Heredity and Variations

Heredity

It includes those traits or characters which are transmitted from generation to generation and are therefore fixed for a particular individual.

- Genertics: Study of Heredity and variations is said to be known as genetics. The term genetics was first of all used by W. Bateson in 1905. An Austrian monk namely Gregor. Johann Mendel was the first person to study genetics. He was therefore regarded as the 'Father of Genetics'.

Variations

Variations is concerned with the difference between the individuals of same species and alos between the offsprings of the same parents.

- Variations could be of two types:

(i) Somatic variation (ii) Germinal variation

(i) **Somatic variation:** Somatic variation affects the somatic cells of an organism. It is acquired by individual during it's own life and is lost with it's death.

(ii) Germinal variation: This variation affects the germ cells of an organism and is consequently inheritable. It is received by the individual from the parents and is transmitted to the next generation.

- Germinal variations could be of two types:

(a) Continuous variations: (Fluctuating variations) These variation are unstable and do not contribute to the formation of new species.

(b) Discontinuous variations: This variation in also known as mutation. It is stable and inheritable.

- Significance of Variation:
- Variation enables the organisms to adapt themselves to the changing environment.
- It forms raw material for evolution.
- In enables the organisms to face the struggle for existence in a better way.
- It is the basis of heredity.
- It also leads to the existence of new traits.

Heredity and Variation in Asexual Reproduction

The asexual reproduction is monoparental and the organism produced by it inherits all the traits of it's single parent. It is almost a carbon copy of the parent and is known as it's clone. It is also called as clonal reproduction.

- The clones may develop variations:
- By environmental factors
- By mutation.

The variations caused due to environmental factors are not transferable but those variations which are caused by mutation are stable and inheritable.

Heredity & variation in Sexual reproduction

The sexual reproduction is biparental and the offspring receives some traits from one parent and some traits from other parent. Interbreeding of closely related individuals reduces the occurrence of variations in the offsprings produced by the sexual reproduction.

Mendel's Experiments and Laws of Inheritance

Gregor Johann Mendel is appropriately called as Father of genetics. With the help of his experiments on garden pea, he was able to formulate laws which explain the manner of inheritance of charaters.

Although Mendel described his results in 1866, his work was recognized only in 1900, When Mendel's laws were rediscovered simultaneously by Hugo de vries a Dutch biologist, Cart Correns a German botanist and Erich von Tshermak an Austrian botanist.

- Some general terms used by him are:
- Dominant trait: The trait which appears in F_1 generation is called as dominant trait. It is denoted by capital letter.
- E.g TT (tall).
- Recessive trait: The traits which does not appear in F_1 generation is called as recessive trait. It is denoted by small letter.
- E.g. tt (dwarf)
- Monohybrid cross: It involves the study o inheritance of one pair of contrasting characters.
- E.g. Inheritance of tall and dwarf characters.
- Dihybrid Cross: It is the inheritance of two pairs of contrasting charaters.
- Trihybrid cross: It is the inheritance of three pairs of contrasting characters.
- Back cross: The cross between F_1 generation with any of the parents is known as back cross.
- Test cross: The cross between F_1 generation and the recessive parent is called as test cross.
- Genotype: It is genetic representation of a trait.
- E.g. TT or Tt for a tall plant.

- Phenotype: It is expression of a trait e.g. Tall pea plant. It can be noted by direct observation of an individual.
- Allele: Trem allele refers to each of the members of a genetic pair.
- Homozygous traits: They have dissimilar alleles for a specific trait (Tt). They produce two types of gametes.

Mendel's Experiment

Mendel chose garden pea as plant material for his experiments, since it has following advantages:

- Well defined characters
- Bisexual flowers
- Predominantly self- fertilization
- Easy hybridization
- Cross fertilization is possible

(i) Traits had been chosed by Mendel for his experiment: There are seven traits which Mendel has chosen they are as follows:

S.No.	Characters	Dominant	Recessive
1.	Stem height	Tall	Dwarf
2.	Flower colour	Violet wh	Ite
3.	Flower position	Axial	Terminal
4.	Pod shape	Inflated	Constricted
5.	Pod colour	Green	Yellow
6.	Seed shape	Round	Wrinkled
7.	Seed colour	Yellow	Green

(i) Result's of Mendel's experiments:

(A) When the self pollination was made and F_1 generation was obtained. The trait which was being expressed is called as dominant, whereas the one which was not expressed is called as recessive trait.

(B) In the F_1 generation, the dominant and the recessive traits obtained were in the ratio of 3:1 i.e. 75% of the offsprings which appeared in F_2 generation had dominant trait, while 25% had recessive trait. This ratio of 3:1 is also said to be known as Mendelian monohybrid ratio.

TT x tt

T T t t

	T	T
t	Tt	Tt
t	Tt	Tt

In F_1 all are tall

(F_1x F_1)

Tt x Tt

T t T t

	T	T
T	TT	Tt
t	Tt	Tt

In F_2 will get 3:1 ratio.

Homozygous tall: Heterozygous tall: Homozygous dwarf

1 : 2 : 1

(C) Mendel further fount that the phenotypic ratio of 3 :1 of dominant to recessive form of a trait was actually a genotypic ratio of 1:2:1 of pure dominant, hybrid and pure recessive forms. The traits which remain hidden in F_1 generation got expressed in F_2 generation. This was later on proved in F_3 generation.

(iii) Reason for of mendel's success:

(A) He selcted true breeding [pure] pea plant for his experiment.

(B) He studied single trait at a time.

(C) He kept an accurate mathematical record of his breeding experiments.

Mendel's Laws to Inheritance

(a) The principle of paired Factors:

Each character in an individual is governed by two factors called as gene. The alternative form of gene is called as alleles or alleleomorphs. If an individual consists of similar types of alleles, They are called as homozygous.

- E.g. TT, tt while those having different types of alleles are called as heterozygous e.t. Tt etc.

(b) The principle of Dominance or Law of Dominance:

When two homozygous individuals with one or more sets of contrasting characters are crossed the characters that appear in the F_1 hybrids are dominant characters and those which do not appear in F_1 are recessive characters.

(c) The principle of Segregation or Law of segregation or Law of purity of gametes:

The law of segregation states that when a pair of contrasting factors or genes or alleles are brought together in a heterozygous condition,

the two remains together without being contaminated but when gametes are formed from them the two separate out from each other. This is also known as Mendel's first law of heredity.

(d) The principle of Independent Assortment or law of Independent Assortment:

If the inheritance of more than one pair of characters is studied simultaneously, the factors or genes for each pair of characters assort out independently. It is called as Mendel's second law of heredity.

Dihybrid Cross

In dihybrid cross Mendel crossed genetically pure yellow round seeded (YYRR) pea plant with green wrinkled (yyrr) pea plant. All the plant of F_1 were all yellow and round seeded (YyRr). In F_2 generation four types of plants appeared as:

- Yellow rounded -9 * Yellow wrinkled -3
- Green round-3 * Green wrinkled -1

So here phenotypic ratio is 9:3:3:1

YYRR x yyrr

YR YR yr yr

	yr	yr
YR	YyRr	YrRr
YR	YyRr	YyRr

All F_1 Plants are yellow and round seeded

YyRr x YyRr

YR Yr yR yr YR Yr yR yr

	YR	Yr	yR	yr
YR	YYRR	YYRr	YyRR	YrRr
Yr	YYRr	YYrr	YyRr	Yyrr
yR	YyRR	YyRr	yyRR	yyRr
yr	YyRr	Yyrr	yyRr	Yyrr

Importance of Mendel's Laws

(i) They are used for various braches of breeding.

(ii) They are used in improving varieties of fowls by producing hybrids.

(iii) They are used in producing disease resistant varieties.

(iv) They are used in improving human race.

Hybridization

- Joseph kolreuter, a German botanist carried out first hybridization experiment in tobacco.
- Hybridization is crossing of two organisms differing from each other genotypically in one or more traits.

(a) Objectives:

(i) To produce single variety having combination of good characters.

(ii) To exploit and utilize the hybrid vigour.

(iii) To generate of genetic variation.

(b) Hybrid vigour:

It is the superiority of the hybrid over either parent in one or more traits.

(c) Significance of Hybridization:

(i) Development of high yield varieties with better quality.

(ii) Disease, insect and pest resistance.

(iii) New varieties for particular environment.

DNA: (Deoxyribose Nucleic acid)

DNA was first isolated by Frederick Meischer from the nucleus of pus cells and called as nuclin. Watson and Crick gave the double helix model of DNA.

(a) Composition of DNA:

DNA molecule consists of following three components:

(i) Deoxyribose sugar (ii) Phosphate group

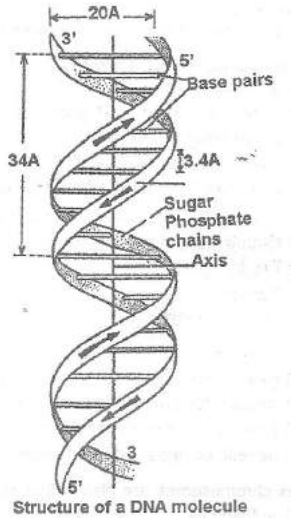
(iii) Nitrogen bases: They could be purines or pyrimidines.

(a) Purines are: Adenine (A) and Guanine (G)

(b) Pyrimidines are: Thymine (T) and Cytosine (C)

- One DNA molecule consists of a unit called nucleotide.
- Nucleotide = nucleoside + phosphate
- Nucleoside = nitrogen base + deoxyribose sugar

(b) Structure of DNA:



Structure of a DNA molecule

- It consists of two helicle polypeptide chains which are cailed around each other.
- Both chains have complementary base pairing i.e.A = T and G =C.
- The diameter of a DNA molecule is 20 A.
- On helix consists of about 10bp.
- It's helicle length is 34 A and the distance between two nearest base pairs is 3.4 A.
- It also consists of major and minor grooves.
- Each strand consists of a backbone made up of alternating deoxyribose sugar and phosphate, they are joined by phosphodiester bonds.

Genes

The term 'gene' was introduced by Johanssen for Mendelian factor. Gene determines the physical as well as physiological characteristics. They are transmitted from parents to their offsprings generaion after generation. Genes are located on chromosomes where they occupy specific position called as locus.

Chromosomes

E. Strasburger discovered chromosomes in 1875. They are thread like structures and are called as chromosomes due to their affinity towards dyes [chroma = colour]. Genes are located on chromosomes and the genetic material of Chromosomes is DNA. These are also called as "hereditary vehicles" as they are capable to transmit hereditary material to the next generation.

- Number of chromosomes: Each species has a fixed number of chromosomes in it's cells. In case of human beings, there are 46 number of chromosomes in each body cell. 46 chromosomes in an ordinary human cell are of 23 different types. So, there are two chromosomes, of each kind. The two chromosomes of each kind are called as homologous chromosomes. A cell which has the full number of chromosomes with two of each kind is called as diploid cell. The gametes (or sex cells) of human being are different from their other body cells because they contain only half the number of chromosomes.
- E.g. sperm and eggs have only 23 chromosomes each, which is half the number of chromosomes of other body cells. So, the gamete is a haploid cell.
- Functions of chromosomes:

(i) They carry hereditary characters from parents to offsprings.

(ii) They help the cell to grow, divide and maintain itself by synthesis of proteins.

(iii) They undergo omutation and thus contribute to the evolution of animals.

(vi) They bring about continuity of life.

Sex Determination

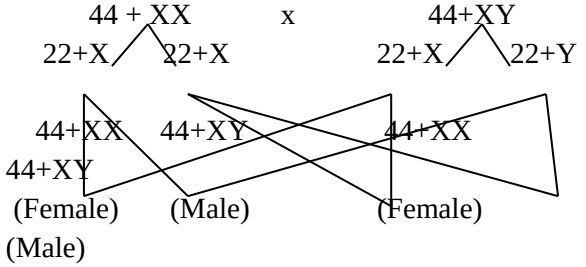
- Chromosomes are of two types:
- Autosomes or somatic chromosomes: These regulate somatic characters.
- Allosomes or Heterosomes or Sex chromosomes These chromosomes are associated with sex determinations. Sex chromosomes were first discovered by "Mc Clung" in grasshopper. X

(a) X X – X Y Type or Laygaeus Type:

This type of sex determination is first observed by Wilson and Stevens in Laygaeus insect.

(i) XX female and XY male: In this type of sex determination female is homogametic while males is heterogametic.

- E.g. Humans



EXERCISE

1. Autoosomes in humans are
(a) 22 pars (b) 23 pairs
(c) 43 pairs (d) 11 pairs

2. Mendel conducted his hybridization experiments with
(a) Pigeon pea (b) wild pea
(c) garden pea (d) None of these

3. Herdity means
(a) Transmission of traits from one generation to successive generations of living beings.
(b) Dissimilarity between same species
(c) Both A & B are correct
(d) None of the above

4. The traits expressed in F_1 generations is called as
(a) Dominant trait
(b) Recessive trait
(c) Both are incorrect
(d) Both are correct

5. DNA strands are anti parallel because of
(a) H- bonds
(b) Phospho diester bonds
(c) Disulphide bodns
(d) Peptide bonds

6. Emasculation is achieved by
(a) Removal of stigma
(b) Removal of anthers
(c) Removal of sepal& petats
(d) Removal of gynoecium

7. A cross between hybrid and a receive parent (Tt x tt) gives a ratio of
(a) 1:1 (b) 2:1
(c) 3:1 (d) 1:2:1

8. Back cross is a cross between
(a) F_1 x F_1 (b) F_1 x recessive
(c) F_1 x dominant (d) F_1 x any parent

9. A pure tall plant can be differentiated from a hybrid tall plant
(a) By measuring length of plant
(b) By spraying gibberellins
(c) If all plants are tall after self- pollination
(d) If all plants are dwarf after self-pollination

10. Who is regarded as ' Father of Genetics'?
(a) Gregor Johann Mendel
(b) T.H. morgan
(c) Lamarck
(d) Hugo de Vries

11. Genotype means
(a) Genetic composition of the individual
(b) Genetic composition of the germ cell
(c) Genetic composition of plastids
(d) Genetic composition of an organ

12. Sex chromosomes are also called as
(a) Autosomes (b) allosomes
(c) monosomes (d) Karyosome

13. The first work on genetics was done by
(a) Lamarck (b) Hugo de vries
(c) Mendel (d) Darwin

14. Number of characters studied by Mendel in pea plant was
(a) 5 (b) 7
(c) 6 (d) 4

15. A recessive character in pea is
(a) Red flower (b) round seed
(c) green cotyledon (d) tall plant

ANSWER - KEY

HEREDITY & VARIATIONS

Q.	1	2	3	4	5	6	7	8	9	10
A.	A	C	A	A	B	B	A	D	C	A
Q.	11	12	13	14	15					
A.	A	B	C	B	C					