GENETICS

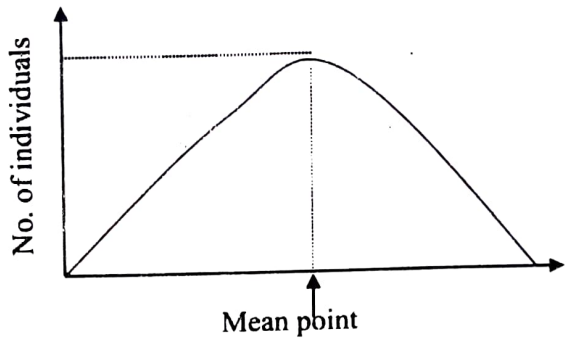
Genetics is the scientific study of heredity and variations between organisms while inheritance describes how the similarities are transferred from the parent to the offspring. The similarities are in form of characteristics such as skin colour, intelligence, height and many others.
Mendel was the first scientist to study genetics and inheritance.

Categories of variation

There are two types of genetic variations.

1. Continuous variations.
These are variations that show a gradual change in individuals without a clear-cut division between the two extremes. It results into formation of intermediates. Such variations include height, intelligence, skin colour, yield in plants, etc. In such variations, organisms are usually very many around the mean/average point.

Graphic illustration of continuous variation



2. Discontinuous variation.
This is a variation, which shows a clear-cut difference between the two extremes without intermediates. This results into expression of only two phenotypes. Examples of discontinuous variations include, tongue rolling, blood groups, sex, etc.

Causes of variation

Some variations are inherited and are called inherited variations while others are occupied as a result of the environment hence called environmental variations.
Examples of inherited variations are blood groups, eye colour, albinism, hair, etc.
Examples of environmental variations are knowledge, etc.

Environmental factors that cause variations

- ✓ Diet
- ✓ Pathogens
- ✓ Altitude
- ✓ Light

Factors that cause inherited variations

- ✓ Mutation
- ✓ Crossing over
- ✓ Fertilization

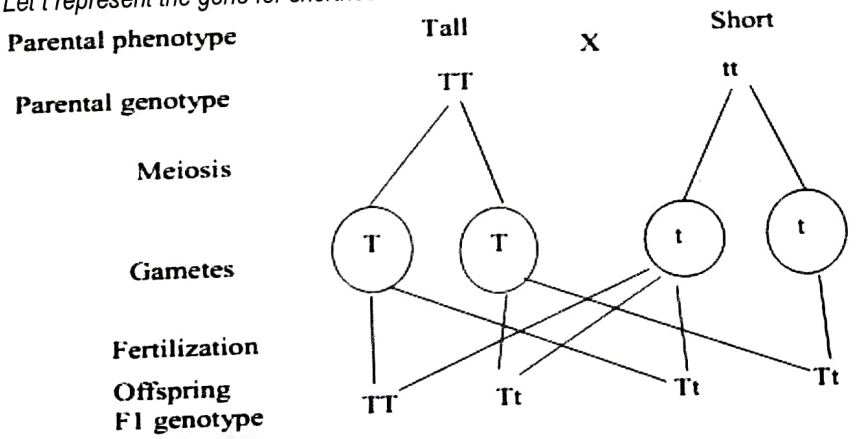
Terms used in genetics.

1. **Chromosome**. These are thread-like structures bearing genes and located in the nucleus.
2. **Chromatid**. This is half of a chromosome split longitudinally.
3. **Bivalent**. This is a pair of homologous chromosomes.
4. **Gene**. This is a unit of the hereditable material found on the chromosome and responsible for controlling a particular trait/character.
5. **Allele**. This is the alternative form of the same gene. Most genes are made up of two alleles. Alleles of the same gene are represented by the same letter but the dominant allele is represented by a capital letter and the recessive allele by a small letter in the case of dominant-recessive characters
6. **Diploid**. This is a description of a cell, which has a whole set of chromosomes.
7. **Haploid**. This refers to a cell with half the set of chromosomes.
8. **Genotype**. This refers to the genetic composition of an organism.
9. **Phenotype**. This is the physical appearance or the outward expression of an individual.

10. **Dominant gene/dominant allele**. This is a description of a gene /allele whose effect is seen in the phenotype of the heterozygous individual. The effect of the dominant gene/allele is seen in the phenotype even in the presence of another gene/allele.
11. **Recessive**. This is a description of a gene whose effect is not phenotypically expressed in the heterozygous state. The effect of a recessive gene/allele is not seen in the presence of another (dominant) gene/allele.
12. **Homozygous**. This refers to a gene with two identical alleles for example if T represents the gene for height where tallness is dominant to shortness then the allele for tallness is T and that for shortness is t. an individual with TT is said to be homozygous tall and tt is said to be homozygous short.
13. **Homozygous dominant**. This is where both alleles of a gene determine a dominant character.
14. **Homozygous recessive**. This is where both alleles of a gene determine a recessive character.
15. **Heterozygous**. This refers to a gene with two different alleles for example if T represents the allele for tallness and t for shortness then Tt is the heterozygous state of this gene.
16. **Hybrid**. This is an offspring produced by parents of two different pure lines.
17. **Incomplete dominance**. This is a condition where neither of the genes is dominant over the other.
18. **Gametes**. These are reproductive cells.
19. **Fertilization**. This is the fusion of the male and female gametes to form a zygote.
20. **Monohybrid inheritance**. This is a type of inheritance, which involves studying a single pair of contrasting characteristics.
21. **Dihybrid inheritance**. This is a type of inheritance, which involves studying two pairs of contrasting characteristics at ago
22. **Test cross**
    This is a type of back cross which involves crossing an offspring having a dominant character with its recessive parent in order to determine the test of that offspring.
23. **Back cross**
    This is the mating of an offspring with one of its parents.

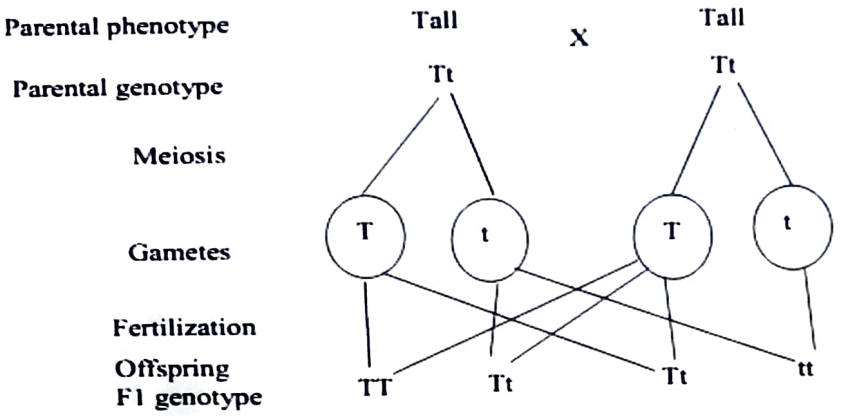
MENDEL'S EXPERIMENT

For his experiment he collected one of the varieties of garden peas (*pisum sativum*) with contrasting features such as one variety was producing tall plants when stems are about 200cm and another short plant with stems of 25cm. He crossed these plants for his experiments.
He crossed pure tall pea plants with pure short pea plants and all the off springs were tall (F1 generation)
Tallness was the dominant character and shortness the recessive character.
The dominant character is represented using a capital letter while the recessive character is represented using a small letter.
Let T represent the gene for tallness
Let t represent the gene for shortness



Offspring phenotype: All tall

Mendel then selfed the plants of the F1 generation and obtained an F2 generation with tall and short plants in a ratio of 3:1



Genotypic ratio; TT: Tt: tt = 1:2:1
Phenotypic ratio; 3 tall: 1 short

Mendel's conclusions

Mendel suggested the following to explain his results.

1. Gametes like pollen grains and ovules of the garden peas carry characters determining factors through which resemblance is passed on from one generation to the next.
2. A character like height of the garden pea is controlled by a pair of genes. These separate during formation of gametes and only one goes into each gamete. This means that only half of the usual number of genes is present in the gametes. However the normal number is restored at fertilization by the fusion of the two gametes
3. He named a gene determining a dominant character as a dominant gene and one determining a recessive character as a recessive gene. In his representation dominant genes were given capital letters and recessive genes were given small letters.

Mendel's laws of inheritance

From his observations, Mendel put up two laws of inheritance.

First law: The law of segregation.

This law states that the character of an organism is determined by a pair of alleles. Only one allele of such a pair is carried in a gamete.

Second law: The law of independent assortment.

This states that each of the alleles in a pair may combine with another allele from another pair randomly.

Conclusions from Mendel's' crosses.

1. A character can be transmitted from parent to offspring independent of other characters.
2. Genes occur as a pair of alleles.
3. Only one allele of the same gene is carried in a single gamete.

MONOHYBRID INHERITANCE

Inheritance is the passing over of characteristics of the parents to their off springs. Monohybrid inheritance involves the study of how one character is inherited from the parents to the off springs. Mendel carried out several experiments on peas to study monohybrid inheritance.

Mendel chose garden peas for his experiments because of the following reasons:

1. They grow very fast and produce results in a very short period of time.
2. They are relatively small and can be grown on a small plot for study purposes.
3. Some of their characters are controlled by single genes, which make it easy to study them.
4. They have characteristics, which show clear-cut differences without intermediates like tall and short, green and yellow cotyledons, etc.

He therefore concluded that their reproduction can be manipulated by pollination.

Questions:

What would be the offsprings for a cross between homozygous black and homozygous brown. Take B for black and b for brown.

Let the gene for black fur be represented by B and that for brown b.

Note.

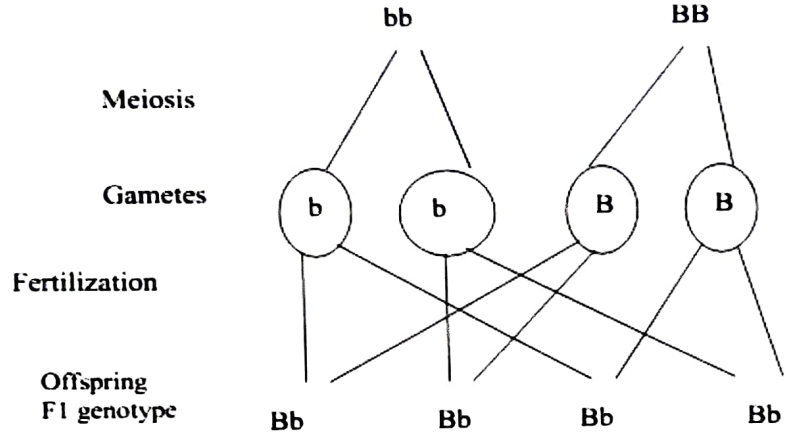
1. It is one gene controlling a character, which is fur colour. For this reason we use the same letter
2. Black colour is dominant that is why we use (B) and brown is recessive (b)
3. The term pure-breeding is used to mean homozygous for that particular gene.

Crosses.

Parental phenotype **Brown Male** **Black Female**

X

Parental genotype bb BB



Offspring genotype: all Bb (heterozygous)

Offspring phenotype: all black.

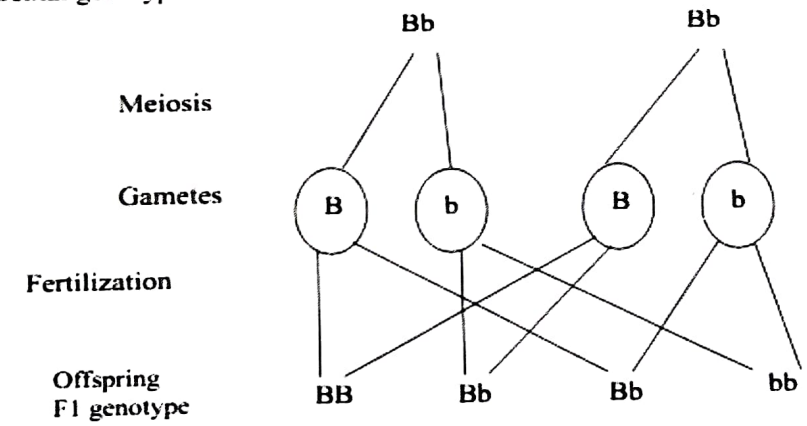
They are all black because black is dominant to brown and it shows up in the heterozygous state.

Consider Selfing of F1 (crossing two offsprings of F1 above).

Parental phenotype **Black Male** **Black Female**

X

Parental genotype Bb Bb



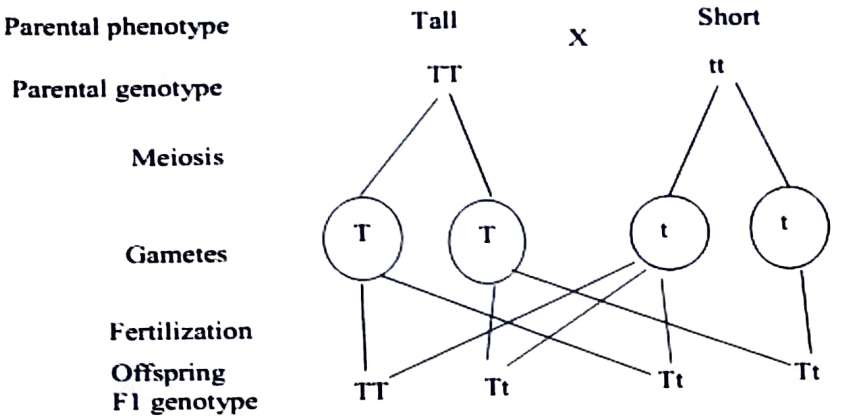
F2 phenotypic ratio. 3 black: 1 brown

3:1

Example ii

Consider a gene for height in garden peas. Tallness is dominant over shortness.

Let the gene for tallness be represented by T and that for shortness t. show the cross between pure-breeding tall pea and a pure-breeding short pea.



F1 phenotype. All offsprings are tall.
Selfing of F1 produces F2 with a phenotypic ratio of 3 tall to 1 brown. (3:1)

Monohybrid inheritance in human beings

1. Albinism

This is a condition in human beings where the individual fail to produce skin pigments called melanin.
Albinos have;

- ✓ Light skin
- ✓ White hair
- ✓ Pink eyes
- ✓ They are sensitive to bright light

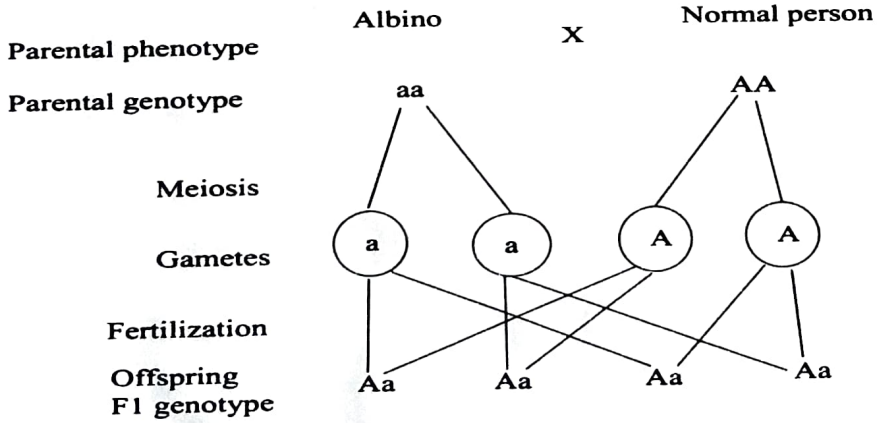
Albinism is caused by a recessive gene.

Examples

1. *What would be the off springs if an albino marries a normal person?*

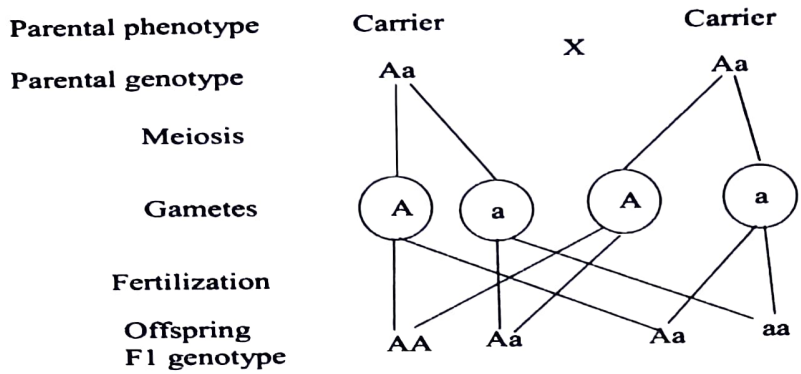
Let A represent the allele for normal skin colour
Let a represent the allele for no skin colour

Genotype	Phenotype
AA	Normal skin colour
Aa	Carrier for albinism
aa	albino



All the off springs will be carriers of albinism

2. *What would be the off springs when 2 individuals who are carriers of albinism get married?*

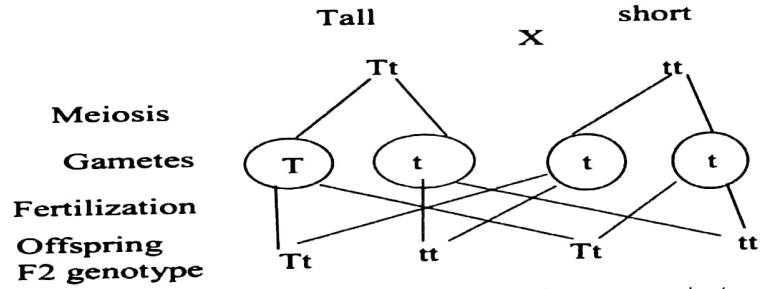


Genotypic ratio; 1 normal: 2 carrier: 1 albino
1:2:1
Phenotypic ratio; 3:1

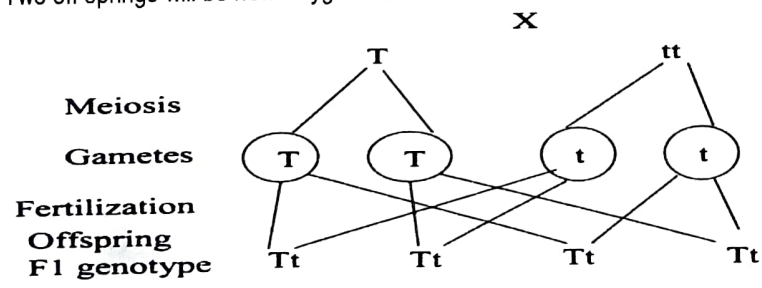
Assignment:
In peas, yellow seed colour is dominant over green seed color. What would be the phenotype of the offspring if a true breeding yellow-seeded plant is crossed with a green-seeded plant?

Test cross

A test cross is used to distinguish between homozygous and heterozygous dominant forms. This is when an F1 individual with the phenotype of the dominant parent is crossed with the recessive parent to determine the phenotype of the parent.
If the F1 is homozygous dominant, all the off springs will show the dominant character.
If the F1 individuals are heterozygous, a 1:1 ratio of dominant or recessive characters is obtained. E.g.
Let T represent the allele for tallness
Let t represent the allele for shortness



Two off springs will be heterozygous tall and 2 will be homozygous short.



All are heterozygous tall

Question:
The fruit fly (drosophila melangaster) usually has wings twice as long as its abdomen but some drosophila have very short or vestigial wings. A long winged drosophila (male) was crossed with a vestigial winged female drosophila and all the F1 off springs were long winged. The long winged F1 generation were then mated.

i) How can the cross be represented diagrammatically
ii) State the phenotypes of the off springs in the F2 generation and state their genotypic ratio.

iii) What is the percentage of the vestigial winged drosophila flies in the F2 generation?
iv) A drosophila is normally used in experiments on heredity, why do you think it is suitable for such experiments.

Solution:

Let L represent the allele for long wing and l represent the allele for vestigial wing l
The long winged female can be LL or Ll because long winged is dominant to short winged.

i)

Parental phenotype Vestigial winged female X Long winged male

Parental genotype ll LL

Meiosis

Gametes l l L L

Fertilization

Offspring F1 genotype Ll Ll Ll Ll

F1 phenotype. All long winged.

ii)

Parental phenotype Long winged X Long winged

Parental genotype Ll Ll

Meiosis

Gametes L l L l

Fertilization

Offspring Genotype LL Ll Ll ll

One of the off springs will be homozygous long winged
Two of them will be heterozygous long winged
One of them will be homozygous short winged or vestigial winged
Genotypic ratio; 1:2:1

iii) ¼ x100=25%

iv) It's because they:

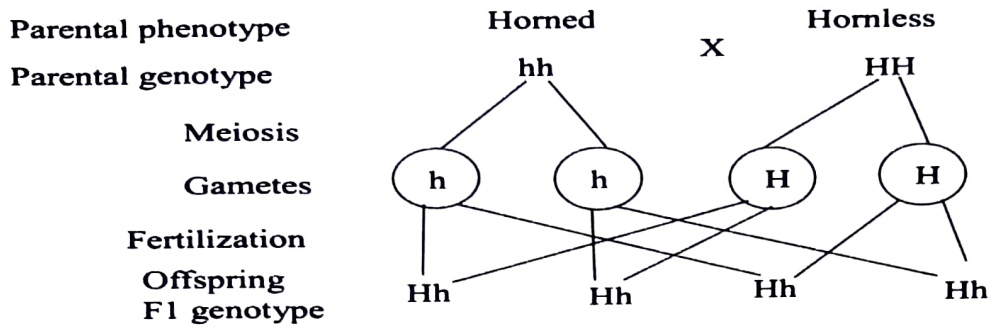
- ❖ Have contrasting characters
- ❖ Have short life span
- ❖ Show clear cut differences.

Question:

In cattle, the gene for hornless condition is dominant over one for horns. A pure hornless cow was mated with a horned bull. Using genetic symbols, show the possible phenotype and genotype of the F1 offspring.

Solution:

Let h represent the allele for horned condition.
Let H represent the allele for hornless condition



All were horned cows.

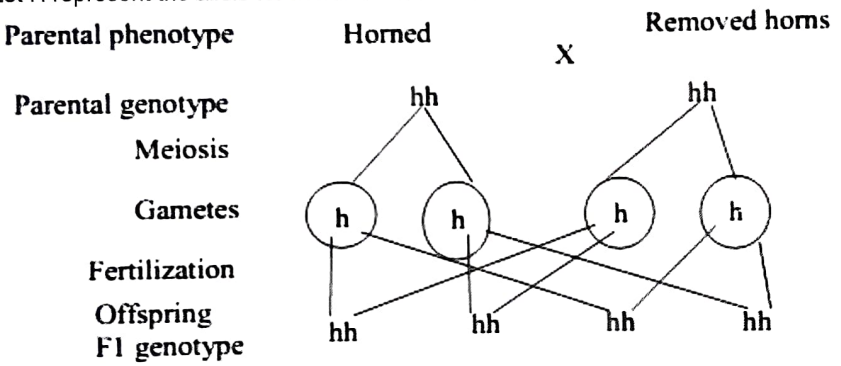
Question:

A bull whose horns were removed was mated to a horned cow. Show the possible genotypes and phenotypes of the F1 off springs. Give a reason for your answer.

Solution:

Let h represent the allele for horned condition.

Let H represent the allele for hornless condition



All are horned

Note: Because the bull with cut off horns still has the genes for horned and cutting off the horns doesn't change the genes.

Sex determination in human beings

There are 23 pairs of chromosomes in each cell of the human body. One pair determines the sex of the individual and they are called sex chromosomes.

There are two sexes, i.e. male and female. The gene controlling sex is carried in the reproductive cells on the sex chromosomes. There are two sex chromosomes the X chromosome and the Y chromosome. These chromosomes occur in a pair to determine the sex of an individual. Each gamete carries one of the sex chromosomes.

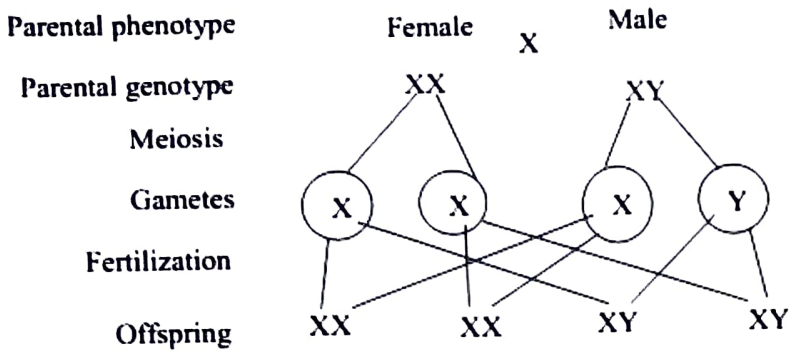
In males some of the sperms contain the X chromosome while some contain the Y chromosome. Y only occurs in males.

In females all the eggs contain the X chromosome.

At fertilization, a sperm fuses with the egg. If the X sperm fuses with an egg (X), the resulting offspring is XX and is a female. If a Y sperm fuses with an egg (X), the resulting individual is XY and is a male. Therefore the male determines the sex of the offspring. This is because the male produces two different sperms (X and Y) while the female produces only eggs with X chromosomes.

Note: The Y sperms are more active and persistent than the X sperms. This increases the chances of an ovum to be fertilized by a Y sperm. So to every 100 girls, 120 boys are born but more boys than girls die at the time of birth.

Illustration:



Phenotypic ratio; 2 boys: 2 girls

SEX LINKED TRAITS/CHARACTERS

These are traits or genes associated with the sex of the individual. These characters are carried on the sex chromosomes and are controlled or determined by the genes on those chromosomes. Such characters appear in a recessive form hence are very common in males than in females. Such characters include;

- ✓ Colour blindness
- ✓ Haemophilia (bleeder disease)
- ✓ Etc.

Inheritance of colour blindness

Colour blindness is a defect of the eyes caused by a recessive gene on the X chromosome.

Example

Let B represent the allele for normal colour vision

Let b represent the allele for colour blindness

Genotype	Phenotype
X^BX^B	Normal female
X^BX^b	Carrier female
X^bX^b	Colour blind female
X^BY	Normal male
X^bY	Colour blind male

Question:

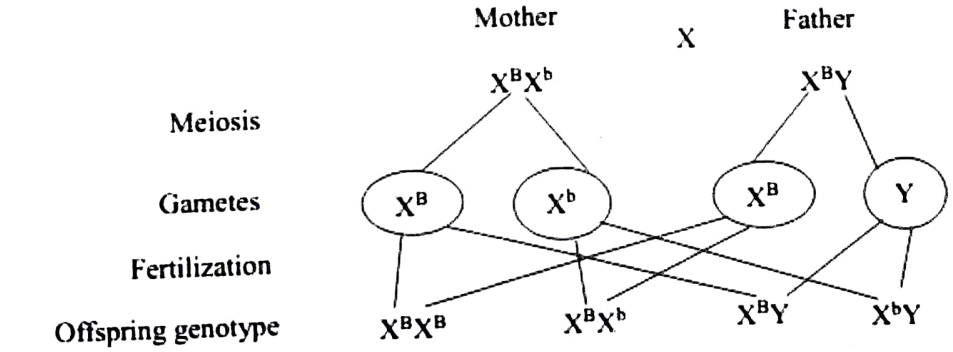
i) What would be the off springs when a carrier female for colour blindness marries a male with normal colour vision?

ii) Write the genotypic ratio of the off springs and make a comment of their condition.

Solution:

Let B represent the allele for normal colour vision

Let b represent the allele for colour blindness.



Genotypic ratio 2:1:1

2 will be normal girls (females)

1 will be normal boy (male)

1 will be carrier girl (female)
1 will be colour blind boy (male)

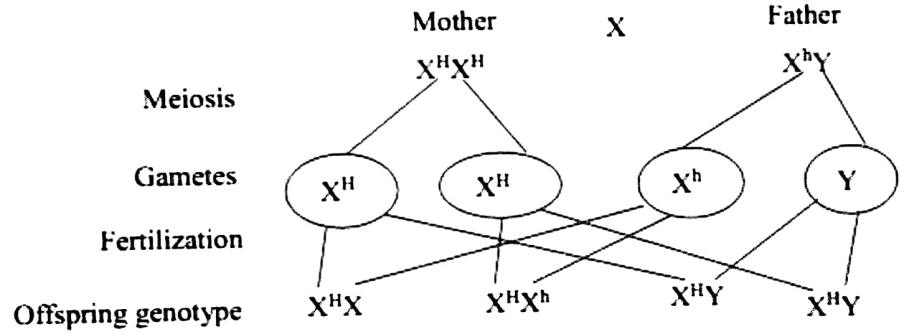
Assignment:
What would be the offspring if a colour blind woman marries a normal man?

Inheritance of haemophilia (bleeder disease)

It is a disease in which blood takes a long time to clot at a wound. It is also known as the bleeder's disease. This disease is caused by a recessive gene which is carried on the X chromosome.
Let H represent the allele for normal blood clotting
Let b represent the allele for haemophilia

Genotype	Phenotype
X^HX^H	Normal female
X^HX^h	Carrier female
X^hX^h	Haemophiliac female
X^HY	Normal male
X^hY	Haemophiliac male

Question:
What would be the off springs if a normal woman marries a haemophiliac man?
Solution:
Let H represent the allele for normal blood clotting
Let h represent the allele for haemophilia



2 carrier females: 2 normal males

Sex limited traits

These are characteristics that only show in one sex e.g. secondary sexual characteristics, hairy pinna, etc.

Sickle cell anaemia

It is due to a mutation of a gene. A person suffering from sickle cell anaemia has a defective type of haemoglobin. ***It is caused by a recessive gene.***
When the concentration of oxygen is low in blood, the red blood cells assume the shape of a sickle. Because of this, the red blood cells cannot absorb oxygen properly.
This is a hereditary disease and can be passed on to the children by the parents in their gametes. Sickle cell anaemia has a fatal effect on people who are homozygous for this mutated gene.
People who are heterozygous i.e. they have mutated and non-mutated genes have normal red blood cells.

Example:
Let B represent the allele for normal RBC
Let b represent the allele for sickle shaped RBC

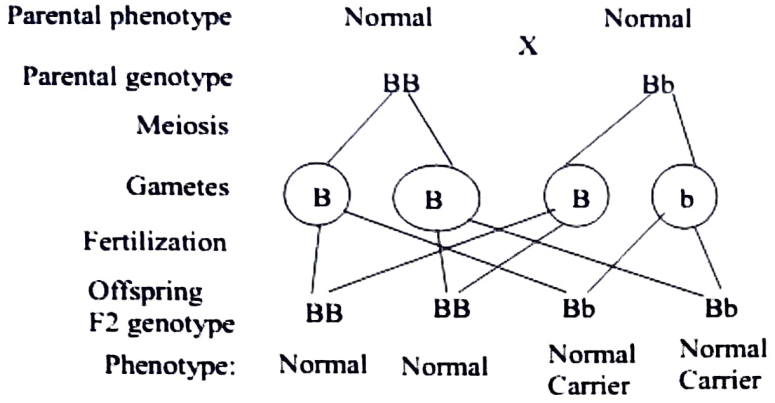
Genotype	Phenotype
BB	Normal RBC
Bb	Normal but carrier
bb	Sickle shaped RBC

Question:

A normal male married a carrier female for sickle cell anaemia. Determine the phenotype and genotype of the children.

Solution:

Let B represent the allele for normal RBC
Let b represent the allele for sickle cell



Assignment:

A normal male whose mother had sickle cell anaemia married a carrier female. What percentage of their children had sickle cell anaemia?

EXCEPTIONS TO MENDELIAN INHERITANCE

The following do not conform to the process of inheritance as illustrated by Mendel.

1. Linkage
2. Incomplete dominance.
3. Co-dominance
4. Multiple alleles.

CO-DOMINANCE

This is a condition where genes determining a particular character all show up such that the phenotype of the offspring is a mixture of that of the parents. All the characters of either parents appear in the offspring, e.g. black and white gives white and black spots in the offspring. ***It mainly occurs in animals.***

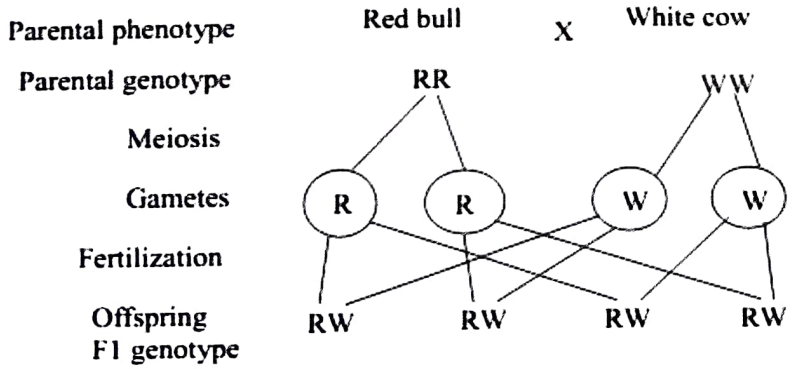
Co-dominance is where in the heterozygous state neither allele is completely dominant over the other i.e. the 2 alleles are co-dominant. This results in the phenotype intermediate between the parent's appearances. The alleles for each trait are represented with different capital letters.

Questions:

1) In animals, the genes for fur colour are co-dominant. What will be the offsprings when a red bull is crossed with a white cow?

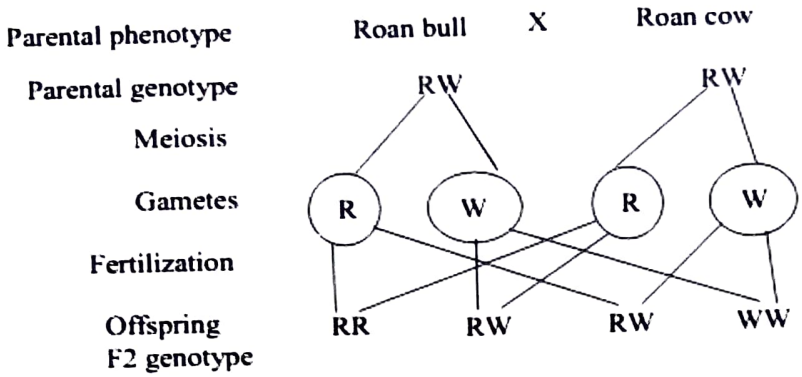
Solution:

Let R represent the allele for red bull
Let W represent the allele for white cow



F1 phenotype: all the off springs will be roan.

2) What would be the off springs in the 2nd generation?



F2 phenotype: 1 red, 2 roan and 1 white.

INCOMPLETE DOMINANCE

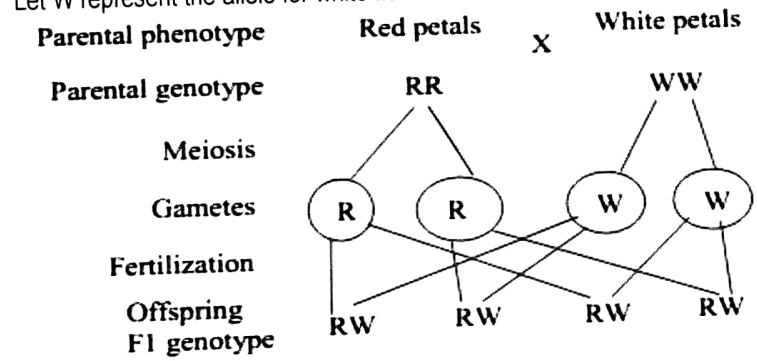
This is a condition in the heterozygous where neither of the alleles is dominant over the other and the phenotype of the offspring is an intermediate between that of the parents. An intermediate of the parents' phenotype results, e.g. black and white gives grey. ***It mainly occurs in plants.***

For example, consider petal colour in flowers: when a red flowered plant is crossed with a white flowered plant, the offsprings produced are all pink coloured petal flowers.

Example:

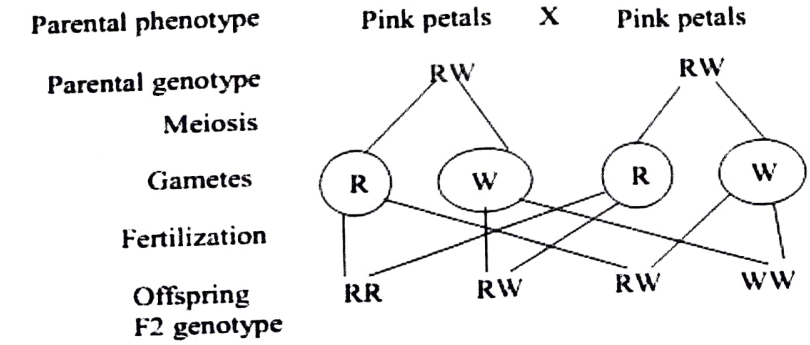
Let R represent the allele for red petal colour.

Let W represent the allele for white flowers



F1 phenotype: all pink petals.

Then Selfing F1. (Cross between offspring in F1)



F2 phenotype: 1 red, 2 pink and 1 white.

F2 Phenotypic ratio: 1 red: 2 pink: 1 white. (1:2:1)

MULTIPLE ALLELES

This is where one character is determined by more than two alleles. This implies that a single gene contains more than two alleles. An example is blood group inheritance.

Inheritance of blood groups

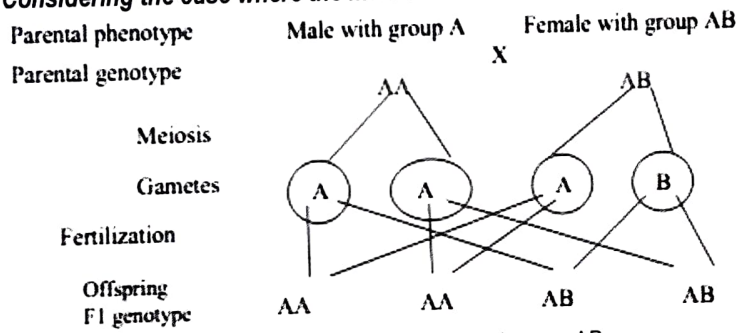
The gene controlling blood groups is made up of three different alleles (multiple alleles). These alleles are A, B and O. The inheritance of blood groups is also an example of co-dominance. There are 4 blood groups that is group A, B, AB and O. An individual inherits two of these alleles one from each parent. The table below shows the possible blood groups that can arise from the different genotypes.

Genotype (alleles)	Blood group (phenotype)
AA	A
OA	A
BB	B
OB	B
AB	AB
OO	O

Example:
Work out the possible blood groups of the off springs produced if a man of blood group A marries a woman of blood group AB

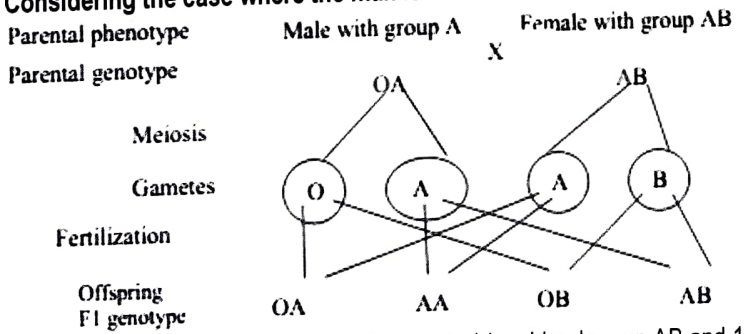
Solution:
The man can have two possible genotypes, i.e. OA and AA. This is because allele A is dominant to allele O.

Considering the case where the man is AA



Offspring phenotype: 2 blood group A and 2 blood group AB

Considering the case where the man is OA



Offspring phenotype. 2 have blood group A, 1 has blood group AB and 1 has blood group B

Assignment one:

a) What is meant by genotype? (01 mark)
b) A man of blood group A, married a woman homozygous for blood group B and they produced a son of blood group B.
   i). Work out the genotypes of the father and of the son. (04 marks)

ii) The son married a wife of blood group O. Show your working and give the percentages of the possible phenotypes of their offspring. (03 marks)

c) Blood groups in humans show discontinuous variation. Explain what you understand by this statement. (02 marks)

Assignment two:

a) i) Give any four differences between mitosis and meiosis. (4 marks)
ii) Give the parts where meiosis occurs in plants and animals respectively. (2 marks)

b) What is the relevance of meiosis? (2 marks)

c) When a white haired male fox was mated with a black haired female fox, both pure breeding, all off springs were grey.
i) Explain why the offsprings were grey in colour? (1 mark)
ii) Using genetic diagrams, show how the F1 offsprings were produced; and F2 offsprings if two of the F1 foxes were allowed to interbreed. (6 marks)

Application of genetics

i) The study of genetics encourages breeding of animals with good characteristics to improve livestock.
ii) It helps to eliminate or reduce harmful characteristics through the study of genetics.
iii) Through genetic counseling and advice individuals may be advised on the possibility of their off springs.
iv) It helps in prediction of offspring from two mating individuals and solves problems like fraternal uncertainty.

MUTATION

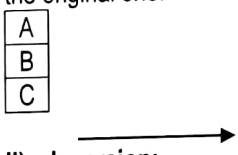
This is a sudden/spontaneous change in the structure and composition of a gene or chromosome.

Types of mutation

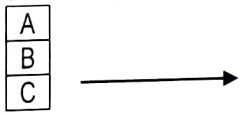
i) Chromosome mutation: this is a sudden change in the number or structure of a chromosome.
ii) Gene mutation: This is a sudden change in the chemical nature of a gene.

Types of chromosome mutation

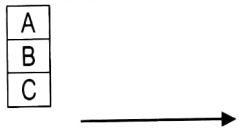
i) Deletion:
This is when a piece of chromosome is broken off and lost therefore the chromosome becomes shorter than the original one.



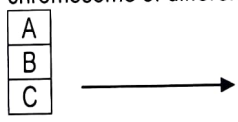
ii) Inversion:
A piece of the chromosome breaks and joins on a different side of the same chromosome.



iii) Duplication:
A chromosome gains a piece from another chromosome of the same type and becomes longer.



iv) Translocation:
A piece of chromosome breaks and joins to another chromosome of different type.



Examples of chromosome mutation in man

i) **Turner's syndrome:** the individual has one X chromosome. This gives rise to a sterile abnormal short female and it is due to loss of one sex chromosome.
ii) **Down's syndrome (mongolism):** this is due to the increase in the number of chromosomes. The individual is mentally retarded with weak muscles, a big or large head, a broad chest, stunted growth and dropped eyes.
iii) **Clinefelter's syndrome:** this is due to an additional X chromosome in an individual. This results in a sterile male who may be mentally retarded.

Examples of gene mutation are: Albinism and Sickle cell anemia

Causes of mutations.

Mutations are caused by substances generally referred to as **mutagens**. These include;

i) High temperatures.
ii) Chemicals such as mustard gas, colchine and caffeine.
iii) High-energy particles such as alpha and beta particles.
iv) High-energy radiations such as x-rays, gamma rays and ultra violet radiations.

Note; most mutations are disadvantageous and recessive. They are rare but persistent in the population.

EVOLUTION

Evolution is the process by which more complex forms of organisms arise from simpler forms over a long period of time. Or

This is a gradual process by which organisms change from simple to complex forms over a period of time.

But how then did the first primitive organisms arise and from where? To answer the question, many biologists have tried to put up theories to explain the origin of life.

Theories of origin of life

The origin of life is not exactly known. However some theories have been put forward to explain the origin of life. These are:

1. **Special creation theory:**

All living things were created by God.

2. **Steady state theory:**

It suggests that life has no origin and it has been in existence.

3. **Spontaneous generation theory:**

It suggests that life arose from non-living matter.

4. **Cosmozoan theory:**

It suggests that life arose from another planet of the universe and arrived on earth by some means.

5. **Biochemical evolution theory:**

It suggests that inorganic molecules i.e. DNA and chromosomes and other protein molecules were organized into a basic unit of life called a cell.

It is the most accepted theory of the origin of life. The simple life (cell) gradually underwent numerous changes along different lines to form the present diversity of complex organisms.

This confirms that all the present organisms despite of their differences arose from the same ancestors, a process called ***evolution.***

Natural selection

This is the process by which organisms that are better adapted to the environment survive to reproduce while those less adapted fail to do so and become extinct. Or

This is a process by which nature selects for the best adapted organisms and selects against the less adapted ones.

When the environment changes, it affects organisms and those, which possess characters that enable them to survive in the changing environment survive while those less adapted, die over a long period of time. This occurs because organisms possess variations (differences between them).

The survival of the best adapted and removal of the less adapted is known as ***survival for the fittest.***

This theory was stated by Charles Darwin.

Darwin suggested that there must be a struggle for existence where by the fit individuals (better adapted) survive and the unfit ones die (survival for the fittest). Over a very long period of time these organisms can change into a different species.

EVIDENCE OF EVOLUTION

There are several evidences put forward to support the theory of evolution. These include;

- ✓ Comparative anatomy
- ✓ Comparative embryology
- ✓ Paleontology
- ✓ Taxonomy

- ✓ Comparative biochemistry
- ✓ Geographical distribution of organisms

1. Paleontology

This is the study of fossils. Fossils are remains of organisms that lived in the past and were preserved in rocks. Fossil studies show that organisms that lived in the past had some resemblance to the present day organisms. This shows that they had a common ancestry. The differences between them shows that evolution has occurred in the present day organisms.

2. Comparative embryology.

The study of the development of the zygote shows that organisms had a common ancestor. In all vertebrates for example the zygote develops a tail in the early stages and it is surrounded by membranes (amnion and allantois).

3. Cell biology.

The study of cells shows similarities between organisms. For example all cells of multicellular organisms have a nucleus, mitochondria and other organelles. This shows that the organisms had a common ancestry. The differences e.g. chloroplasts in plant cells shows that evolution took place

4. Comparative anatomy.

When anatomical structures of organisms are studied, they show similarities and differences. Similarities indicate that the organisms had a common ancestor while the differences show that they have evolved. For example all vertebrates have a pentadactyl limb but the limb has been modified in the different vertebrates and it performs different functions.

Homologous structures: These are structures from the common ancestral origin that serve different functions e.g. the pentadactyl limb composed of five digits like in the horse for running, monkeys for grasping, human beings for handling and bats for flying.

This type of evolution is called ***divergent evolution*** which is the type of evolution where by organisms with common ancestors have developed structures that perform different functions because of change in the environment they live in.

When structures are further compared, it is observed that some of them differ but serve the same functions. Such structures are known as ***analogous structures.***

Thus ***analogous structures are structures from different ancestral origin but serve the same functions***. Such evolution is called convergent evolution which is a type of evolution where by different organs with different ancestral origins perform the same function. This is because of the similar environments they live in e.g. wings of birds and wings of insects.

5. Comparative biochemistry.

The study of chemical composition and functioning between living organisms shows that they have a common ancestor for example all organisms have DNA, they have enzymes made out of protein, etc.

6. Geographical distribution:

Distribution of plants and animals in different parts of the world indicates evolution. I.e. different environment look different. However some organisms in different geographical location are similar meaning that they had a common ancestor.

"What men have done, man can do"

REPRODUCTION

Reproduction is the process by which organisms multiply to increase in number. This is important in maintaining the life of organisms from one generation to another.

Types of reproduction

There are two types of reproduction.

1. Asexual reproduction
2. Sexual reproduction.

ASEXUAL REPRODUCTION

This is a type of reproduction, which does not involve fusion of gametes, and therefore only one individual is involved. This type of reproduction takes several forms, which include the following.

a) Budding.

This is a mode of asexual reproduction in which an organism develops an outgrowth (bud), which detaches its self from the parent organism and starts to grow as a self-reliant organism. It is common in yeast and hydra.

b) Spore formation

This is a mode of asexual reproduction, which involves production of spores. Spores are microscopic structures, which can be dispersed and have the ability to germinate into a new organism under favorable conditions. This mode of reproduction is common in fungi and some bacteria.

c) Fragmentation

This is a mode of asexual reproduction where an organism breaks into many small parts (fragments) and each is able to grow into a new individual. It is common in tapeworms and spirogyra.

d) Binary fission

This is a mode of asexual reproduction where a single celled organism divides up into two parts, which start to grow as separate individuals. It is common in amoeba and other protozoans

Question:

Describe the process of asexual reproduction in;

i) Amoeba
ii) Rhizopus
iii) Yeast
iv) *Spirogyra*

e) Multiple fission

This is a mode of asexual reproduction where a single celled organism divides into many parts, which grow into separate individuals. This occurs in plasmodium.

f) Vegetative reproduction

This is a mode of reproduction in plants where part of the plant other than the seeds develops into a new individual.

This normally takes place in rhizomes, bulbs, corms, suckers, stolons, runners etc

Table showing various parts of vegetative propagation/asexual reproduction in plants

Name of plant part	Characteristics	Examples
Rhizome	Underground stem, swollen with food, has lateral buds, has scale leaves, and has nodes and internodes.	Ginger, Cana lily
Stolon	Underground stem, not swollen with food, has lateral buds, has scale leaves.	Couch grass, spear grass
Runners	Grows on the surface, has fibrous roots, has lateral buds, has scale leaves, has nodes and internodes.	Star grass
Bulbs	Leaves swollen with food, has a short stem, has adventitious roots, has scale leaves, has thick foliage leaves, has lateral buds.	Onions, garlic
Corms	Vertical stem swollen with food, has adventitious roots, has lateral buds, and has scale leaves.	Yams
Suckers	New individual plant produced alongside the parent plant	Pineapple, banana

Advantages of vegetative reproduction

- New plants resemble the parent plant and any good quality in the parent is retained.
- The growth of the new plant is rapid.
- The reproductive organ stores plenty of food which the new plant uses.
- It does not involve processes like pollination, fertilization and dispersal agents are not required.
- Large areas can be covered in relatively little time.
- It involved only one individual.

Disadvantages

- Since new plant grows on its parent, it can lead to crowding.
- Shortage of water and mineral salts is likely to occur due to competition.
- Diseases of the parent plant can be transmitted to the young ones.
- If the parent plant has poor characters, they can be maintained by the young ones.

ARTIFICIAL VEGETATIVE PROPAGATION

This is a mode of reproduction where man is involved in the propagation process. It is done in several ways, which include, budding, grafting, layering, cuttings, etc.

1. Budding

This is the process where a bud is detached from a plant and grown in suitable conditions into a new plant.

2. Grafting

This is the insertion of part of one plant onto another plant so as to come into organic union and to grow as one plant. The part inserted can be a bud or a shoot of a plant and it is called a **scion**. The part in the ground on which the scion is inserted is called a **stork**. The scion and stock should be of different varieties but same species.

3. Layering

This is where a branch of a plant is bent to touch the ground and allowed to develop roots. When the roots are developed, it is cut from the plant and it starts to grow as a separate self-supporting plant.

Advantages of asexual reproduction

1. It is reliable because it is less likely to be affected by adverse environmental factors like for the case of seeds.
2. It leads to genetic consistence since there is no mixing of genes during reproduction.
3. It results into early maturity because the organisms produced have enough food reserve from the parent.
4. It is self-sufficient because it does not rely on external processes like pollination, fertilization and dispersal.
5. It does not result in indiscriminate and wide spread distribution like in the case of seeds, which leads to wastage.
6. It does not require formation of sex organs.
7. It is the only means of reproduction in some organisms.

Disadvantages of asexual reproduction

1. It leads to maintenance of bad characters.
2. It does not introduce variations in the offspring since there is no gene mixing.
3. It easily results into competition between offspring due to overcrowding.
4. It gradually results into reduction of the strength and vigor of the succeeding generations.
5. There is a high chance of disease transmission from parent to offspring.

SEXUAL REPRODUCTION

This is a type of reproduction which involves the fusion of male and female gametes to form a zygote.

SEXUAL REPRODUCTION IN NON FLOWERING PLANTS

Reproduction in spirogyra

Spirogyra is a green non flowering plant belonging to a group of plants known as algae. The main type of sexual reproduction in spirogyra is conjugation.

Spirogyra reproduces by conjugation between filaments lying side by side as follows;

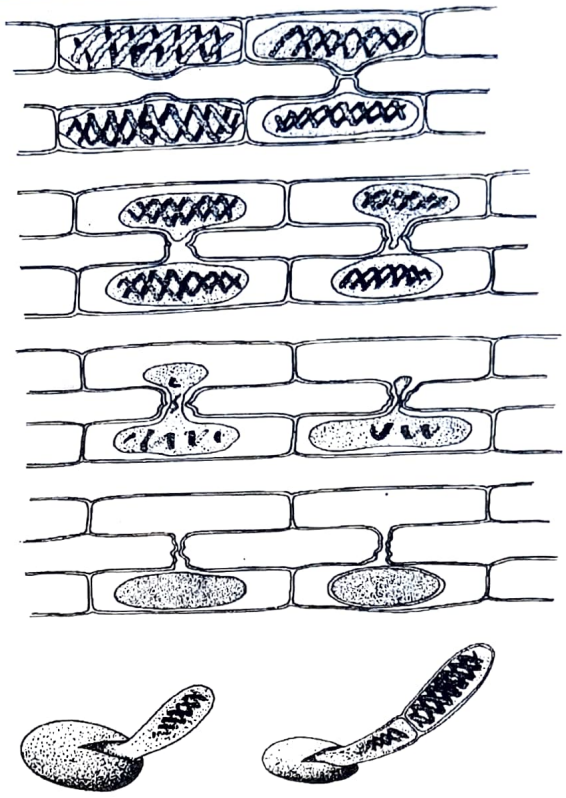
i) The opposite cells of the two different filaments lying side by side develop a swelling or an out-growth which begins to grow towards each other.

ii) On touching they dissolve to form a conjugation tube and at the same time the contents change into gametes.

iii) The gametes from one cell (male gamete) migrate through the conjugation tube to another cell (female) gamete.

iv) The two gametes fuse to form a zygote which develops a thick resistant wall and becomes a zygospore.

v) When the conditions are favorable, the zygospore germinates and grows into another filament.



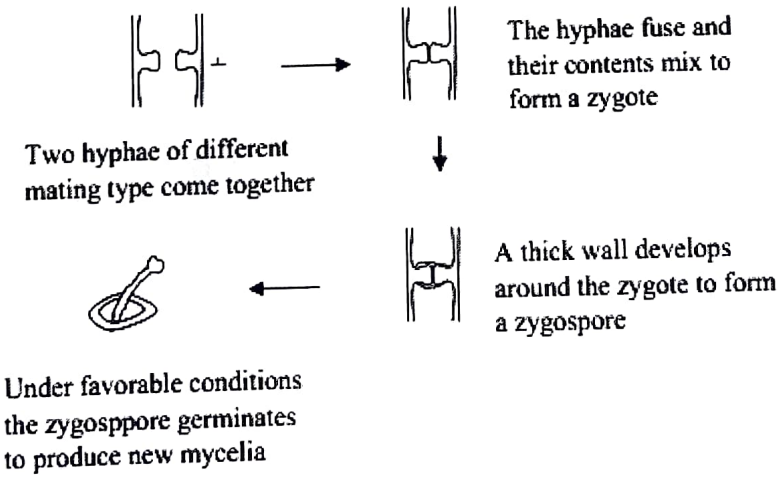
Sexual reproduction in fungi (Rhizopus) E.g. mucor

i) The tips of the two hyphae of different mycelia become swollen and grow towards each other until they touch. The two opposite swellings are referred to as positive and negative hyphae.

ii) The swellings are cut off from the rest of the mycelia by a cross wall, nuclear division takes place and each swelling contains several nuclei.

iii) When they touch, the wall dissolves and nuclei fuse in pairs. The thick outer cover forms around them to form a zygospore. This remains dormant for as long as conditions are unfavorable but germinate if the conditions are favorable.

Diagram to show sexual reproduction in Rhizopus



SEXUAL REPRODUCTION IN FLOWERING PLANTS

In flowering plants the flower is the reproductive organ.
The male gametes are the male nuclei found in the pollen grains produced by the anthers.
The female gametes are the egg nucleus and polar nuclei found inside the ovules located in the ovary. These two are brought together shortly after pollination.

POLLINATION

Pollination is the transfer of pollen grains from the anther of a flower to the stigma of the same flower or different flowers of the same species.
Pollination is of two types; Self-pollination and Cross pollination.
Self-pollination; is the transfer of pollen grain from anther of a flower to the stigma of the same flower.
Cross pollination; is the transfer of pollen grain from anther of a flower to the stigma of another flower of the same species. Flower may or may not be from the same plant.

Features that promote cross pollination

- Brightly colored petals.
- They have a nice scent to attract insects.
- Produce nectar which is food source for the insects.
- Stamen produce sticky pollen grains which adhere firmly to the bodies of visiting insects.
- The stigma are flat, lobbed and have sticky surface to which pollen grain can easily adhere.
- Presence of landing plat form and pollen guide which ensures that insects visit the flower.
- Stamen hanging outside the corolla to ensure that pollen grains are blown away by wind to another flower.

Characteristics of wind pollinated flowers

- Usually not brightly colored
- Not scented and lack nectar.
- Stamen of wind pollinated flowers produce large quantity of light powdery pollen grains.
- Usually small and inconspicuous but are borne in large inflorescences.
- The stigma are large often feathery and hang outside the flower by long styles. This provides a large surface area on which pollen grains floating in the air may be trapped.

Arrangements that promote self-fertilization (arrangements preventing cross pollination)

i) Maturation of both male and female parts of the flower at the same time.
ii) Flowers borne underground.
iii) Flowers being bi-sexual.
iv) Flowers remaining closed.

Arrangements that promote cross pollination (arrangements preventing self-pollination)

i) Possession of unisexual flowers such that both sexes appear on different plants (dioecious). E.g. in pawpaw
ii) Self-sterility in monoecious plants like maize.
iii) **Dichogamy,** a condition in which the stamens and pistils do not ripen at the same time. This results in failure of cross fertilization. If the stamens ripen before the pistil the condition is referred to as **protandry** while if the pistil ripens before the stamens it is called **protogyny.**
iv) Stigmas being higher than anthers.

Differences between wind pollinated and insect pollinated flowers.

Wind pollinated	Insect pollinated
1. Produce light pollen grains	Produce relatively large and heavier pollen grains.
2. They produce large quantities of pollen grains	Produce small quantities of pollen grains.
3. They are usually not scented	They are scented.
4. Petals are dull colored.	Petals are brightly colored.

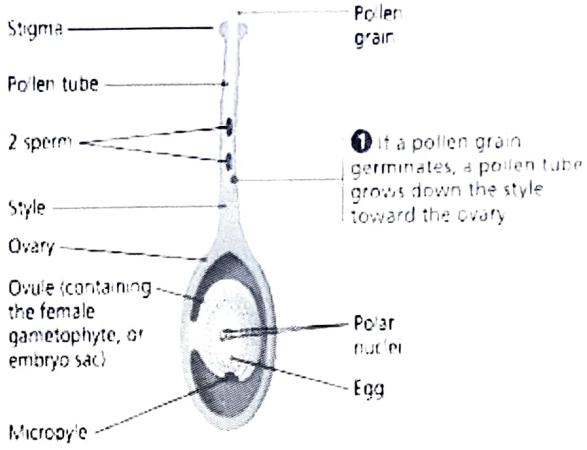
N.B:
Self-pollination has the disadvantage of failing to introduce variation in the new generation. This results into maintenance of poor characters from one generation to the next.
Cross pollination results into mixing of genetic material which leads to variation. This results into introduction of new character from one generation to the next.

FERTILIZATION IN PLANTS

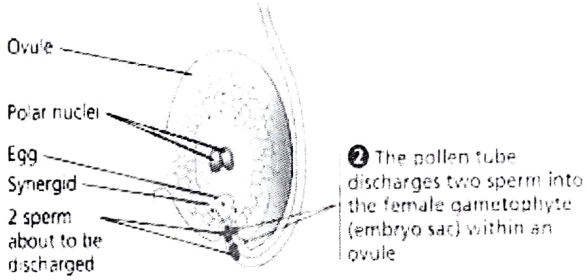
This is the fusion of male and female gamete to form a zygote. Fertilization in plants is internal taking place inside the ovary in the structure called embryosac.

The process of fertilization in plants:

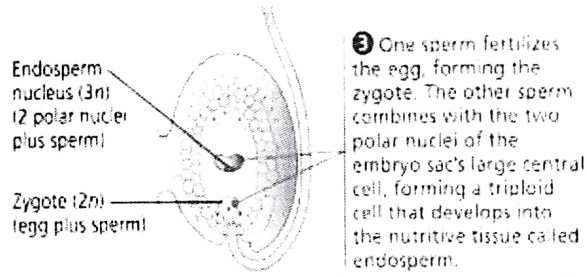
1. Pollen grain lands on the stigma of a flower of the same species.
2. On the stigma, pollen grain absorbs water, nutrients and then germinates to form a pollen tube which grows through the style under the control of the tube nucleus at the tip.
3. Pollen grain has two nuclei i.e. generative nucleus and pollen tube nucleus. The generative nucleus divides mitotically to form two male nuclei which lie behind the pollen tube nucleus.



4. The pollen tube enters the ovary and the tip of the pollen tube breaks. The pollen tube nucleus disappears.

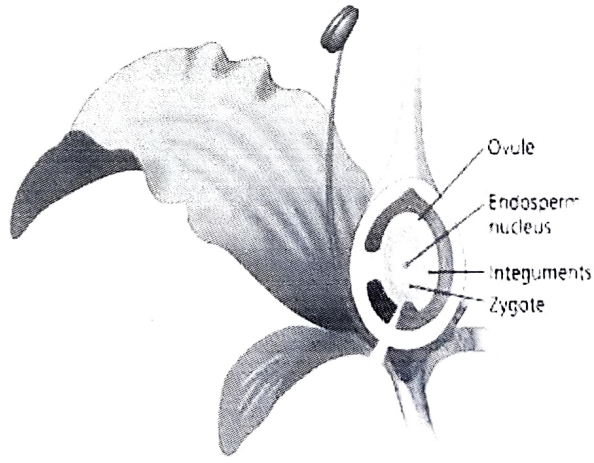


5. One of the male nucleus fuse with the egg nucleus to form a zygote which divides mitotically to form embryo.
6. The other male nucleus fuses with two polar nuclei to form a triploid endosperm which develops into endosperm. This is called double fertilization.



Events after fertilization

1. The zygote divides mitotically followed by growth and development resulting into an embryo.
2. The triploid endosperm divides mitotically to form good solid organs called endosperm.
3. The ovules develop into seeds.
4. The integuments become the seed coat.
5. The ovary develops into a fruit and ovary wall develops into a fruit wall which protects the seeds.
6. Petals, stigma, style and stamen wither and fall off while the calyx may wither and fall off or may remain in shriveled form.



REPRODUCTION IN ANIMALS

Sexual reproduction is the only form of reproduction in vertebrates and few invertebrates. E.g. Arthropods. For this reason, most of animals have reproductive organs in which the gametes are produced. To adopt various conditions in the habitat in which they live different animals show different forms of fertilization and development.

Reproduction in insects

Insects show internal fertilization and external development with complete and incomplete metamorphosis.

Metamorphosis:

This is the developmental change from the eggs to the adult stage in the life cycle of an organism. It is divided into two, i.e. complete and incomplete metamorphosis.

i) Complete metamorphosis

This is the type of metamorphosis where eggs hatch into larvae, pupa then to adult.

It occurs in houseflies, butterflies and moths. Insects which show complete metamorphosis are called holometabolous insects.

ii) Incomplete metamorphosis

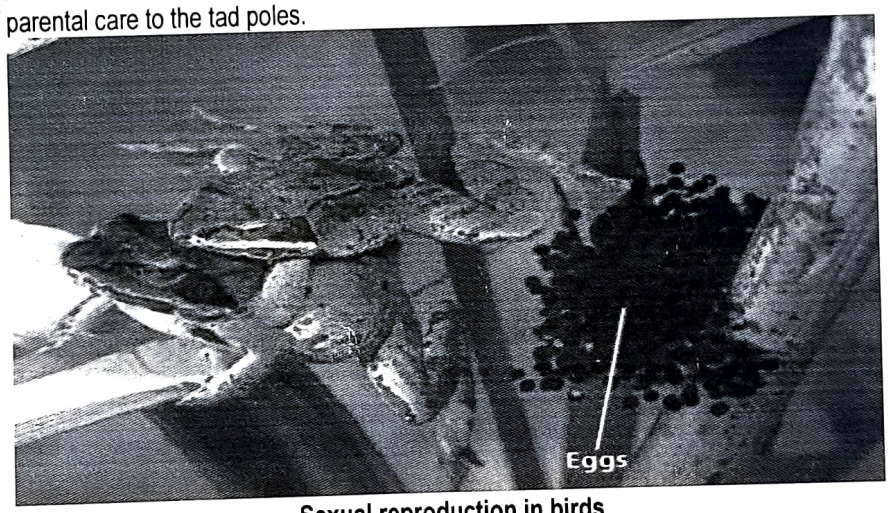
This is the type of metamorphosis where eggs hatch into nymph that resembles the adult except that it lacks wings, smaller than the adult and sexually immature. It occurs in insects such as cockroaches, grass hoppers and locusts. Insects which show incomplete metamorphosis are known as hemimetabolous insects.

Sexual reproduction in Bony fish

Like Tilapia, show external fertilization and external development beginning with laying of large quantities of eggs. Mating may follow courtship in some species and the eggs after hatching may get minimum parental care in form of protection from enemies.

Sexual reproduction in amphibians

They show external fertilization and external development. There is some protection offered to the eggs by a jelly but there is lack of parental care to the tad poles.



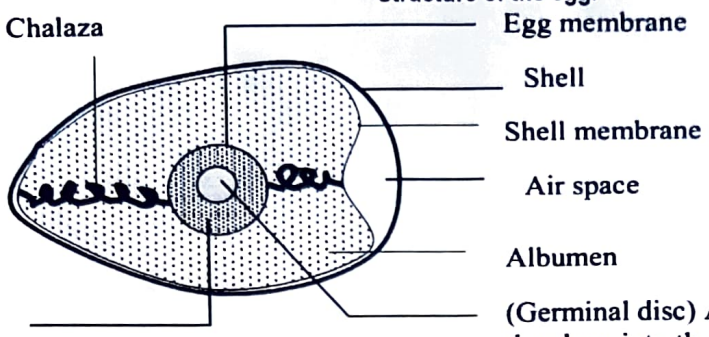
Sexual reproduction in birds

Birds show internal fertilization and external development. Prior or before fertilization most birds show courtship behavior, nest building and development begins with laying of eggs which hatches into young ones.

Courtship stimulates the female sexually to a point (nest) where the male bird is;

- ✓ On mating, the male presses his cloaca directly against the female's cloaca and sperms are released directly into the oviduct through the cloaca.
- ✓ The sperms swim up to the oviduct until they come into contact with the eggs without shell. Here internal fertilization takes place.
- ✓ The fertilized eggs pass to the oviduct where they release albumen and a hard protective shell.
- ✓ The eggs are laid in the nest and incubation starts after all the eggs are laid.

Structure of the egg.



Parts of the egg

Shell; this protects the egg and prevents it from desiccation.
Airspace; this stores air for gaseous exchange of the embryo.
Chalaza; this holds the yolk in position.
Albumen; this is a source of proteins and fats to the embryo.
Germinal disc; this develops into an embryo.
Yolk; this stores food for and surrounds the embryo.

Development:

The living cells in the egg divide to make the tissues and organs of the young birds. The yolk provides the food for this development. The albumen is the source of proteins and water. The shell and shell membrane are permeable to air. Oxygen diffuses into the airspaces and is absorbed through the blood capillaries of the embryo. The blood carries oxygen to embryo and Carbon dioxide is eliminated through the egg shell by the reverse process. When the chick is fully developed, it breaks out of the shell by help of its beak during hatching.

Incubation:

The female bird is responsible for incubation of the eggs. The function of incubation is to provide the optimum temperature for the embryo's development in the egg. The incubation period differs from one species of birds to another.

Differences between internal fertilization and external fertilization

External fertilization	Internal fertilization
Water as an external factor is necessary	Water as an external factor is not necessary
A lot of gametes are produced and necessary	Less gametes are involved in the process
Embryos develop not well protected and mostly helpless after birth	Embryos develop well protected and normally offered help after birth
A lot of energy is involved since more gametes are produced.	Less energy is involved since fewer gametes are produced
Chances of fertilization occurring are fewer	Chances of fertilization are higher

N: B the above points can serve as advantages of internal over external fertilization.

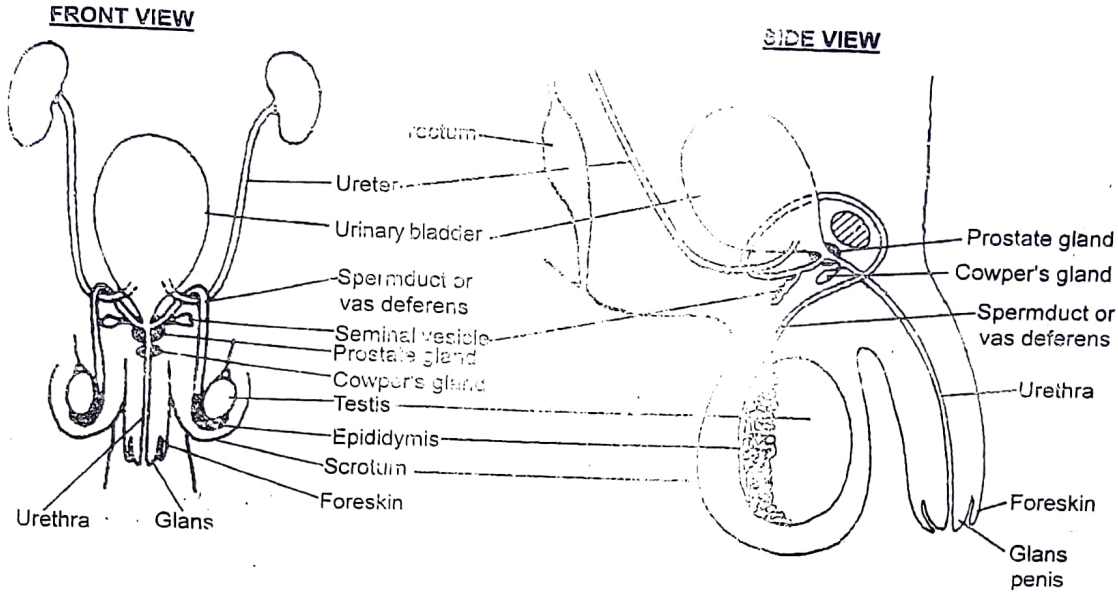
SEXUAL REPRODUCTION IN MAMMALS

Mammals reproduce sexually. They have special reproductive organs that produce the gametes i.e. sperms and ovum.

THE MALE REPRODUCTIVE SYSTEM

It consists of the testis, epididymis, seminal vesicles, prostate gland, Cowper's gland and penis.

Vertical section through the male urino-genital system



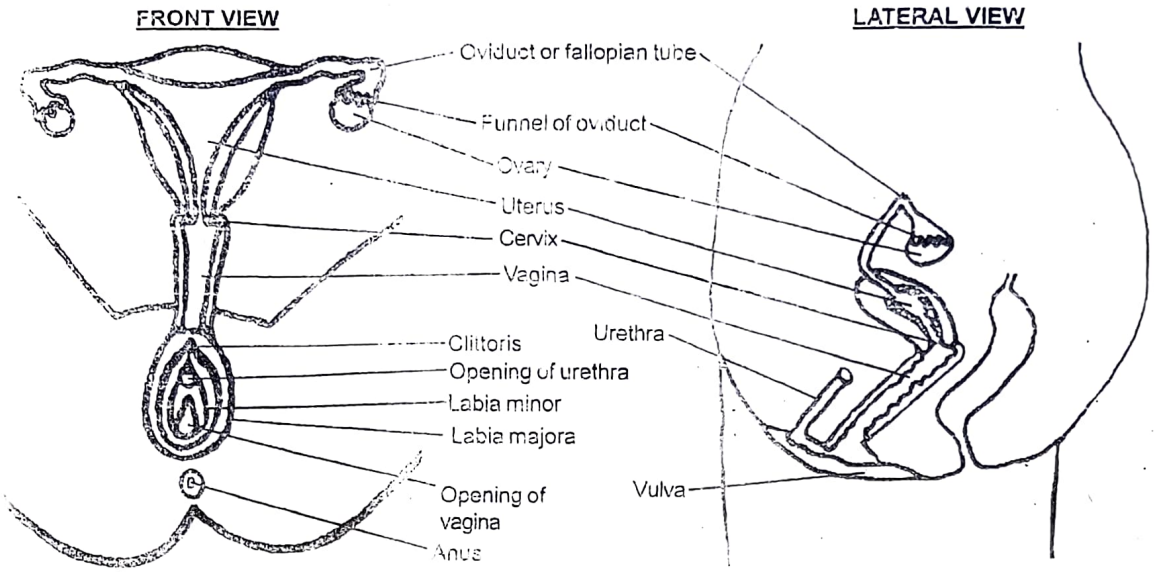
Functions of the parts:

1. **Seminal vesicle;** secrets viscous fluid-containing fructose which acts as a nutrient for sperm cells.
2. **Prostate gland;** this gland secretes an alkaline, milky-white fluid that neutralizes the acidity of the Vagina.
3. **Penis;** delivers sperms into the female reproductive organ.
4. **Testis;** manufactures and store sperms.
5. **Scrotal sac;** protects the testis.
6. **Vas deferens;** conducts sperms from the testis to urethra during ejaculation.
7. **Urethra;** passage of sperms and semen during ejaculation.
8. **Cowper's gland;** produces mucus for lubrication of both the male and female urethra to ease copulation.

Functions of the male reproductive system

- Used in the delivery of sperms into the female reproductive organ.
- Production and storage of sperms.
- Secrets male sex hormones e.g. testosterone hormone.

FEMALE REPRODUCTIVE SYSTEM



Function of parts:

1. **Uterus;** provides suitable environment for growth and development of the fetus. It is also an area for implantation.
2. **Vagina;** it provides the following functions;
   - Passage of sperms to the uterus.
   - Passage of blood during menstruation.
   - Allows passage of the fetus at birth.
3. **Oviduct (fallopian tube);**
   - It allows movement of fertilized egg towards the uterus for implantation.
   - It provides suitable place for fertilization.
4. **Cervix**; contains elastic muscles which allows its expansion during birth and it is the gate way to the uterus.
5. **Vulva**; This is a collective term for the external genetalia. It is made up of two skin folds that is the inner fold (**labia minora**) and the outer fleshy fold **(labia majora**). Labia minora contains mucus secreting glands which lubricates the vagina during sexual intercourse (copulation).
   Labia majora cushion the vagina and helps in sexual arousal. In the place where labia majora and **labia minora** meet is a bean-like structure called **clitoris**. This is the most sensitive part, which brings about sexual excitement in females.
6. **Vagina**; This is a muscular tube, which connects the vulva to the uterus. It has an average length of 10cm. It secretes acidic mucus, which prevents growth of bacteria and fungi. The mucus also lubricates the vagina. The vagina plays the following roles.
   - ✓ It is a passage for menstrual flow.
   - ✓ It is a birth canal.
   - ✓ It is where the male inserts his erect penis during sexual intercourse.

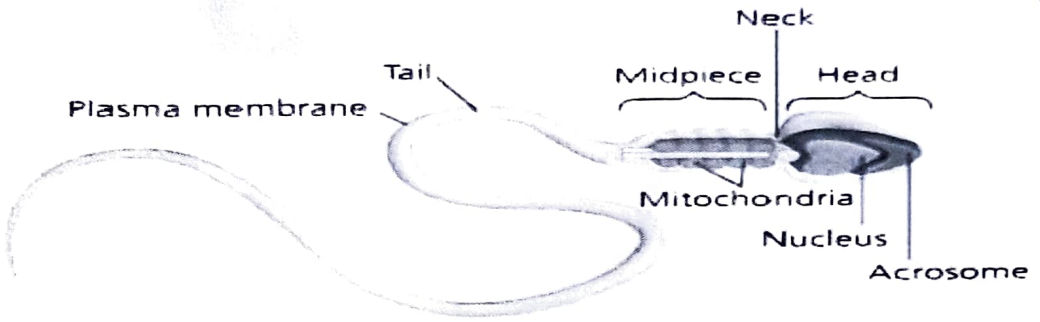
General function of the female urino-genital system

- Production of the female gametes i.e. the ovum
- Reception of the male gametes i.e. the sperm
- Provision of a suitable environment for fertilization
- Provision of a suitable environment for the fetus development.
- Provision of a means for the expulsion of the developed fetus during birth.
- Secretion of hormones like oestrogen

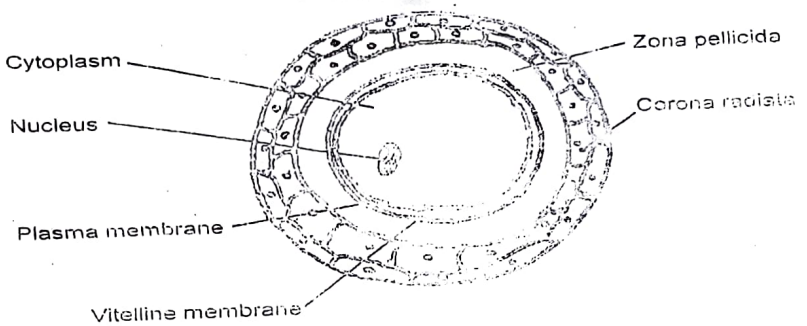
GAMETES

These cannot develop any further until fertilization occurs. There are two types of gametes namely; male and female gametes also known as sperm cells and ova (singular; ovum or egg cell) respectively. Both male and female gametes are haploid.

The structure of a sperm cell (male gamete)



The structure of the ovum



Functions of the parts:

1. **Acrosome;** contains juice together with enzymes which dissolve the egg membrane (Vitelline) to bring about fertilization.
2. **Nucleus;** contains genetic material which is responsible for transmission of characters from the parent to the off spring.
3. **Middle piece;** contains mitochondria which provides energy required for the movement of the sperm.
4. **Tail;** propels the sperm forward as it swims towards the ovum.
5. **Neck;** connects the head and tail of the sperm.
6. **Cytoplasm;** it acts as a food store for the embryo.
7. **Vitelline;**
   - It provides protection to the inner part of the egg.
   - Allows exchange of materials around the egg and its surrounding.

Differences between sperm and ovum

Sperm cell	ovum
Has a tail	It is spherical and has no tail
It is very small	It is big
Has less food store	It has more food store
It is mobile	It is immobile
It has either X and Y chromosomes (XY)	It has only X chromosomes (XX)

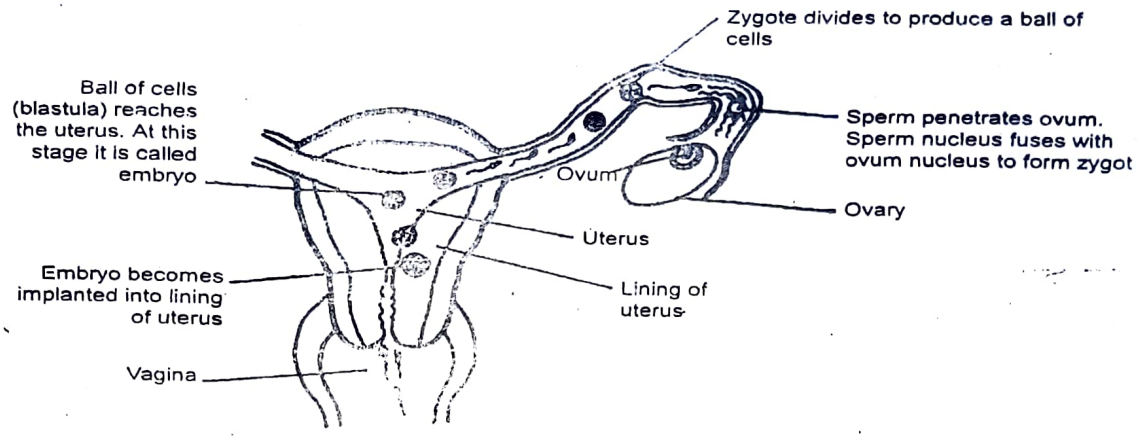
FERTILIZATION IN MAN

Fertilization in man occurs after copulation where erect penis is inserted into the vagina. At orgasm, the penis releases large number of sperms (200-300 millions) near the cervix. The cervix relaxes and opens as sperms swim through its opening to the uterus then to the oviduct where fertilization takes place.

When a sperm get into contact with the egg membrane, it releases enzymes from acrosome which breaks the egg membrane and enable the sperm cell penetrate into the cytoplasm of the ovum.

When the sperm cell enters, the egg membrane becomes thickened to form the fertilization membrane which serves as a barrier preventing the entry of other sperm cells.

The nuclear membrane of the two gametes breaks down and male nucleus fuse with a female nucleus to form a fertilized egg. This process is known as fertilization and the female is said to have conceived.

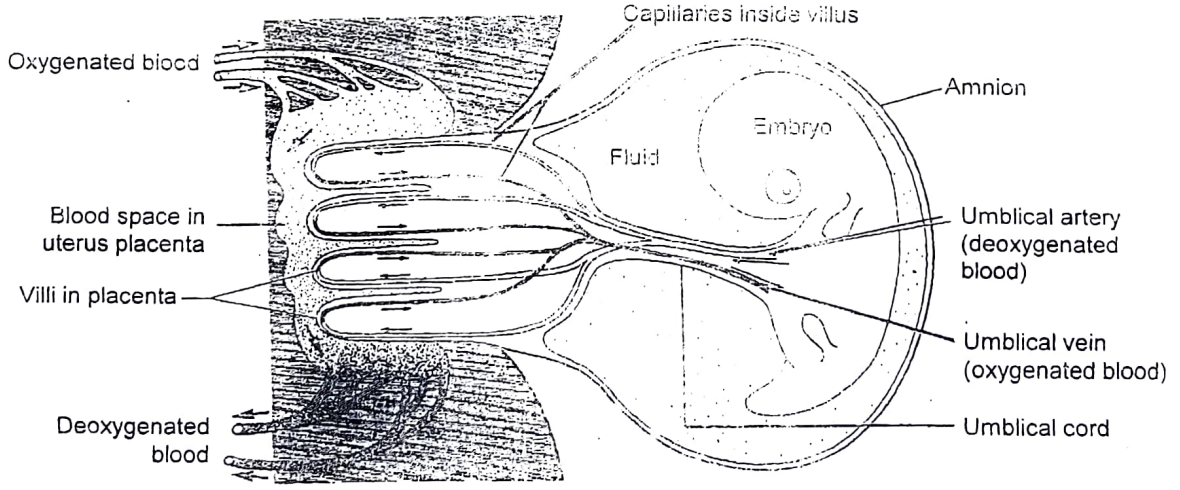


PREGNANCY

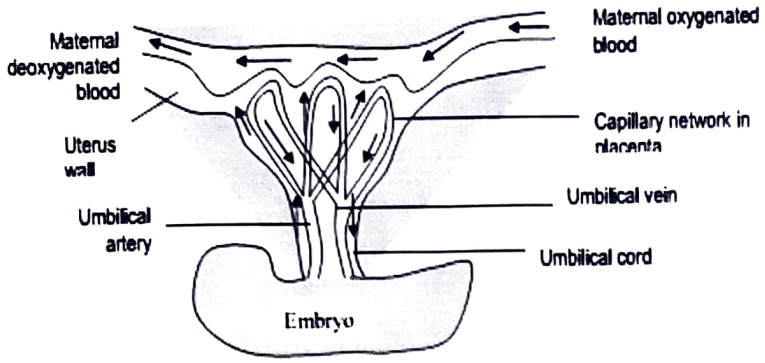
Gestation is the period from fertilization of an ovum to birth. After fertilization, the under goes cell division by mitosis and move down to the uterus. Its movement is aided by constriction of the oviduct and it takes about one week. Finally the fertilized egg (zygote) is embedded in the lining of the uterus a process known as implantation and it continues with its development.

The fertilized egg now becomes known as the fetus. Later, finger like connections develop between the fetus and the mother's blood system. This later unites to form placenta connected to the fetus by umbilical cord.

Diagram showing blood circulation to and from the fetus



Or summarized as below



Major nutrients needed by a pregnant mother

i) Calcium and Phosphates. These are needed for the development of bones and cartilage of foetus.
ii) Iron needed for the formation of foetal red blood cells
iii) Proteins needed for the formation of new tissue.
iv) Vitamins needed for proper growth.

Functions of the placenta

i) It allows exchange of materials without the mother's blood mixing with that of the fetus.
ii) It allows transfer of oxygen, water, glucose, amino acids and other substances into the fetus which are used as nutrients.
iii) Carbon dioxide, urea and other wastes are transferred from blood circulatory system of the fetus to the mother's blood across the placenta.
iv) It protects the fetus by preventing certain toxins and foreign materials from crossing to the fetus.
v) It acts as a barrier to mother's hormones and some other chemicals which may affect the fetus.
vi) It allows anti bodies to pass onto the fetus there by providing immunity against diseases.

Nutrition of the fetus

Soluble food substances, oxygen, water and mineral salt passes across the placenta by either diffusion or active transport from the mother's blood to the fetal blood through the umbilical vein. Waste products such as carbon dioxide and nitrogenous wastes are brought in to the placenta by umbilical artery where they are passed into mother's blood. The placenta is therefore the excretory organ of the fetus as well as respiratory surface and source of nourishment.

Protection of the fetus

The fetus is contained in a sac called the amnion which is filled with amniotic fluid. The amniotic fluid protects the fetus from mechanical shock and drying.
The fetus is warmed by blood temperature all the time and regulated by mother's blood.
The placenta prevents passage of bacteria, other foreign materials, nervous transmissions and maternal blood pressure from affecting fetal circulation and also it keeps out toxins from the fetus.

BIRTH (PARTURITION)

The embryo turns head down wards in the uterus a few days before birth which occurs at approximately 9 months after fertilization. At time of birth, the uterus contracts rhythmically.
The opening of the cervix dilates (relax) to allow the young's head to pass through. The amniotic fluid passes out through the vagina.
The contraction of the uterus pushes the young one through the vagina to the exterior. It takes the 1st breathe of life and usually cries, a sign of changed conditions in its environment. After some time the placenta separates from the uterus and finally expelled as after-birth.

Differences between sexual and asexual reproduction

Sexual reproduction	Asexual reproduction
i) Two parents are involved	Only one parent is involved

ii) Needs males and female gametes	Does not need gametes
iii) Off springs are not identical	Off springs produced are identical
iv) Rate of reproduction is slow	Rate of production is fast
v) Fertilization usually occurs	Fertilization does not occur
vi) Usually few off springs are produced	Usually very many off springs are produced

MALE HORMONES

At puberty, the hypothalamus stimulates the anterior part of the pituitary to release two hormones.

i. The **follicle stimulating hormone (F.S.H)** which stimulates sperm production.
ii. The **Luteinizing hormone (LH)** also known as the interstitial cell stimulating hormone (ICSH) which stimulates the interstitial cells of the testis to release another hormone **testosterone** which stimulates the development of the male secondary sexual characters.

Secondary characteristics in man

- ✓ Deepening of the voice
- ✓ Growth of pubic hair
- ✓ Enlargement of the penis
- ✓ Onset of wet dreams
- ✓ Growth of beards
- ✓ Growth of hair in the arm pits

Secondary characteristics in females

- ✓ Softening of the voice
- ✓ Enlargement of breasts
- ✓ Enlargement of hips
- ✓ Onset of menstruation
- ✓ Enlargement of reproductive organs
- ✓ Growth of pubic hair
- ✓ Growth of hair in arm pits

FEMALE HORMONES AND THE MENSTRUAL CYCLE

When the ovum is released by the ovary, the uterus wall thickens with addition of new layer of cells for the ovum to sink if fertilized. The blood supply also increases at the same time. If the ovum is not fertilized, the new layer of cells breaks down and the unwanted cells, mucus and some blood pass out through the cervix and vagina. This is called menstruation. It takes place once about 28 days, 12-14 days after the release of the ovum.

The menstrual cycle

The menstrual cycle is controlled by four hormones of which two are secreted from **the interior lobe of pituitary gland and the other two from the ovaries.** The pituitary gland secretes **Follicle stimulating hormone (FSH) and Luteinizing hormone (LH)** and the ovary secretes **progesterone and oestrogen**. The four hormones are secreted in the following sequences.

FSH ⟶ Oestrogen ⟶ LH ⟶ Progesterone

It is a reproduction cycle occurring in sexually a mature female in absence of pregnancy and involves series of changes in the female reproductive system which is controlled by hormones.

1. **Follicle stimulating hormone (FSH)**

- ✓ Causes the development of the graafian follicles in the ovaries.
- ✓ It stimulates the ovary to produce oestrogen.

2. **Oestrogen.**

- ✓ This stimulates the repair of the uterine wall after menstruation.

- ✓ When in high levels, it stimulates the pituitary gland to produce LH
- ✓ It inhibits the production of FSH from the pituitary gland.

3. Luteinizing hormone (LH)

- ✓ This cause ovulation in the middle of the cycle.
- ✓ It also stimulates the ovary to produce progesterone from the corpus luteum.

4. Progesterone.

- ✓ This maintains the uterine lining in preparation for implantation.
- ✓ It inhibits production of FSH and LH if its level is high.

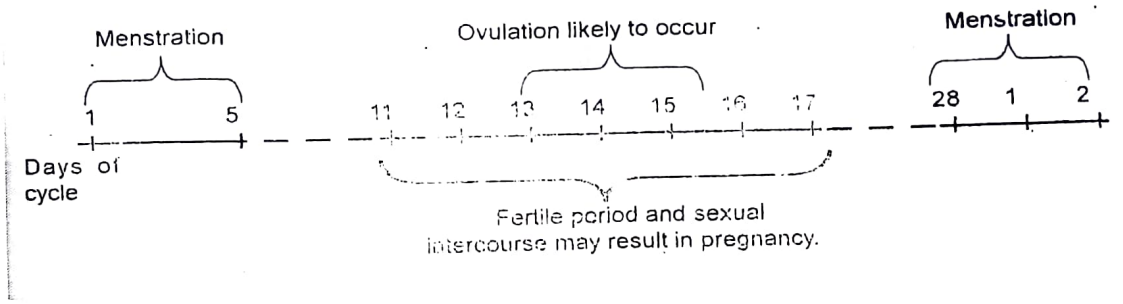
This leads to the breakdown of the corpus luteum within 14 days after ovulation and hence stops the production of progesterone.

If the ovum is not fertilized;

i) When production of progesterone stops, the endometrium breaks leading to the flow of blood a process called menstruation.

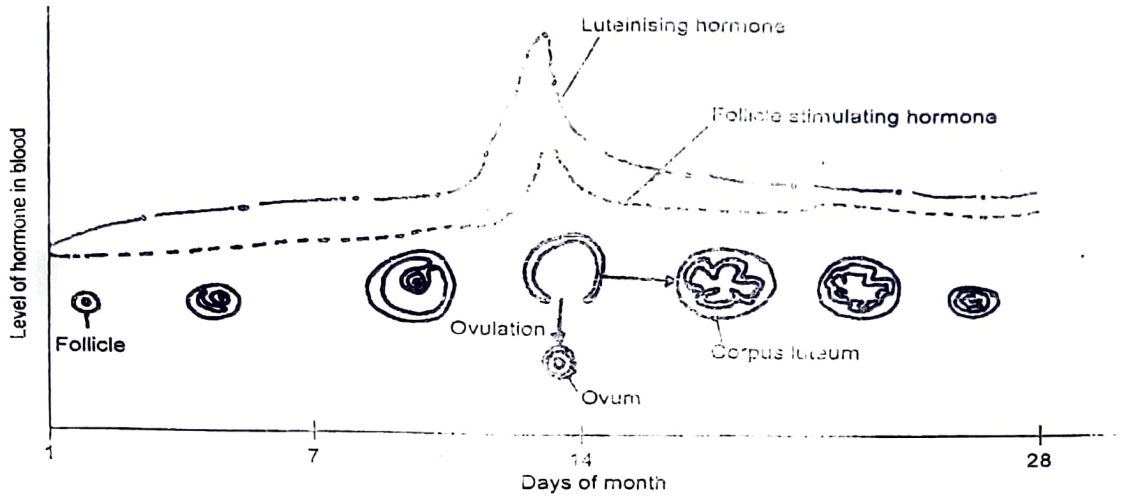
ii) If fertilization occurs, the placenta produces the progesterone which prevents menstruation and maintains pregnancy.

Menstruation stops at around the age of 45 years on average and one is said to have reached menopause. At this stage no more pregnancy is possible.

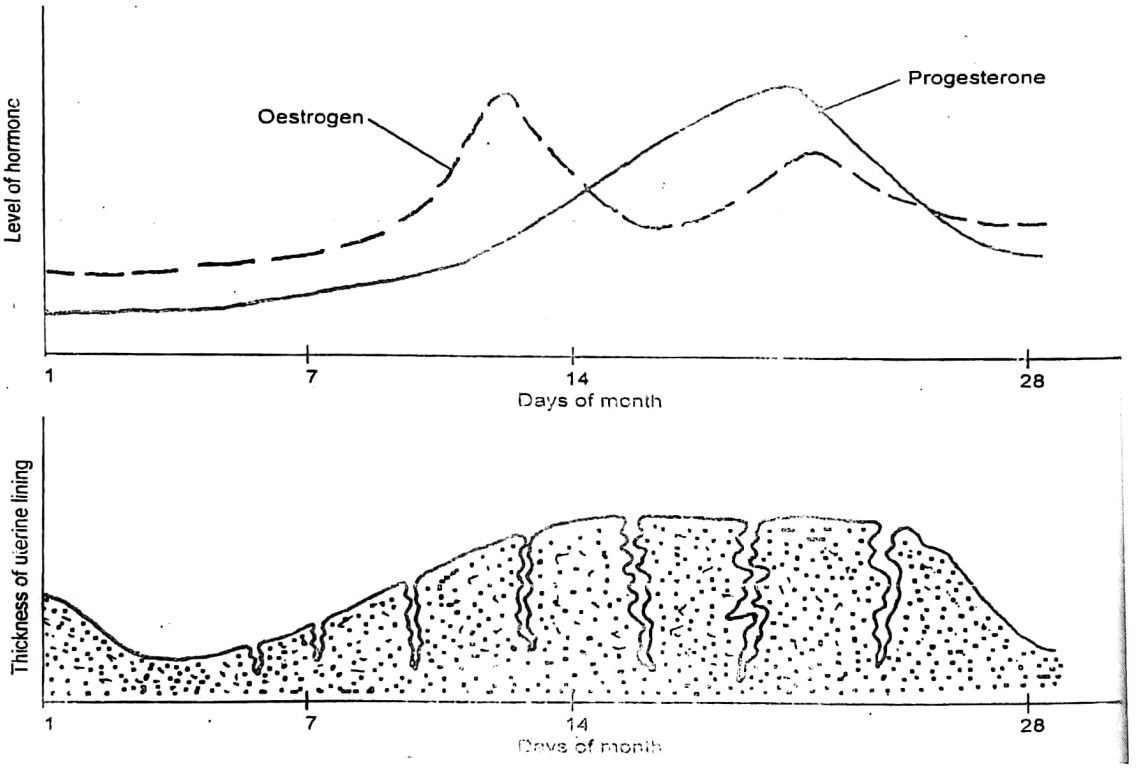


Graph illustrating the hormonal changes in blood during a menstrual cycle.

A. OVARIAN CYCLE



B. UTERINE CYCLE



SAFE PERIODS

It refers to the days within the menstrual cycle when there is no mature ovum in the reproductive system so a female can have sexual intercourse without getting pregnant.

During the first safe period, there is development of a graafian follicle and takes about 10 days from the end of menstruation.

A female should obtain for first 2 days before ovulation and 2 days after ovulation because the sperm cannot survive for more than 2 days.

The 2nd safe period starts from around the 18th day up to the 28th day. Thus a mature egg dies after waiting in vain.

TWINS

These are two babies produced with in the same time to the same mother as a result of the same pregnancy.

Types of twins

1. **Fraternal twins**. These are twins who arise from the fertilization of two ova produced at the same time and fertilized by two different sperms. The babies are not identical but resembles as normal babies in the family. They may or may not be of the same sex.
2. **Identical twins**. These are two babies, who develop from one fertilized ovum that latter divides into two and the two develop as separate individuals. Such babies look alike and are of the same sex

Multiple births

These are more than two babies produced to the same mother with in the same time as a result of the same pregnancy.

METHODS OF BIRTH CONTROL

1. Coitus interruptus where the penis is withdrawn from the vagina before ejaculation.
2. Rhythmical method where sexual intercourse is avoided at times when ovulation is likely to occur.
3. Use of condoms and diaphragms which prevents sperm from reaching the eggs.
4. Vasectomy where vas deferens are cut by surgical means there by preventing the passage of sperms.
5. Tubal ligation where the fallopian tubes are cut by surgical means there by blocking the passage of the egg.
6. Use of oral contraceptives known as pills, these prevents development of the egg.
7. Use of injectable contraceptives. This is taken every 3 months to prevent ovulation.
8. Intra uterine devices. This prevents fertilized egg from implanting into the uterus.
9. Use of intra-vaginal rings. This ring secretes progesterone like substance which inhibits development of the egg.
10. Use of morning pills which are taken 3 days after sexual intercourse.
11. Abortion which involves termination of viable pregnancies.

QUESTIONS:

What is vegetative reproduction in flowering plants?
Define the term menstruation.
Describe the menstrual cycle in females
What are the causes of infertility in males?
Describe the process of fertilization in man
Describe the different forms of asexual reproduction in flowering plants.

*****

"You can have anything you want-if you want it badly enough. You can be anything you want to be, have anything you desire, accomplish anything you set out to accomplish-if you will hold to that desire with singleness of purpose" Robert Collier.

GROWTH AND DEVELOPMENT

Growth is defined as an irreversible or permanent increase in the size and dry weight of an organism. Growth in multicellular organisms is divided into 3 phases.

1. **Cell division**

This involves increase in the number of cells mainly as a result of mitosis.

2. **Cell expansion**

This is the permanent increase in the cell size as a result of uptake of water or synthesis of living materials.

3. **Cell differentiation**

This involves specialization of cells to suit particular functions. Growth is usually accompanied by an increase in the complexity of an organism which is also called **development.**

Development is the increase in complexity and change of form of an organism.

FACTORS AFFECTING GROWTH

A. **External factors**

i) **Nutrients**

Growth of an organism increases in the availability of nutrients and decreases when nutrients are in short supply. This is because nutrients are used in the building up of new protoplasm and organic matter. Also nutrients can be oxidized to provide energy required for growth. Therefore lack of nutrients can lead to decrease in growth or even death.

ii) **Accumulation of the byproducts of metabolism (excretory substances):**

Growth may be inhibited by metabolic waste products which are toxic to the body cells. Fortunately most plants and animals are not affected much because they can convert these substances to less toxic excretions.

iii) **Temperature:**

Growth depends on bio-chemical reactions which are catalyzed by enzymes. Temperature affects growth by affecting enzymes which catalyzes the chemical reactions in the body. Increase in temperature to the optimum increases the rate of growth, beyond which retardation of growth occurs.

iv) **Light:**

In plants, light affects growth by affecting the rate of photosynthesis which adds more organic matter to the plant. Therefore increase in light intensity in green plants increases the rate of growth and decrease in light intensity decreases the rate of growth.

v) **PH:**

The PH affects the activity of enzymes which catalyzes reactions in the body. This can result into decrease in growth of an organism.

vi) **Carbon dioxide:**

In animals, carbon dioxide is a waste product of metabolism. If allowed to accumulate, it can lead to a decrease in the rate of growth while in plants carbon dioxide is a raw material for photosynthesis therefore increase in carbon dioxide concentration increases the rate of growth.

B. **Internal factors**

i) **Hormones:**

In animals, the presence of growth hormones and thyroxin in blood increases the rate of growth while in plants the presence of auxins also increases the rate of growth.

ii) **Hereditary factors:**

Growth is under the control of genes which determines the particular size of an organism.

GROWTH AND DEVELOPMENT IN PLANTS

In plants, growth is continuous processes which occurs mainly at the tips of the root and shoot systems. These regions are called **meristems.** ***A meristem*** *is a group of undifferentiated plant cells which are capable of dividing repeatedly by mitosis.*

Types of meristems

i) **Apical meristems**

They are located at the tip of roots and shoot. They bring about increase in length or height of the plant. This type of growth which involves increase in length or height of a plant is known as **primary growth.**

ii) **Lateral meristems**

These are laterally situated in the stems and roots of the dicot plants. It brings about **secondary growth** after primary growth. Secondary growth (secondary thickening) involves increase in girth/thickness in a plant.

- It dissolves the stored food.
- It is a medium in which all the chemical and enzymatic reactions proceed.
- It is a medium of transport of the dissolved food substances to the developing shoot and root of the new plant.
- Water is needed for the development of cell vacuoles. Large cell vacuoles contribute to increase in size of cells.

2. Oxygen

Oxygen is necessary for the process of respiration, the oxidation of food to provide energy required for growth.

3. Warmth

Suitable temperature is important for the enzyme controlled reactions in the cotyledon of the germinating seed. At low temperatures, the enzymes are inactive and at high temperatures, they are denatured hence no germination. Germination will require an optimum temperature which varies from 10°C-50°C for most tropical seeds.

EXPERIMENTS ON GERMINATION

An experiment to demonstrate the conditions necessary for germination

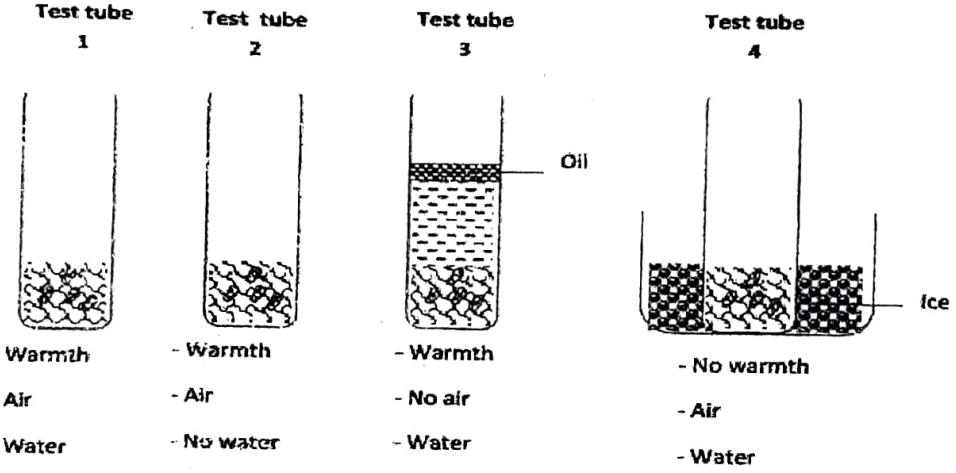
Apparatus:

4 test tubes, Cotton wool, Seeds, Oil and Water.

Procedure:

a) Arrange four test tubes labeled 1-4
b) To test tube 1 add moist cotton wool, seeds and leave test tube open.
c) To test tube 2 add dry cotton wool, seeds and leave test tube open.
d) To test tube 3 add seeds, boiled cooled water and a layer of oil.
e) To 4 add seeds, moist cotton wool, ice and leave test tube open. Leave all test tubes for 3 days.

Setup:



Observations

Seeds germinated in only test tube 1 and those in 2, 3 and 4 did not germinate.

Conclusion:

Air, water and warmth are necessary for germination.

Experiment to show that oxygen is necessary for germination

Apparatus:

2 conical flasks, 2 corks, Water, Cotton wool, Seeds and Pyrogallic acid.

Procedure:

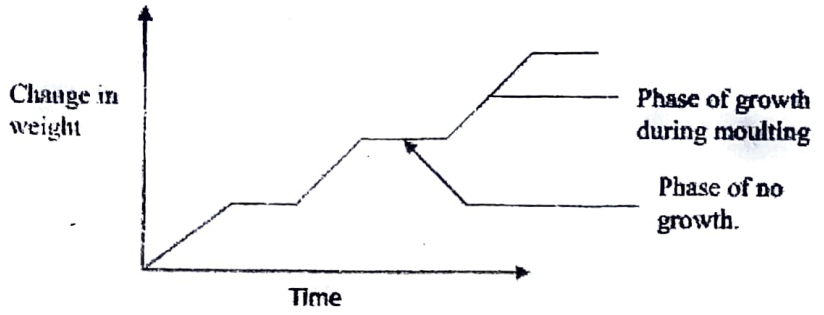
- ✓ 1. Pour some water in one conical flask and some alkaline pyrogallol in another conical flask.
- ✓ Tie some seeds in wet cotton wool and suspend the cotton wool in the flasks using a thread.
- ✓ Fix the threads using a cork.
- ✓ Leave the set up for three days

Set up:

GROWTH AND DEVELOPMENT IN INSECTS

Insects have an exoskeleton which is rigid and prevents expansion of the insect during growth. Before the insect grows, it sheds the exoskeleton in a process called moulting (ecdysis).
Without the exoskeleton, the insect expands and grows. A new exoskeleton then forms and growth ceases. This kind of growth is referred to as intermittent growth or discontinuous growth. Successive moults result into formation of a new form of the insect. This is called metamorphosis. Metamorphosis has already been discussed under insects.

A graph showing intermittent growth in insects



GROWTH AND DEVELOPMENT IN VERTEBRATES

After fertilization, the zygote undergoes three changes during its growth and development. These changes are;

1. **Cleavage:**

This is the mitotic division of the zygote to form a mass of cells. The zygote at this stage is called a **blastocyst.**

2. **Gastrulation.**

This is the rearrangement of the cells into distinct layers. The outer cells make up a layer called ectoderm. The cells in the middle make up a layer called mesoderm and the inner cells make up the endoderm. From these layers the various organs and systems are formed.

3. **Organogenesis:**

This is the formation of organs and organ systems.

EXPERIMENT TO FIND OUT THE REGION OF ELONGATION IN A ROOT

Materials:

- ✓ Water
- ✓ Ink
- ✓ Cock
- ✓ Seedlings
- ✓ Conical flask
- ✓ Dark cup board
- ✓ Pin

Procedure:

a) Take bean seedlings with straight radicles.
b) On each seedling mark the radicle every 2mm with lines in black ink.
c) Pin the seedlings to the other side of the cork with the radicles hanging down wards.
d) Insert the cork into the neck of the flask containing little water.
e) Put the flask in the dark cup board for 3-4 days.

Experimental set up:

Observation:

Some lines on the radicle are 2mm apart while others are more than 2mm apart.

Conclusion:

The region where the lines are further apart is the zone of elongation (region of growth).

"Every adversity, every failure and every heartache carries with it the seed of an equivalent or greater benefit"