TENDER HEART HIGH SCHOOL, SEC-33B, CHD

08.07.2024

CLASS - 10

SUBJECT - BIOLOGY

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CHAPTER-3 Genetics - Some basic Fundamentals

Genetics is the study of heredity i.e. transmission of body features (both similarities and differences) from parents to offspring and the laws relating to such transmission.

Gregor Mendel is called the father of Genetics He gave some laws releted to genetics These are called the Mendel's laws of Inheritance.

Modern applications of genetics

1) Genetic Engineering is a technique in which the genetic constitution of an organism is altered by introducing new gene into its chromosomes. Such organisms are called Genetically modified organisms.

2) Genetic Counselling - In this newly married couples are advised to consult a specialist regarding the possibilities of any undesirable trait which their children might inherit. Diseases like haemophilia with defective genes can be prevented to some extent by proper genetic matching of the prospective parents.

Heredity is transmission of genetically based characteristics from parents to offsprings or genetic constitution of an individual.

"Like begets like" means youngones look like their parents. Yet there are variations.

All the offsprings of a couple are never identical to their parents To elaborate - A baby of human will look like human. But still all humans are not identical/alike. Human beings as a species share some common characteristics/traits

among themselves. Yet, various races / Tribes look different in several features. Even within the same race, within a family the individual members in population show differences. These small differences among the individuals of same species are called variations

Character - Any inheritable feature of an organism Eg Colour of the eyes

Trait - The alternative form of a character Eg Blue eyes or Brown eyes.

Students may see a few more characters and traits in humans (given on Page 23 of text book).

Chromosomes - the carriers of heredity.

Karyotype - The human chromosomes arranged in pairs in order of their size and shape on a chart. [Fig 3.2 on Pg 24 of text book shows Karyotype of human beings.]

Chromosome number - is constant for the individuals of a species. Each body cell of that species has same number of chromosomes For eg in humans chromosome number is 46. i.e. all the cells in a human body contains 46 chromosomes. Students may see the chromosome number in other organisms as given on Pg 24 of text book.

Homologous Chromosomes.

Chromosomes always occur in pairs. Two chromosomes of each pair are similar in size and shape and are derived as one each from the two parents These identical Chromosome pairs are called homologous chromosomes.

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Two main categories of chromosomes

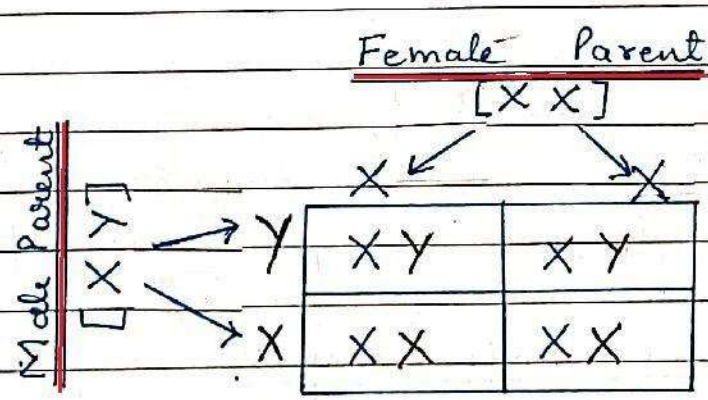
Autosomes - The first 22 pair of chromosomes (i.e. each one of the chromosome pairs numbered 1-22) have identical chromosomes. These chromosomes in human karotype are called autosomes

Sex chromosomes - The last pair i.e. 23rd pair of chromosome is different and its chromosomes are called sex chromosomes which are designated as X and Y. The XX pair with similar partners are found in females and XY pair with dissimilar partners are found in males. The Y chromosome of male is much smaller than the X chromosome. Thus this last 23rd pair of chromosome determines the sex of an organism.

Autosomes determine the general body features like complexion, height etc.

Sex determination - Son or daughter

Sex of a child depends upon the kind of sperm that fertilises the egg.



Children -
50% Male
i.e. XY
50% Female
i.e. XX
[i.e. equal chances for a male or female child to be born]

Father's 23rd pair of chromosome has XY pair
Mother's 23rd pair of chromosome has XX pair
One of the father's and similarly one of the mother's chromosome is received by the offspring

Mother only can give X chromosome to the offspring (as mother has only XX pair)
Father may give 'X' chromosome or may give 'Y' chromosome to the offspring. It is simply a matter of chance as to which type of 'X' or 'Y' chromosome fertilizes the ovum with 'X' chromosome (of the female)
If the egg 'X' fuses with 'X' bearing sperm, the child produced is female (XX)
If the egg X (of mother) fuses with 'Y' bearing sperm (of father) the offspring produced is Male (XY)

Chromosomes carriers of genes

All chromosomes carry some 'genes' on them that determine the characteristics of an organisms like behaviour, body functions, appearance etc. Lion and cat have same number of chromosomes (38) yet they have different characteristics This is because the chromosomes in them carry different genes.

Gene - is the unit of heredity. These are specific parts (DNA segments) of a chromosome, which determine the heredity characteristics
Genome - is full complement of DNA (including all genes and intergenic regions) of an organism.

Genes and their alleles

Alleles. Every gene has two alternative forms for a character producing different effects. The alternative forms of a gene, occupying the same position (locus) on homologous chromosomes and affecting the same characteristic but in different ways. For eg. for characteristic 'height'

two alleles are T (tall) and t (dwarf / short)
Out of the two alleles of a gene, one is super-ruling or dominant and other is recessive (subord--inate) The dominant gene is represented by capital letter (Eg T) and recessive gene by the same letter but small letter (Eg t for dwarfness)

Dominant Allel - The kind of allel which expresses itself regardless of the presence of another allele/s for a given gene Eg The dominant allel for height is 'Tall'

Recessive allel - The kind of allel whose expression is suppressed in presence of a dominant allel for a given gene. Eg the recessive allel for height is 'dwarf'

Thus we can have the following combination of genes -

(i) TT (both dominant) - Organism is Tall
(ii) Tt (one dominant & one recessive gene) - Organism is Tall.
(iii) tt (both recessive genes) - Organism is dwarf

TT is homozygous (similar) dominant pair and tt is homozygous (similar) recessive pair, hence the organisms are 'Tall' & 'dwarf' respectively
Tt is heterozygous dominant with dissimilar pair. In this condition 'Tt' the dominant gene expresses itself hence the organism is tall.

Recessive allel can only express itself in presence of the same recessive allel. For eg 'tt' is the only genotype ie type of genes which may be present in the cells of that organism

Genotype The set of genes present in the cells of an organism Eg TT, Tt, or tt

Phenotype The observable characteristics of an organism which are genetically controlled
Eg Tall or Dwarf organism.

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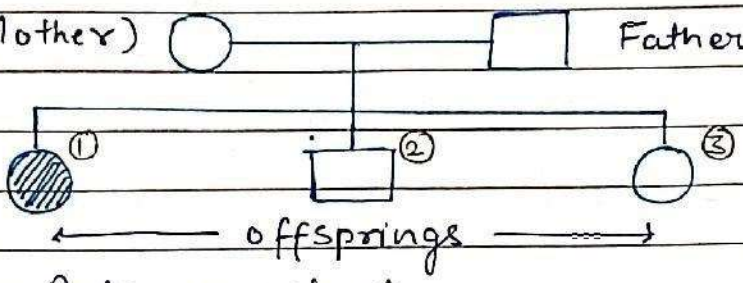
From Parents to children / offsprings -

Lets take Eg of Tongue rolling character.
Pedigree / Family chart of a family is shown below-



In Pedigree chart -

○ = denotes female □ - denotes male
◍ - Solid symbol indicates the character being traced
○ or □ - Hollow symbol indicates the usual expressed character. i.e. dominant trait i.e. tongue rollers in this case.

Now in the above family -

Father, mother and their two children (No. 2 & 3) are tongue rollers and one child (i.e. No 1) in the family is non roller.
Now from this known phenotype (i.e. outwardly observed characteristic of tongue rolling / non rolling) genotype of all family members can be determined as -
Firstly from the given phenotype we conclude Child No 1 has the genotype as rr. (as recessive character / allele can only express itself in presence of same recessive allel)
Now since the child 1 has rr pair it must have received them one from each parent.
So mother and father bears the genotype as Rr (with one 'r' which they have given to Child 1)
(R - because both are tongue rollers so should have atleast one dominant gene - R.)

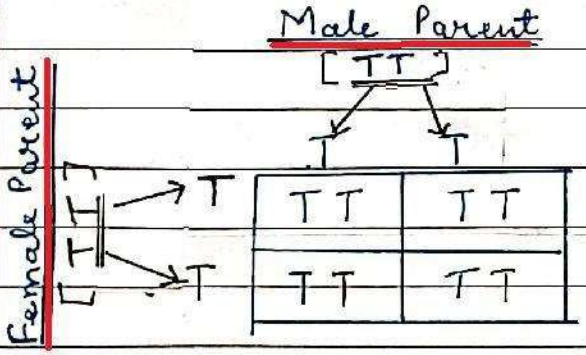
Other two children (No 2 & 3) may either have RR or Rr as the genotype (as both are tongue rollers which is a dominant trait hence both these children must bear atleast one dominant allel of the character of tongue rolling ie. R.).

Punnet square is a simple diagram in which the different types of gametes (sex cells with the concerned trait) of one (female) parent are placed along one side of the square and those of the other parent (male) are placed along the other side. Then the possible combinations (genotypes) of the opposite gametes are given in the sub squares.

Foreg - In tall or dwarf traits of height - Mother & Father may either bear TT, Tt or tt pair

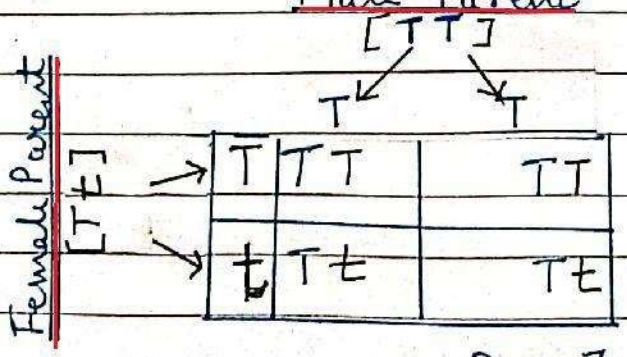
Case I When both are homozygous ie. TT or tt.

Let take example when both are TT (dominant)



100% - All children will be Tall

Case II When either parent is homozygous Tall TT and other is heterozygous Tall (ie. Tt)



Children - All Tall.
50% Homozygous tall ie. TT
50% Heterozygous tall ie. Tt