D II / Hons (Zoology) Paper III rd Gr-B.

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MULTIPLE ALLELE

Blood Groups in Man: Several genes in man produce multiple allelic series which affect an interesting and important physiological characters of human red blood cells (RBC). The red blood cells have special antigen properties by which they respond to certain specific antibodies of the blood Serum. The antigen-antibody relationship is one of the great specificity like that between lock and key. Each antigen and its associated antibody has a peculiar chemical Configuration. Landsteiner discovered in 1900 that when a red blood cell of one person are transfused in blood serum of another person, the RBC cells become clumped or agglutinated.

If blood transfusions were made between persons of two such incompatible blood groups, the transfused cells were likely to clump and shut out the cappilaries in the recipient, some times resulting in death.

However, such rxns occured only when the cells of certain individuals were placed in serum from certain other persons. It was found that all persons could be classified into four groups with regard to antigen properties of RBC. The blood groups are designated as A, B, AB and O. The persons belonging to blood group A have antigen A in their RBC and antibody b (anti-b) in the Plasma. Persons have blood group B have antigen B and in their RBC and antibody a (anti-a) in their plasma. Persons of group AB have antigen A and B in their RBC but no antibodies in their plasma. Persons of group O have no antigens in RBC and both a & b antibodies in their Plasma.

So, the RBC from individuals of blood group O are not clumped by the serum of any blood group because they lacks the antigens.

Blood groups, their antigens & antibodies in Man

Blood groups	Antigen present in RBC	Antibody present in Plasma
A	A	anti-B or b or β
B	B	anti A or a or α
AB	A and B	NO.
O	NO	anti A & anti B or a & b or α & β

The evidences shows that these blood properties are determined by a series of 3 allelic genes I^A, I^B and i as follows

Blood group	Genotype
AB	$I^A I^B$
B	$I^B I^B$ or $I^B i$
A	$I^A I^A$ or $I^A i$
O	ii

The alleles of these genes which affect a variety of biochemical properties of the blood, act in such a way that in a heterozygous compound $I^A I^B$, each allele exhibits its own characteristics & effect. The cells of heterozygot contains both antigens A & B. On the other hand I^A and I^B both show complete dominance over i, which lacks both antigens.

Parents		Children	
Phenotype	Genotype	Phenotype	Genotype
O × O	ii × ii	O	ii
O × A	ii × $I^A I^A$ or $I^A i$	O, A	ii, $I^A i$
O × B	ii × $I^B I^B$ or $I^B i$	O, B	ii, $I^B i$
O × AB	ii × $I^A I^B$	A, B	$I^A i$, $I^B i$
A × A	$I^A I^A$ or $I^A i$ × $I^A I^A$ or $I^A i$	A, O	$I^A I^A$, ii.
A × B	$I^A I^A$ or $I^A i$ × $I^B I^B$ or $I^B i$	A, AB, B, O	$I^A i$, $I^A I^B$, $I^B i$, ii.
A × AB	$I^A I^A$ or $I^A i$ × $I^A I^B$	A, B, AB	$I^A I^A$, $I^B I^B$, $I^A I^B$
B × B	$I^B I^B$ or $I^B i$ × $I^B I^B$ or $I^B i$	B, O	$I^B I^B$, ii.
B × AB	$I^B I^B$ or $I^B i$ × $I^A I^B$	A, B, AB	$I^A I^A$, $I^B I^B$, $I^A I^B$.
AB × AB	$I^A I^B$ × $I^A I^B$	A, B, AB	$I^A I^A$, $I^B I^B$, $I^A I^B$.

Table showing possible blood group types of children from Parents of various blood groups

The 'Rhesus' Blood Group in Man

A very interesting series of alleles affecting the antigens of human blood has been discovered through the work of Wiener, Landsteiner, Race, Levine, Sanger, Mourant & several others. The original discovery was that the RBC are agglutinated by a serum prepared by immunizing rabbit against the blood of Rhesus monkey. The antigen responsible for this reaction was consequently called as Rh factor and the gene that causes this property was denoted as R-r or Rh or rh.

Levine studied a characteristic form of anaemia occasionally in new born infants and known as Erythroblastosis foetalis. It was found that the infants suffering from this anaemia are usually Rh+ and so are their fathers, but their mothers are Rh negative. & The Rh+ foetus developing in uterus of Rh⁻ mother causes the formation of mother's blood stream of ~~Rh⁻~~ anti Rh antibodies

These antibodies, specially as a result of a succession of several Rh+ pregnancies, gain sufficient strength in the mother's blood so that they may attack the RBC of the foetus. The reaction between these antibodies of mother and RBC of her unborn child provokes haemolysis & anaemia & it may cause of death of newborn infant or abortion.

Thus an Rh⁻ woman immunized during pregnancy by the Rh+ children may have in her blood stream antibody that agglutinate not only Rh+ RBC but also cells from a normal Persons known to be Rh⁻.

Rhogam Method of Preventing Erythroblastosis Foetalis

The Rh⁻ mother is given special blood test after delivery of her Rh+ child. If foetal Rh+ cells are present in mother blood she is given injections Rhogam.

Pleiotropism - The opposite of Polygene effect is known as pleiotropism i.e. a single gene influences or govern many characters. For Ex - gene for vestigial wing of Drosophila influences the nature of halteres.

Theories of Allelism:—

Various theories have been given to explain the nature of allelism & its origin

① **Theory of Point Mutation**: According to this theory multiple alleles have developed as a result of mutations occurring at same locus but in different directions. Hence, all the different wings lingth of Drosophila necessarily the result of mutations which have occured at same loxy normal wing locus in different directions.

② **Theory of close linkage or Positional Pseudoallelism**:- According to this view the multiple alleles are not the gene mutations at same locus but they occupy different loci closely situated in the chromosome. These genes closely linked at different loci and said Pseudoalleles and affect the expression of the normal gene i.e. Position effect.

③ **Heterochromatin Theory of Allelism**: occasionally heterochromatin becomes associated with the genes as a result of chromosomal breakage & rearrangement. These heterochromatin particles suppress the nature of genes due to Position effect.

In Drosophila, the apricot might be a partially suppressed red and white completely suppressed red which apricot and white hybrid may give rise to red or intermediate by Unequal crossing over.

Importance of Multiple Allelism: It has increased our Knowledge of heredity. According to T. H. Morgan a great Knowledge has come from multiple alleles. These alleles suggest that a gene can mutate in different ways causing different effects. Multiple allelism also put forward the idea that different amounts of heterochromatin prevent the genes to different degree or space.

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