Life Sciences

GENETICS

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A. GENETIC TERMS

Definition of genetic terms

* **Variation**: differences between individuals within a population. These differences may be due to environment (e.g. nutrition, soil type) or heredity. Evolution is concerned only with genetic or heritable variations

* **Gene**: a short piece of DNA containing a particular nucleotide sequence carrying a specific trait e.g. tallness.

* **Locus**: the particular position occupied by a gene on a chromosome.

* **Allele**: alleles are alternate forms of a gene localised on the same locus on homologous chromosomes.

* **Mutation**: a change in the nucleotide sequence of a gene, resulting in a new allele.

* **Diploid**: cells contain a complete set of genetic material (2n). Chromosomes appear as homologous pairs. This means a diploid cell may have two different alleles for a single characteristic.

* **Haploid:** cells contain half a set of genetic material (n) in each nucleus. Chromosomes are unpaired. Only one allele is present for each characteristic.

* **Gene pool**: the total collection of genes making up all the individuals in a population (i.e. every gene of every member of the population).

* **Genotype**: the genetic makeup of an individual.

* **Phenotype**: the physical appearance, behaviour and physiology of an individual due to the expression of genes. (i.e. phenotype is determined by the genotype)

* **Dominant allele**: an allele that is always expressed in the phenotype.

* **Recessive allele**: an allele that is expressed in the phenotype if not accompanied by a dominant allele.

* **Homozygous/Pure breeding/True breeding**: when both alleles controlling a particular trait in an individual are the same.

* **Heterozygous/Hybrid**: when the two alleles for a particular trait in an individual are different.

* **Mendel's Laws:**
  Law of Segregation: states that, for each characteristic, a plant possesses "two factors" (genes) which separate or segregate so that each gamete contains only one of these factors.
  Law of Dominance: states that when two individuals with pure breeding contrasting characteristics are crossed, the individuals of the F1 generation all display the dominant characteristics.
  Law of Independent assortment: states that the various "factors" controlling the different characteristics (height, colour etc) are separate entities, not influencing each other in any way, and sorting themselves out independently during gamete formation.

Activity 1: Genetics terminology

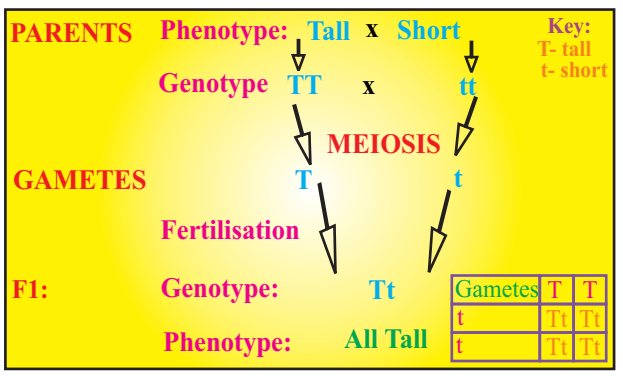
1. Complete the following information regarding cells in the human being.
   A: **Somatic cells**
   B: **Sex cells**

Cell type	Synonym	Chromosome condition	Chromosome number	Cell division by which it was formed
Somatic cells				
Sex cells				

2. How many pairs of chromosomes are present in a human somatic cell?
3. What name is given to these pairs of chromosomes?
4. How did this cell come to have this number of chromosomes?
5. Now consider a pair of homologous chromosomes.
5.1. Name the segment of a chromosome that is responsible for a particular characteristic.
5.2. How many such units are there for each characteristic in each somatic cell?
5.3. Name the above units that are found on corresponding positions on homologous chromosomes.
6. What term denotes the outward appearance of an Individual?
7. What term denotes the genetic constitution of an Individual?
8. What term denotes a gene that always expresses itself in the phenotype of an individual?
9. What term denotes a gene that does not expresses itself in the phenotype of an individual, because its influence is masked off by the dominant gene?
10. What do we call an individual that has two genes that influence a characteristic in the same way? Would the genes both be dominant or recessive?
11. What do we call an individual that has two genes that influence a characteristic in different ways? Would the genes both be dominant or recessive? Explain.
12. Consider the following two genes "Rr" which represents the shape of seeds (R=round and r= wrinkled).
12.1. Is Rr the individuals genotype or phenotype? Explain
12.2. Is the individual homozygous or heterozygous? Explain
12.3. Which gene is dominant and what shape does this Represent?
12.4. Which gene is recessive and what shape does this Represent?
12.5. Although there are two genes in the genotype, what would the phenotype be? Explain.
12.6. When the individual forms gametes by meiosis, what would the genotype of the gametes be?

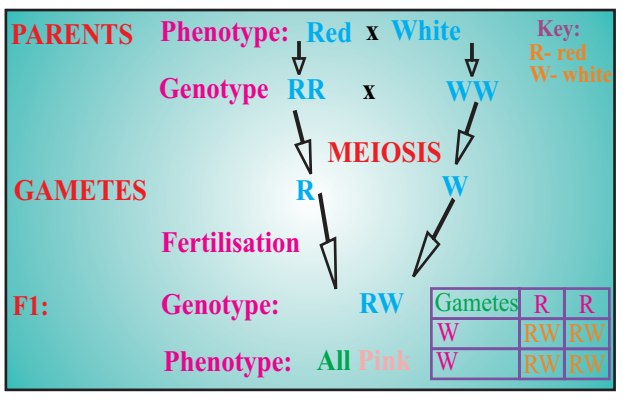
2. COMPLETE DOMINANCE

Gregor Mendel's law of Dominance states that when two individuals with pure breeding contrasting characteristics are crossed, the individuals of the F1 generation all display the dominant characteristics.



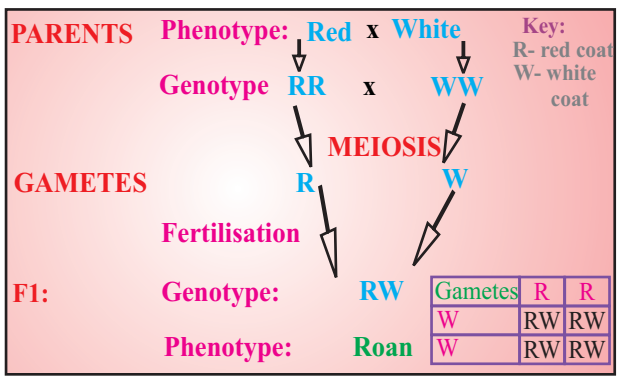
3. INCOMPLETE DOMINANCE

Sometimes contrasting alleles are equally dominant. For example the colours of some flowers such as petunias or snapdragons are incompletely dominant. If you cross red flowered plants with white flowered plants, all the F1 generation plants have pink flowers



4. CO-DOMINANCE

Codominance occurs when both alleles are equally dominant and are expressed in the phenotype of a heterozygote. The heterozygote has characteristics of both parents. For example, in certain cattle, parents with red and white coats produce calves that are roan. Coats of roan calves have both red and white hairs.



5.TEMPLATE FOR MONOHYBRID CROSSES

Note: This template should only be used by learners for first few problems, thereafter learners are requested to know the format.

Characteristic: _____

Key: _____

P1 Phenotype _____ x _____

Genotype _____ x _____

Meiosis

Gametes ___, ___, ___, ___ x ___, ___, ___, ___

Fertilisation

F1 Genotype _____

Phenotype _____

6. BLOOD INHERITANCE

In 1900, Karl Landsteiner discovered the existence of different blood groups or blood types. The ABO system he came up with is still in use today. Humans have one of four blood types: group A, group B, group AB or group O. These are the phenotypes. Blood groups are controlled by three alleles, I^A, I^B and I^O. These are genotypes. Only two of the three alleles can be present in a person, so a person may have any of the following combinations: I^AI^A, I^AI^O, I^BI^B, I^BI^O, I^AI^B, I^OI^O.

A. Possible gene combinations (genotypes) and blood groups (phenotypes) are shown in the table below.

GENE COMBINATION (GENOTYPE)	BLOOD GROUP (PHENOTYPE)
I^AI^B	AB
I^AI^A, I^AI^O	A
I^BI^B, I^BI^O	B
I^OI^O	O

Activity 2: Blood grouping problems.

From genotype I^A and I^A, show the phenotype.
From genotype I^A and I^O, show the phenotype.
What will be the F1 blood groups of the genotypes I^B and I^B

Activity 5: Prediction of blood grouping.

Two newborn babies were accidentally mixed up at the hospital. In an effort to determine the correct parents of each baby, the blood types of the babies and the parents were determined as follows:

Baby 1 type O — Baby 2 type A
Mr Dube type AB — Mrs Dube type B
Mr Danki type B — Mrs Danki type B

Determine which baby belongs to which parents and the genotypes of each person. Show all working.

7. GENETIC DISORDERS:

This is a condition that may be inherited and that results in disturbance of a person's normal body functioning. Mutations of genes or chromosomes may cause a person to have a genetic disorder. The greatest benefits of the Human Genome Project have allowed scientists to locate the genes responsible for thousands of genetic disorders. Examples of FOUR genetic disorders to be studied are: Down's syndrome, Sickle cell anaemia, Haemophilia and Albinism