GENETICS

DEFINITION OF TERMS

- **GENETICS** – This is the study of heredity and variation in living things.
- **HEREDITY** – Transmission of inherited traits or characters from parents to their offspring
- **VARIATION** – Differences among individual which can be passed from parents to their offspring.
- **GENE** – unit of hereditary material located on the chromosomes which is responsible for the transfer of traits from parents to off spring. It is made up of chromosome.
- **CHROMOSOME** – Strands of proteinous or hereditary materials located in the nucleus which contain the genes. They usually occur in pairs (23 pairs in man) called homologous chromosomes.
- **DOMINANT GENE** – A gene whose tract is already expressed when present in the organism. Such tracts that are always expressed are called dominant traits
- **RECESSIVE GENE** – It is a gene whose traits is not expressed when a dominant gene is present but it can be passed on to the generations: Such traits that can be suppressed by dominant traits are called recessive traits/allied genes alternate/contrasting of a gene occupying the same position or locus on the homologous chromosomes and controlling a particular trait (Alternate/contrasting forms of a gene located on the same position on a chromosome pair that control a particular trait.
- **HOMOZYGOTE** – An organism whose allelic genes in respect of a particular character are the same. The organisms is said to be homologous for that character.

- **HETEROZYGOTE** – An organism with contrasting alleles or genes in respect of a particular character e.g Tt. The organism is said to be heterozygous for that character.
- **PURE /TRUE BREED** – organisms showing the same types of traits from generation to generation. They are usually homozygous for the trait
- **HYBRID** – offspring of a cross between two parents that are different in one or more traits. They are usually heterozygous.
- **PHENOTYPE** – The observable or visible expressions of the characters of an organism resulting from the interaction between the genes and the environment.
- **GENOTYPE** – sum total of genes present in the cells of an organism i.e total genetic make-up of an organism both expressed and unexpressed.
- **FILIAL GENERATION** – Generations of offspring formed during genetic crossings.

The basic laws of Genetics were laid down by Gregory Mendel in 1866, Johansen called the factors that transmit Mendel's characters as **GENES** in 1909 and in 1912 Thomas Morgan showed that the genes were carried on chromosomes.

Organisms for genetic studies must have

a. Distinguishable characteristics
b. Reproduce rapidly
c. Should be able to be kept in the laboratory

d- Must have a few numbers of chromosomes e.g Bacteria, viruses, fungi, the fruit fly (Drosophila melanogaster.)

MENDEL'S EXPERIMENTS

- He used simple methods
- He confined his attention to one character at a time (e.g flower colour, height, seed shape etc).
- He carefully counted the number of each type of off spring resulting from the cross.
- He made sure his artificially pollinated flowers were not contaminated (e.g by removing pollen grains). A cross between red and white flowers produced all red flowers, f1 show that red is dominant while crossing the red offsprings, F2 produced 3 out of every 4 red and one white flower (showing that white is recessive).

Mendel's Law

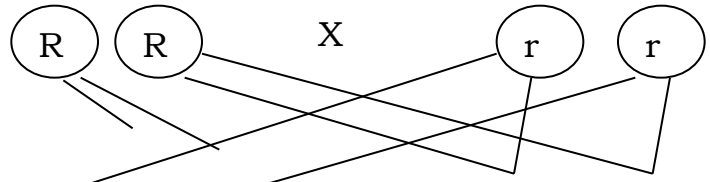
1. **The first law is the law of segregation of genes:** it states that genes are responsible for the development of the individual and that they are independently transmitted from one generation to another without undergoing any alteration

   Key R - red, r – white

Parents R R X rr

red flower white Flower

Gamete R R X r r

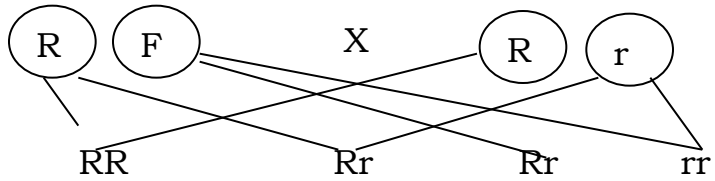


F1 Rr Rr Rr Rr

all red

Parents Rr X Rr

Gametes R F X R r



F2 RR Rr Rr rr

RR, Rr, Rr rr

3 red white

(MONOHYBRID/ INHERITANCE CROSS)

When hybrids are self-fertilized, the 2 contrasting characters in them segregate or separate pure and uncontaminated and pass into different gametes formed by the hybrid and then go to different individuals in the off spring of the hybrid. ¾ resemble dominant grandparent, ¼ resemble recessive grandparent. See the crossing above;

BACK CROSS OR TEST CROSS

This is a cross used to determine the genotype of organisms. It is done by crossing the offspring with a recessive parent genotype.

It differentiate between homozygous red and heterozygous red.

Parents RR x rr

Gametes R R r r r

F1 Rr Rr Rr Rr

All red

Parent Rr X rr

Gamete R r x r r

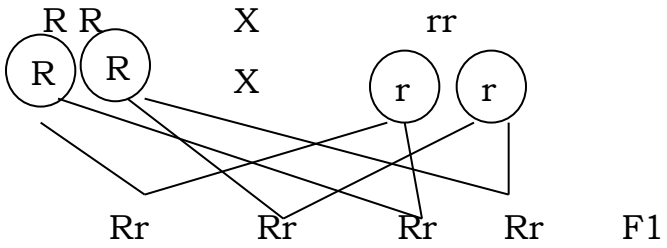
F1 Rr Rr rr rr

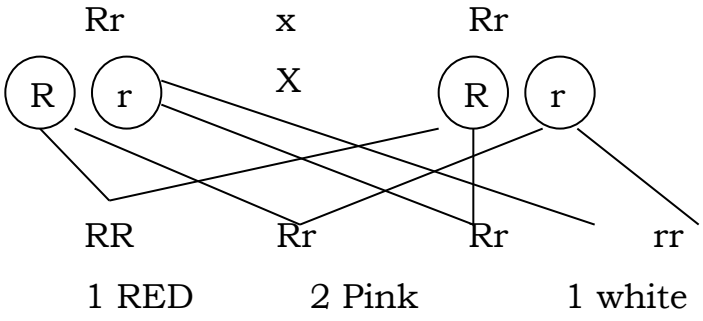
2 red : 2 white

Punnet square

	R	r
r	Rr	rr
r	Rr	rr

INCOMPLETE DOMINANCE: This occurs when neither of the genes is completely dominant over the other gene. A good example of this phenomenon can be found in 40'clock plant, also in Andalusian fowls. In 40' clock plant, when a red flower plant is cross with a white flower plant, the results of the offspring are all pink. If RR represent gamete for red and rr represent gamete for white, then the cross can be rep





RW Allowed in incomplete dominance

The second law is known as the law of independent assortment of genes. It states that each character behaves as a separate unit and is inherited independently of any other character.

During the formation of offspring the different allelic genes controlling the various characters can combine with each other randomly.

(DIHYBRID CROSSING

E.g crossing pea plants with round and yellow seeds with that of wrinkled and green seeds produced f1 all Round and Yellow, crossing the F1 offspring among themselves brought new combinations.

Key:-

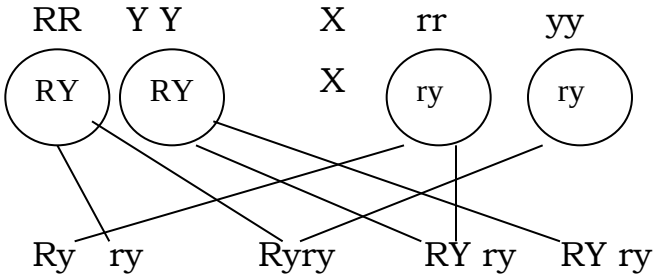
R - Round

Y - Yellow

r - Wrinkled

y - Green

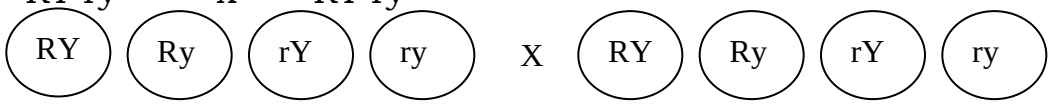
Round & Yellow X Wrinkled & Green



All Round and Yellow

Parents RY ry x RY ry

Gametes



PUNNET SQUARE CHECKERS – BOARD

	RY	Ry	rY	ry
RY	RYRY	RYRy	RYrY	RYry
Ry	RyRY	RyRy	RyrY	Ryry
rY	rYRY	rYRy	rYrY	rYry
ry	ryRY	ryRy	ryrY	ryry

9 = Round and Yellow

3 = Wrinkled and Yellow

3 = Round and Green

1 = Wrinkled and Green

Ratio 9: 3: 3:1

VARIATION

Transmissible characteristic in Animals

- Height, Height
- Colour of skin/eye/hair
- Albinsm
- Sickle cell anaemia
- Colour blindness
- Haemophila
- Intelligence, blood group
- Shape of body/nose/hear etc.

IN PLANTS

- Size of leaf
- Height
- Colour of flower petal
- Shape of fruit/seed
- Colour of fruit/seed etc

SICKLE CELL INHERITANCE

- Normal gene A produces normal haemoglobin ($Hb^{A)}$
- It is alleles S produces haemoglobin that cannot carry enough oxygen Hb^{S} resulting in sickle – shaped erythrocytes
- The two genes can be expressed – The heterozygote form (co-dominance e.g)

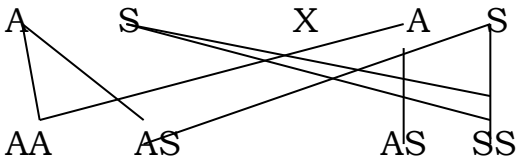
A A - Normal

SS - Sickler

AS - carrier

- A cross between two carriers

A S X A S Parents



Normal Carries Sickle

Marriage counseling

- Albinism follows the same pattern of inheritance ( )

ABO BLOOD GROUP INHERITANCE:

There are two allelic genes A and B and they are co-dominant. They can however both absent i.e Both A and B are dominant over 0.

A and B show equal dominance with each other

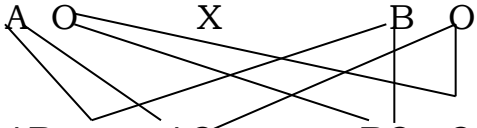
O is recessive

Phenotype	Genotype
Group A	AA or AO
- B	BB or BO
- AB	AB
- O	OO

A cross between a heterozygous blood group A parent and a heterozygous blood group B parent has the chances of producing all the possible blood groups.

A O X B O parents

A O X B O Gametes



AB AO BO OO F1

Group Group Group GP

AB A B O Phenotype

Useful in determination of paternity

RHESUS FACTOR

It is a substance in the red blood cell

Rh + is dominant over Rh-

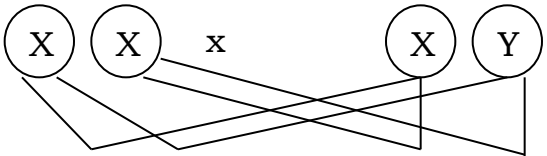
- It has medical implication if the mother is Rh- and the father Rh + The embryo which is Rh + is attached by the mother anti bodies resulting in jaundice or miscarriage however the embryo can be brought out earlier and blood trapped on given.
- **SEX DETERMINATION**

In man the 23rd pair of chromosome determines the sex of the child and they are called the sex chromosome. They are X and Y. XX results in female while XY results in male. A cross between a male and female therefore will result in equal chances of male and female off spring.

X X x X Y parents

female male

X X x X Y Gametes



XX XY XX XY F1

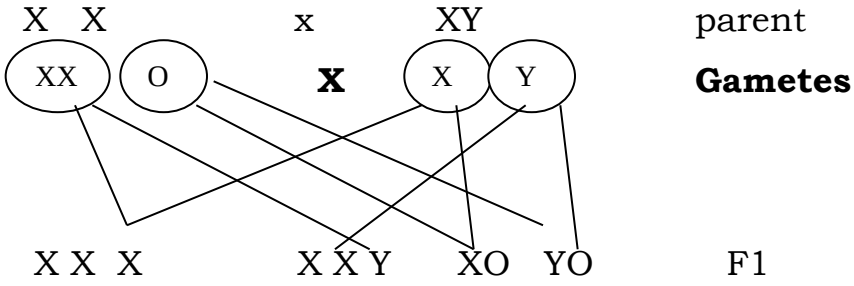
F M F M

Ratio 2 : 2

NON DISJUNCTION

Sometimes a pair of homologues chromosome fail to separate during gamete formation. This result in

- One gamete having both numbers of the given chromosome pair and
- The other not having any member of the chromosome pair fertilization these results in some abnormalities e.g klinefester syndrome



X X Y = **KLINEFELTER'S SYNDROME**

47 chromosomes

- Male
- Small tastes
- No sperms produced
- Mentally retarded
- Some degree of breast
- Development
- Voice higher pitched than in normal males

X O = **TURNER'S SYNDROME**

Female 45 Chromosomes

- Poorly developed ovaries
- Sterile
- Broad chest
- Under developed breast

X X X

- 47 Chromosomes
- Female
- Poor development of genitals
- Below average I.Q
- Fertile

YO cannot survive because

X chromosome meet be present for life to exist

Non disjunction of the pair of autosomes (other chromosomes that are not the sex chromosomes) gives rise to zygotes that are either; - trisomic = have 3 chromosomes of one type 1 or

Monosomic = have only one chromosome of one type.

Monosomic zygote usually fail to developed E.g of Trisomic

Zygote with 3 copies of chromosome 21 result 1- individuals with Down's syndrome (4) chromentally retarded with typical folded eye lobe which give them a mongoloid look (more common with older mothers).

SEX LINKED CHARACTERS

Characters determined by a gene located on the X chromosome are said to be sex – linked such traits show a different pattern of inheritance in males and females e.g a recessive allele of the X chromosome.

- Would be mashed in a female if the corresponding allele on the other X chromosome is dominant
- Would always be expressed in a male because the Y chromosome does not have a corresponding active allele.

Therefore a female may possess a homozygous or heterozygous allelic pair for a sex linked character but a male will only have one allele for it such characters show more in males than in females e.g colour blindness and Hemophilia.

CC= Normal female

Cc= Carrier female

Cc= Sickler female

CY= Normal male

Cy= Sickler male

A cross between a carrier female and a normal male

	Cc		CY
Parents	Cc	X	C Y
	Carries		Normal
	Female		male

Gametes Cc x CY

F1	CC	Cc	CX	CX
	CX	TY	CX	TY
	Normal	Normal	carries	Coloure

Female male female blind male

PROBABILITY IN GENETICS

The probability or chance of an event is it's relative frequency of occurring. In practical terms it may not be exactly so for excenyle the probability that an unborn baby may be male or female is ***** but a couple may have 4 children all males or females. However the lager the number off spring, the more the figure tally with the probability e.g in plants.

PEDIGREE OR FAMILY TREE.

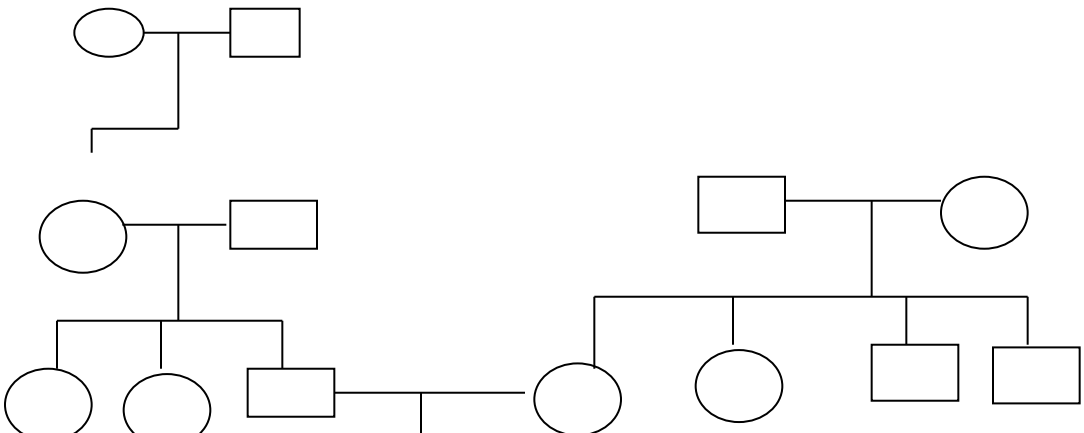
This is used to represent the pattern of inheritance of a particular trait in an extended family Key: = males

= females

- (horizontal line = marriage/vertical line) = off spring)

INHERITANCE OF SICKLE CELL TRAIT IN A FAMILY.

- Normal male
- Carrier male
- sickle male
- normal female
- carrier female
- sickle female



TYPES OF VARIATION

Variations are usually caused by:-

- New genetic combinations reproduction and
- Mutations – spontaneous change that occurring genes and chromosomes

CONTINUOUS VARIATION

A gradual change in a trait from one extreme to the other which is produced by the combination of many genes and affected by environmental factors is called Continuous Variation.

They are usually analyzed statistically by using mean standard deviation, frequency histogram. E.g Height, weight, intelligence, skin colour, shape etc.

DISCONTINUOUS VARIATION

This is a variation in which there were differences in a trait with no intermediate state which is controlled by one or two major genes and not affected by environmental factors.

They are usually analyzed by making counts and ratios. E.g Tongue rolling, blood groups, ability to taste PTC, colour blindness, Hemophilia, finger prints sickle cell anaemia etc.

The variations noticeable in the physical appearance of individuals of the same species are called morphological variations e.g height, weight, shape of face/nose finger paints, colour of skin/hair/eye, etc.

Each does to calculate % of tongue rollers x non rollers in their class members of the same species behave or recent certain things or conditions in their environments constitutes physiological variations e.g ability to roll tongue ability to tacts PTC.

TYPE OF FINGER PRINTS

(Types of finger prints ceeh, fented arch, loop, plain whorl, accidental, central pocket loop, double loop College Biology P 411 – Crime detection) uses

Application of Genetics

Agriculture

- Development of high yielding varieties of plants and animals

PTC = Phenyl thiocarbamide

- Development of early matiering varieties
- Development of disease resistant varieties
- Cross breeding

Medicine

- Counselling for genetic disorders e.g sickle cell,
- Rhases factor etc
- Blood transfusion and determination of paternity
- Genetic engineering = (the transfer of the DNA of on organism to that of another which naturally cannot produce it but can replicate the new D N A) e.g gene for in production in human be transferred to a bacterial (E - coli) to produced insur for human's treatment knowledge of variation can be used in crime detection e.g if the finger prints of a inspect match those at the scene of a crime, he would be held responsible.
- Variation can also be used in the classification of human race into fever for major groups –

(i) Cavacasord – light shinned people with new row nose and weavy hair e.g Europeans.

(ii) Negroid – Blach – shinned people with woolly hair and broad nose e.g Black Africans, Afro Americans

(iii) Mongoloid - Yellow – brown shinned people with straight hair and moderately broad nose e.g Chinese and Japanese.

(iv) Australoid – Brown shinned people with curly hair and moderately broad nose e.g Australian aborigines.

D N A structure

D N A is composed of 3 different chemical substance

- A 5 – carbon (pentose) sugar called deoxyribose.
- Phosphate group
- 4 nitrogenous organic bases

The subunits of DNA are called nucleotides ******* to the model, the structure of the DNA is like a double helix i.e a twisted ladder are made up of alternating sugar and phosphate groups while the middle of runge is made up of 2 pairing nitrogenous bases.

The nitrogenous bases are Adenine and Guanine (Perines), Cytpsine and Thymine (Pyrimidinea)

A usually pairs with T

C

DIAGRAM

Watson and crick model of D N A

DIAGRAM

For DNA to replicate, the stands separate and each strand replicates a complementary strand.

Ribonudeic Acid – RNA

RNA is a single stranded nucleic acid winling DNA it is present meaning the cytoplasm. It contains ribose sugar instead of deoxyribose. It contains the base vracil instead of thymine in DNA

There are 3 types of RNA namely:-

- Messenger RNA (MRNA)
- Transfer RNA (+ RNA)
- Ribosomal RNA (Rrnn)

Messenger RNA is synthesized in the nucleus by the DNA and it carries the genetic to the cytoplasm for protein synthesis.

Transfer RNA carries ****** of protein synthesis.

Ribosomal R N A is located in the ribosome and this is where protein synthesis takes places.