type allele is dominant over other alleles.

4) There is no crossing over in the multiple alleles.

5) In a series of multiple alleles wild type is always dominant.

6) When two mutant types are crossed wild form cannot be recovered.

7) The cross between two mutant alleles will always produce mutant phenotype.

Example 1: Skin colour in rabbit

In rabbits, four kinds of skin colour are known

- ★ CC, Cc^{ch}, Cc^{h}, Cc - Agouti (wild type),dominant over all others
- ★ c^{ch}, c^{ch}, $c^{ch}c^{h}$, $c^{ch}c$ - Chinchilla (salivary grey hair), dominant over himalayan and albino
- ★ $c^{h}\,c^{h}$, $c^{h}\,c$ - Himalayan (white except black feet nose ear tail), dominant over albino
- ★ cc - Albino (complete white), recessive to all others.

Possible genotypes	CC, Cc^{ch}, Cc^{h}, Cc	$c^{ch}c^{ch}$	$c^{ch}c^{h}$, $c^{ch}c$	$c^{h}c^{h}$, $c^{h}c$	cc
Phenotype	Dark gray	Chinchilla	Light gray	Himalayan	Albino

Example 2: ABO Blood Group in Man

- ❖ Bernstein (1924) found that the blood group antigens are controlled by an autosomal gene designated I (isohemagglutinin) which has 3 alleles I^A, I^B and I^O.
- ❖ Allele I^A produces type A blood and is dominant over the allele I^O. An A type individual can have the genotype I^AI^A or I^AI^O.
- ❖ Allele I^B produces blood group B, and is dominant over the allele I^O. An individual with blood group B may be homozygous I^BI^B or heterozygous I^BI^O.
- ❖ AB type persons have the genotype I^AI^B where both alleles are codominant and equally expressed.
- ❖ Allele I^O in the homozygous state (I^OI^O) produces type O blood.

Blood Type	Genotype		Can Receive Blood From:
A	$i^A i$ $i^A i^A$	AA AO	A or O
B	$i^B i$ $i^B i^B$	BB BO	B or O
AB	$i^A i^B$	AB	A, B, AB, O
O	$i\,i$	OO	O

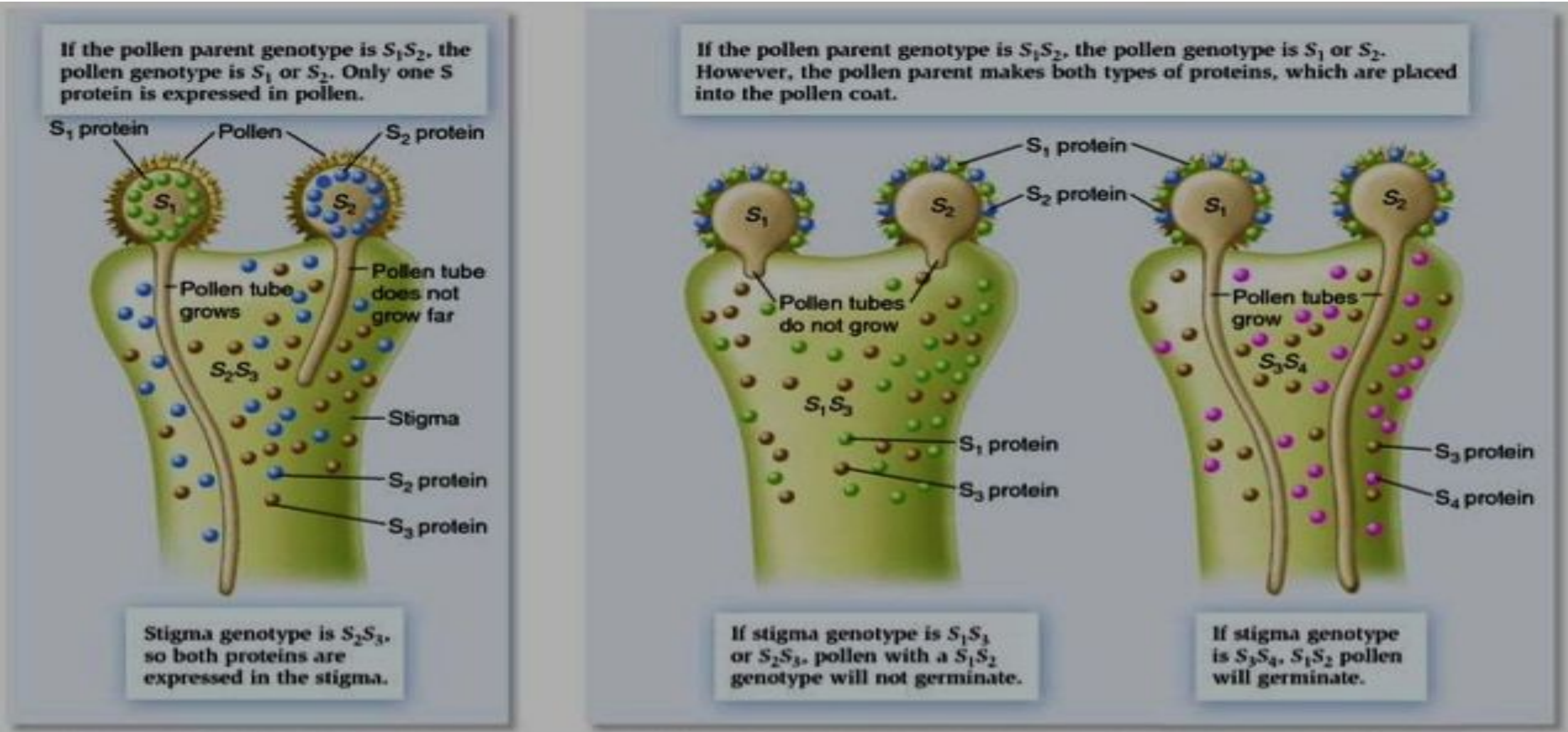
Example 3: Self Incompatibility Alleles in Plants

- ➢ Bisexual plants produce functional male and female gametes, yet self pollination does not lead to fertilisation and there is no seed setting.
- ➢ The pollen grains may fail to germinate on the stigma; or, even if pollen tubes are formed their growth may be inhibited. Such a condition where pollen grains fail to fertilise ovules of the same plant is known as self-incompatibility or self sterility.
- ➢ Nicotiana (tobacco) was one of the first plants in which self-sterility was noticed (explained in next slide)

Female parent (Stigma spot)	**Male parent (Pollen source)**		
	S_1S_2	S_2S_3	S_3S_4
S_1S_2	Self Sterile	S_3S_2 S_3S_1	S_3S_1 S_3S_2 S_4S_1 S_4S_2
S_2S_3	S_1S_2 S_1S_3	Self Sterile	S_4S_2 S_4S_3
S_3S_4	S_1S_3 S_1S_4 S_2S_3 S_2S_4	S_2S_3 S_2S_4	Self Sterile

Table: 3.5. Different combinations of progeny in self-incompatibility

Self Incompatibility Alleles in Plants



(a) Gametophytic SI: If pollen *S* allele does not match either stigma allele, pollen will germinate.

(b) Sporophytic SI: If pollen coat S proteins do not match either stigma S protein, pollen tubes will grow.

Multiple Allele with Complex Loci

- ➢ Earlier concept of genetic recombination- crossing over between genes, not within a gene, based on breakage and exchange of segments of paired homologous chromosomes, resulting in new linear arrangements of genes.
- ➢ Oliver(1942) showed that in the case of lozenge eye alleles in Drosophila, crossing over would occur between alleles present in the same locus predicting gene to be divisible.
- ➢ They could produce recombinant progeny in test crosses, due to crossing over between two mutant sites in a locus. It became doubtful that they were true alleles, thus such alleles were named pseudoalleles (contd).

Multiple Allele with Complex Loci (contd.)

- Thus, a gene is a sequence of nucleotides in DNA that control a specific gene product.
- The different mutations of the gene may be due to changes in single nucleotides at more than one locations in the gene.
- Crossing over could take place between the altered nucleotides within a gene. Since the mutant nucleotides are placed so close together, crossing over is expected with a very low frequency.
- When several different genes which affect the same trait are present so close that crossing over is rare between them, the term complex locus is applied to them.
- The term multiple alleles can also be redefined as - Within the nucleotide sequence of DNA that represents a gene, multiple alleles are due to mutations at different points within the gene.

Thank you