What is genetics?

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Genetics

What is genetics?

It is a branch of Biology, which studies the inheritance of characteristics from parents to offspring,

Why did Mendel choose pea plant?

1. *It grows easily*
2. *It gives new offspring in a short time*
3. *It is hermaphrodite and its reproductive organs are surrounded with petals in the form of keel so they can do self or cross-pollination.*
4. *It gives large number of offspring.*

Self-pollination:

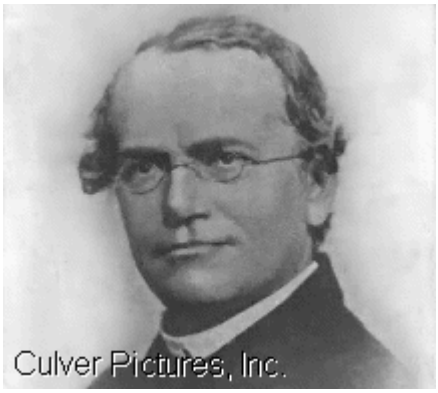
The transfer of pollen grains from the male organ to the female organ of the same flower or another flower in the same plant.

Cross-pollination:

The transfer of pollen grains from the male organ to the female organ of another plant.

Factors of Mendel's success:

1. *He **chose** clear allelomorphic characters (pink and white flowers).*
2. *He **continued** studying the inheritance of the chosen character for more than one generation.*
3. *He applied quantitative studies (**Mathematics**) in Biology for the first time.*
4. *He **arranged** his data in a way that makes it easy to evaluate his work.*



Gregory Mendel

Known as the father of modern genetics, Gregory Mendel developed the principles of heredity while studying seven pairs of inherited characteristics in pea plants. Although the significance of his work was not recognized during his lifetime, it has become the basis for the present day field of genetics.

Mendel's experiments

- *He chose 2 pea plants, which carry one pair of allelomorphic characters (Red and white flowers).*
  - *He removed the stamens (pollen grain producers) from one flower before **maturation** (white) after maturation he pollinated the stigma of the flower with pollen grains from red flowered plant.*
  - *To prevent any other pollen grains from reaching the stigma (except what he used) he surrounded the flower with a paper sac).*
  - *The resulting seeds which were cultivated produced (F_1) was 100% red flowers.*
  - *He left red flowered plants to do self-pollination and then the cultivated seeds produced (F_2), which contained the two coloures red and white.*
  - *When Mendel counted the individual for each colour he got 705 ones with red flowers and 224 white ones (3:1).*

Mendel's explination

- *The characters, which appear on (F1), are called **dominant** and the other are called recessive.*
- *Each trait character is controlled by one pair of factors (genes) that lead to its appearance.*
- *The factors, (genes) segregates (separates) during gametes formation so that each gamete has one factor for each character.*
- *Fusion of gametes makes zygote (individual cells) contains one pair of factors again.*

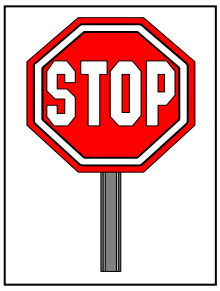
Allelomorphic characters alternate characters that mean one of them appears on the living organism (the plant either red flowered or white flowered).
The factors of heredity are transmitted through the reproductive cells (sperms and ova in humans, pollen grains and ova in plant) Both of them are called gametes.

Character	Dominant	Recessive
Height of stem	Tall	Short
Position of flower	Axillary	Apical
Shape of fruit	Swollen	Segmented
Texture of seeds	Smooth	Wrinkled
Color of seeds	Yellow	Green
Color of root	Red	White
Color of flower	Green	Yellow

Mendel's first law of segregation:

When two individuals of one pair of allelomorphic characters are crossed (f_1) caries the dominant character only and (F_2) have two characters in the ratio 3 dominant: 1 recessive.

Important Biological terms:



Phenotype: *the external feature.*

Genotype: *Contents of genes.*

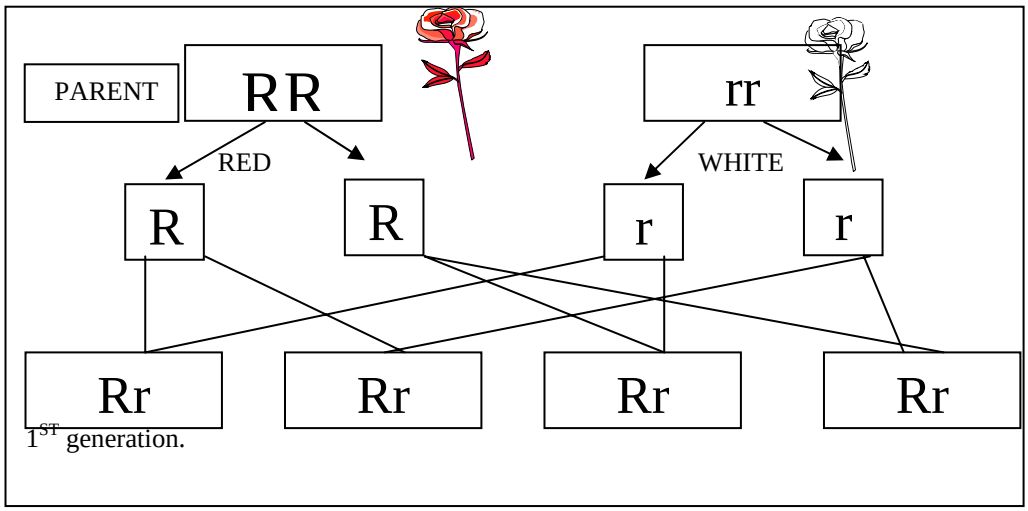
Dominant character: *gets a symbol due to its 1st letter (in capital).*

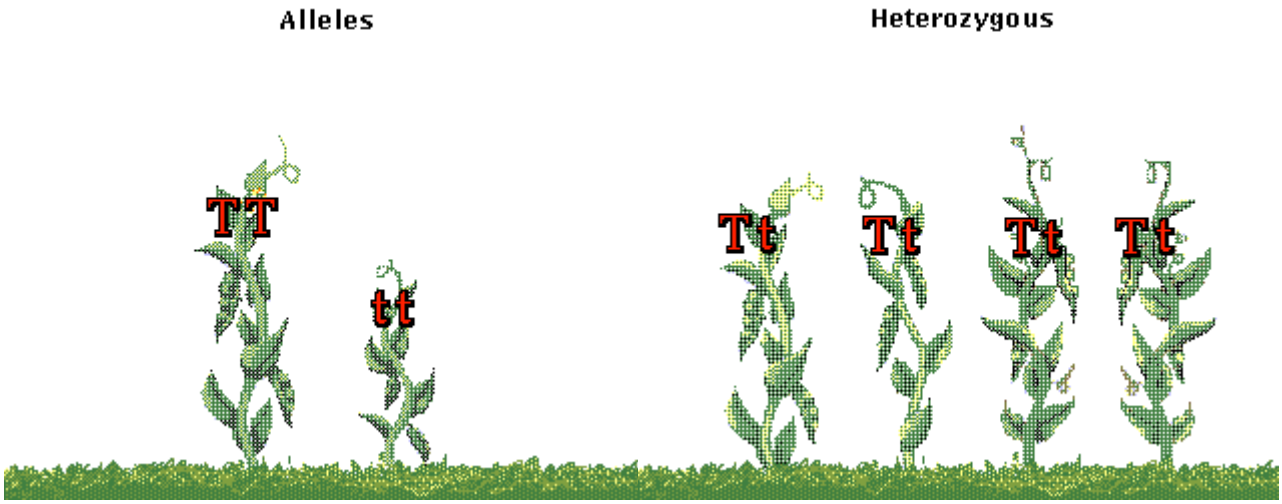
Recessive character: *gets the same letter but small.*

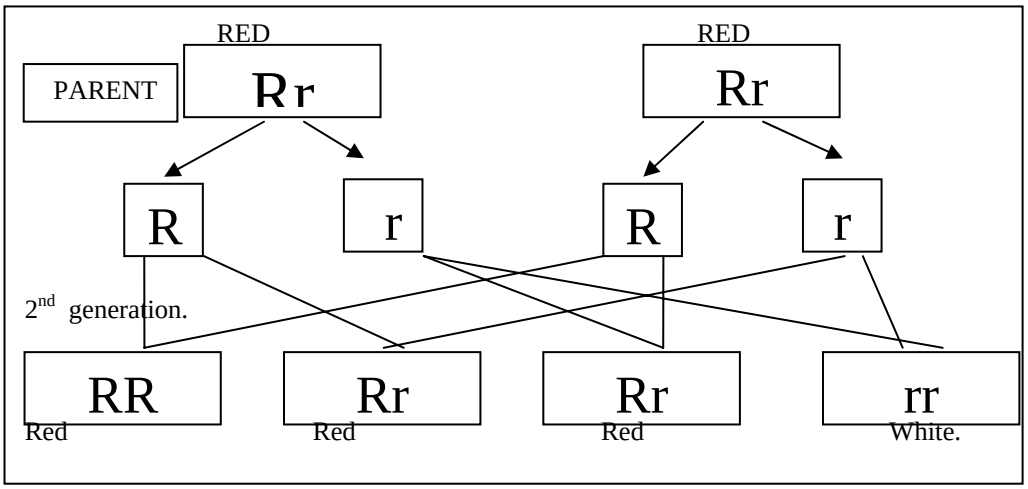
Homozygous:*(Cary 2 identical genes) (pure).*

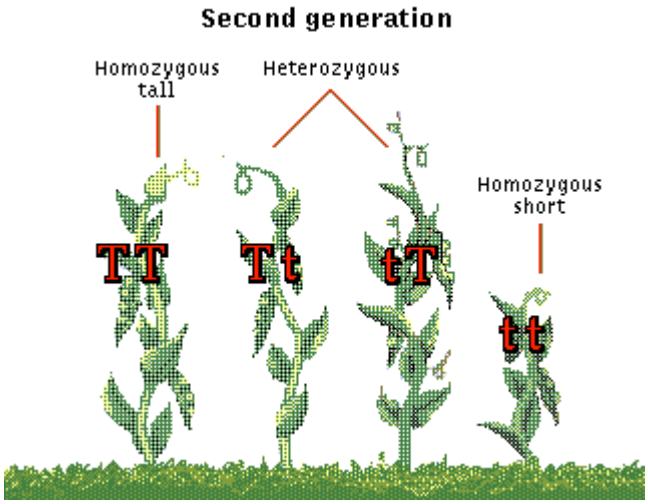
Heterozygous: *Cary one dominant and one recessive gene. (Impure or hybrid)*

Examples









And as you Can see from the 2 examples you can do any other character just the same way.

Another examples on Mendel's 1st law:

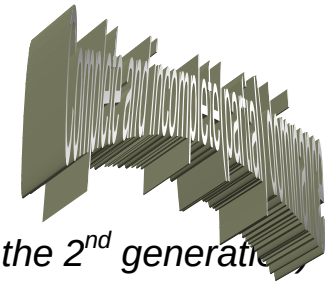
1. *The inheritance of the colour of skin on mice(Black is dominant over the brown) " you can do 1st and 2nd generations by your own"*

2. *The following characters follow Mendel's 1st law of segregation you can do the 1st and 2nd generation of each pair giving that the parents were different homozygous genotype and phenotype.*

The character	**The allelomorphic characters**
Hair	**1- curly and straight** **2- Dark and light** **3- Dense and light**
Skin	**Normal and albino**
Eye	**Brown and blue** **Wide and narrow**
Ear lobules	**Free and fused**
Nose	**Curved and straight**

Complete dominance:

It means that one of the two Genes of the allelomorphic Characters is 100% dominant (it means That the character appears 100% in the first Generation and appears with a ratio of 3:1 in the 2nd generation)



Examples: *all the previous examples.*

Incomplete dominance

It means that neither one of the two characters are completely dominant over the other but an intermediate character appears in the 1st generation then the 2nd generation will be 1:2:1 one like the male parent, one like the female parent and two like the offspring (an intermediate character)

Examples on incomplete dominance

1-The colour of the flower of ***Miribilis Jalapa:***

Red flower plant RR

White flower plant WW

Pink flower plant RW

Notice that neither of them is dominant and they do not have the same letter(non mendelian)

Can you do the 1st and 2nd generation please.

2- The colour of feathers of ***Andalusian fowls :***

Black (BB) white (WW) blue (BW)

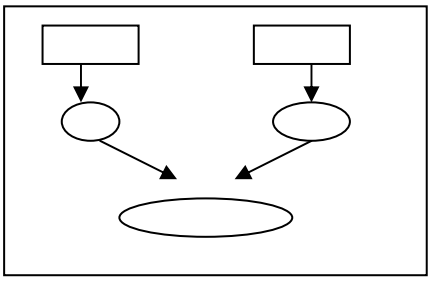
Comparison between complete And incomplete dominance

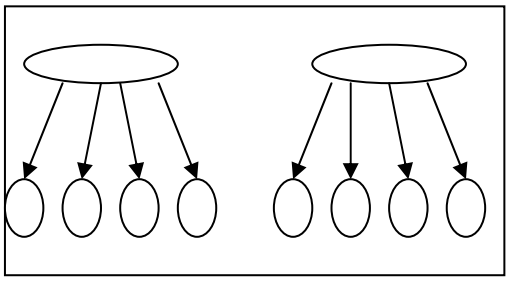
	Complete dominance	Incomplete dominance
1st generation	Only one character appears (dominant) and the other disappear (recessive)	A new intermediate character appears while both characters of the parents disappear.
2nd generation	3 dominant :1 recessive	1 : 2(new) :1
Differentiation	We can not differentiate between pure and impure dominant except by test cross.	Phenotype is enough to differentiate.
example	Colour of flowers of pea plant.	Colour of flowers of Miribilis

Mendel's 2nd law

Law of independent assortment

The first law studied the inheritance of one pair of allelomorphic characters.
What will be in the case if he studied 2pairs of characters?
Mendel studied the inheritance of the flower colours and positions which each other: -
Parents: pink axially flower x white apical flowers
F_1: pink axially 100%.
F_2: 9 : 3 : 3 : 1
Pink Axillary pink apical white Axillary white apical
Considering that: -
A-each character is controlled by one pair of genes segregates during gametes formation.
B-if count in f_2 for each characters the ratio will be
12 pink: 4 white or 3:1 12 Axially: 4 apical or 3:1 too
C- this indicates that each character alone is inherited according to the 1st law, That means the pair of genes (allel) for each character during gametes segregates independent from the other so that the ratio 9:3:3:1 this can be represents as follows:





	PA	Pa	pA	.pa
PA	PPAA Pink Axillary	PPAa Pink Axillary	PpAA Pink Axillary	PpAa Pink Axillary
Pa	PPAa Pink Axillary	Ppaa Pink apical	PpAa Pink Axillary	Ppaa Pink apical
.pA	PpAA Pink Axillary	PpAa Pink Axillary	.ppAA White Axillary	.ppAa white Axillary
.pa	PpAa Pink Axillary	Ppaa Pink apical	.ppAa White Axillary	.ppaa whit apical

Mendel second low

When two homozygous individuals bearing two pairs of allelomorphic characters are crossed, each pair of characters assorted randomly and inherited independently of the other.

Problems

1. In cows black colour dominants red colour and horn less character dominants horned character if mating took place between 2 pure homozygous individuals find out the result of F1 and F2.
2. In man the dark hair dominants the light hair and curled hair dominants the soft, if a man with pure dark curled hair married to a woman with light soft hair what will be the genotype and phenotype of the 1st and 2nd generations.

Difficulties which face applying genetic studies on man

1- its impossible to plan mating among human individuals for experiments.
2- Human has long life cycle that mans individuals need at least 17 year to mature and can marry.
3- he gives few offspring so that the offspring have not all the probabilities .
E.g. the ratio of 3:1 or 9:3:3:1 impossible to be covered in one birth of one woman.
4- its difficult to have full information about genetic structures of man because their is no full record about him in spite of all these difficulties scientist have managed to study the inheritance of large numbers of characteristics of man

Test cross

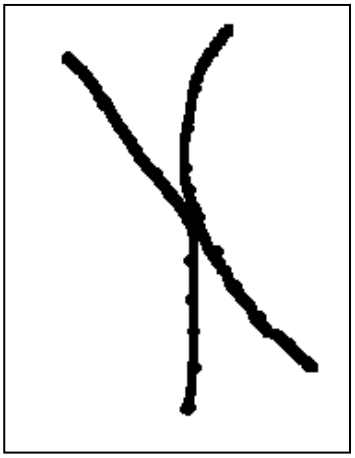
During Mendel's experiments when he crossed pollinated 2 white flowers pea plant all the offspring where white which indicates that the individual are pure homozygous.

This proves that the recessive individuals are always pure genotype (homozygous).
But when red individuals of F1 crossed with white one the offspring were 50% red and 50% white.
This is the base of the test cross idea, if an individual has the dominant trait, we can identify its genotypes, if crossed with another caring the recessive allelomorphic from the offspring produce.

a- if the offspring 100% dominate that means the tested individual is pure
b- if the offspring 50%:50% this indicates the tasted one is hybrid

Problems

1- In a certain plant the yellow flowers are dominant character while white is the recessive character what are the phenotype and genotype in F1 and F2 may be produced when 2 individuals one is yellow and the second is white flowered are pollinated giving that the yellow is homozygous.
2- Black male of rabbits crossed with brown female, they produced 8 individuals black
a- which character is dominant and why explain on genetic bases
b- if one of the produced offspring crossed with brown female what are the phenotype and the genotype that will be produced.
3- In pigs long legs dominants short legs
a- if you have a long leg pig how can you identify its genotype. b- how can you get pure strain of short leg pigs.
4- In certain kinds of birds blue feather dominants yellow.
If you have blue bird how can you identify its genotypes to do this you can do test cross with yellow one



The chromosome theory

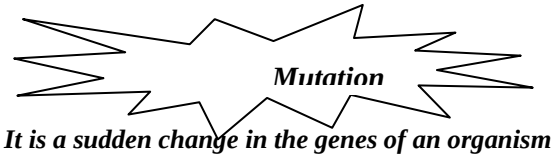
Note:-

- Chromosomes carry the genes.
- Gene is the factor, which controls the characteristics in the cell.
- Chromosome exists in pair.
- Each kind of living organisms is characterized by a certain number of chromosomes in its cell.
- The full number of chromosomes in the body cell is known as diploid number.

- The recent biological studies of the cell especially during gametes formation, cleared that each cell contains diploid number of chromosomes each pair of 2 chromosomes are identical in size, place of genes and shape .BECOUSE OF the number of traits (genes) are more than the number chromosomes during division to produce gametes the number of chromosomes are divided so that each gamete has ½ of the chromosomes (haploid) one chromosome from each pair.
- That means the male and female gametes meet one chromosome from the male and one from the female to produce a zygote with diploid no of chromosomes
- E.g. pea plant has 7 pairs of chromosomes the gametes have 7 chromosomes after fertilization the no of the chromosomes becomes 7 pairs (14) chromosome.
- Relation between Mendel's law and modern study:
    - He put his laws and assumption without knowing any thing about chromosomes or cell division, but he was very lucky because he chose 7 allelomorphic characters.
    - The genes of each character on certain pairs of chromosomes.

Morgan's theory

- The heredity material is built up of chromosomes, which carry the genes.
- Each gene is located in a certain position of a certain chromosome.
- Genes are arranged in a single and unique linear order along the length of the chromosomes.
- The gene is a very tiny particle.
- The gene is a chemical structure responsible for definite specific inherited characteristic.
- Morgan preformed many experiments on a fruit fly called dorosophlia ,
- He selected dorosophlia because of its high rate of reproduction.



It is a sudden change in the genes of an organism and it may be:
Natural due to the exposure to the cosmic rays or artificial due to the exposure to X rays.

Chromosomes and sex determination

- The somatic cells which share in the bodybuilding contain diploid number of chromosomes in homologous pairs (each 2 similar chromosomes are called homologous pair).
- This case is the common case in plants but in animals it differs as the following examples illustrate:

1. ***Drosophila***: It has 4 pairs of chromosomes 3 of them are similar in both male and female (Autosomes) but the fourth pair is different (in male it consists of 2 different chromosomes ***X Y*** while in female ***XX***
   so they can be represented as 6+xy in male and 6+xx in female.
   And we can say that the male is responsible of the determination of the sex of offspring due to the presence of the 2 different sexual chromosomes.
2. ***Humans***: the man have 23 pairs of chromosomes (44+xy in male) and (44+xx in females) so in humans also the man is determining the sex.
3. ***Cucurbita bug:*** the sex determination is due to the number of chromosomes (male has 21 chromosomes and female has 22 chromosomes) ***so*** in this case the male is the sex determiner due to it can produce 2 kinds of gametes (11 and 10) while female can only produce one kind of gametes (11).

Its never too late BUT you must do your best to get the best.