16. Heredity and Variation

➢ Inheritance ➢ Heredity: Characteristics and their appearance ➢ Mendel's laws of inheritance ➢ Diseases due to chromosomal aberrations

Think about it

1. Do all the boys and girls of your class look alike?
2. Think about the following characteristics and note similarities and differences. (Teachers should help in this activity.)

Sr. No.	Personal characteristics	Own	Grandfather	Grandmother	Father	Mother
1	Colour of skin					
2	Shape of face (Round/ Oblong)					
3	Height					
4	Colour of eyes					
5	Orientation of thumb					

Earlier, we have seen that there is great variation within every species in nature. In this chapter, we shall study the factors that give rise to these variations.

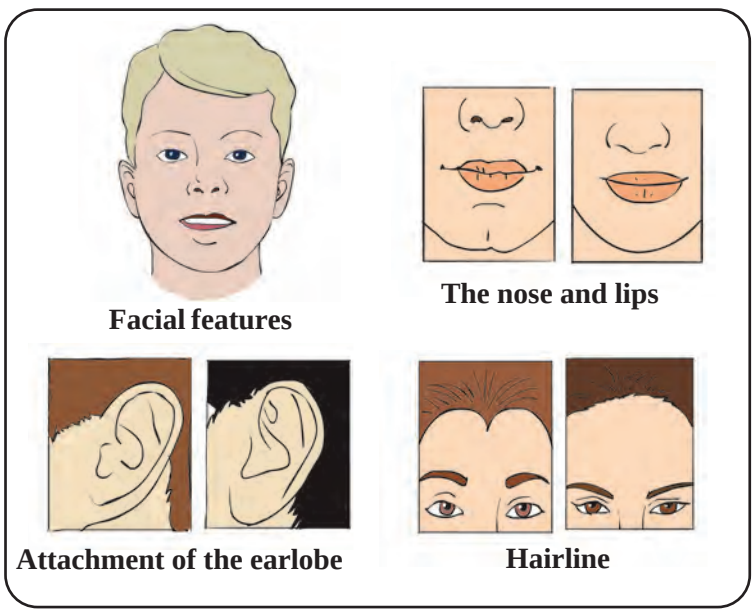
Inheritance

The branch of biology which studies the transfer of characteristics of organisms from one generation to the next, and genes in particular, is called 'genetics'.

New progeny is formed through the process of reproduction. Except for a few minor differences, the offspring shows great similarities with parents. Organisms produced by asexual reproduction show minor variations. However, offspring produced through sexual reproduction, show comparatively greater variations.

Observe

1. Carefully observe your classmate's earlobes.
2. Irrespective of all of us being humans, what difference do you notice in our skin colour?
3. All of you are in std. IX. Why then are some students tall and some short?



16.1 Some differences in facial features

Heredity :

Transfer of characteristics from parents to offspring is called heredity. It is due to heredity that puppies are similar to dogs, squabs are similar to pigeons and infants are similar to humans.

Inherited traits and expression of traits :

Can you tell? How do specific traits or characteristics appear in organisms?

Though there are many similarities between parents and their offsprings there are some differences too. These similarities and differences are all the effect of heredity. Let us study the mechanism of heredity. Information necessary for protein synthesis in the cell is stored in DNA. The segment of DNA which contains all the information for synthesis of a particular protein is called a 'gene' for that protein. It is necessary to know the relationship of these proteins with the characteristics of organisms.

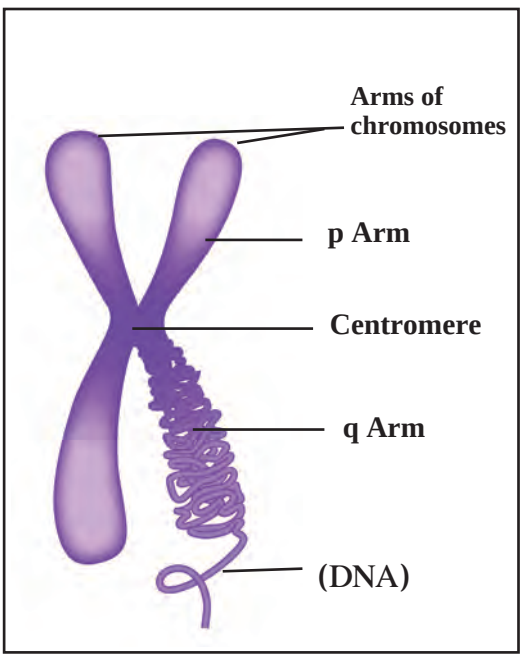
To understand the concept of heredity let us consider the characteritic 'plant height'. We know that there are growth hormones in plants. Increase in height of plants depends upon the quantity of growth hormones.

The quantity of growth hormones produced by a plant depends upon the efficiency of the concerned enzyme. Efficient enzymes produce a greater quantity of the hormone due to which the height of the plant increases. However, if the enzymes are less efficient, a smaller quantity of hormone is produced leading to a stunting of the plant.

Chromosomes

The structure in the nucleus of cells that carries the hereditary characteristics is called the chromosome. It is made up mainly of nucleic acids and proteins. During cell division chromosomes can be clearly seen under the compound microscope. 'Genes' which contain the information about hereditary characteristics in coded form are located on chromosomes. Each species has a specific number of chromosomes.

Each chromosome is made up of DNA and it appears dumbell-shaped midway during cell division. There is a constricted region on each chromosome. It is called the **'Primary constriction'** or **'Centromere'**. This divides the chromosome into two parts. Each part is called an 'arm'. The centromere has a specific position in each chromosome. Depending upon this, there are four types of chromosomes.



16.2 Organization of chromosome

Types of chromosomes :

Find out Number of chromosomes in different organisms

Types of chromosomes can be easily identified during cell division.

1. Metacentric : The centromere is exactly at the mid-point in this chromosome, and therefore the chromosome looks like the English letter 'V'. The arms of this chromosome are equal in length.

2. Sub-metacentric : The centromere is somewhere near the mid-point in this chromosome which therefore looks like English letter 'L'. One arm is slightly shorter than the other.

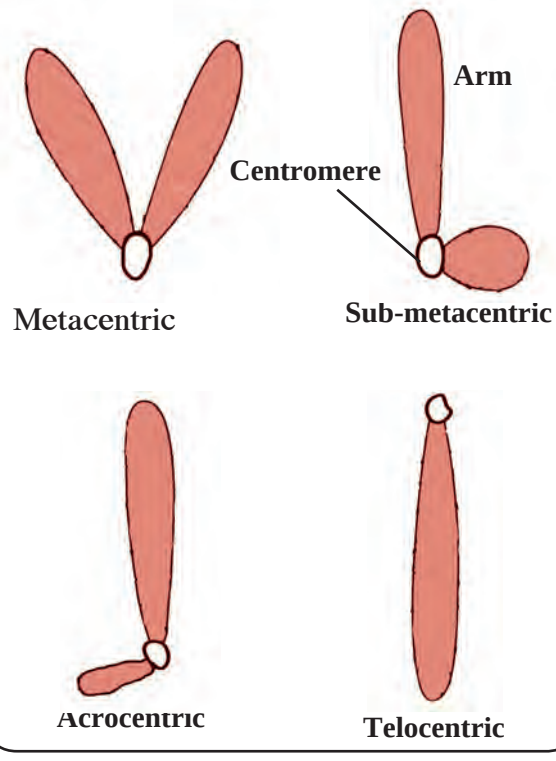
3. Acrocentric : The centromere is near one end of this chromosome which therefore looks like the English letter 'j'. One arm is much smaller than other.

4. Telocentric : The centromere is right at the end of this chromosome making the chromosome look like the English letter 'i'. This chromosome consists of only one arm.

Generally, in somatic cells chromosomes are in pairs. If the pair consists of similar chromosomes by shape and organization, they are called **'homologous chromosomes'** and if they are not similar they are called **'heterologous chromosomes'.** In case of organisms that reproduce sexually one of the chromosomal pairs is different from all than others. Chromosomes of this different pair are called **'sex chromosomes'** or **allosomes** and all other chromosomes are called **'autosomes'**.

Chromosome number of some organisms has been given in the following table -

Sr. No.	Organism	No. of Chromosomes
1	Crab	200
2	Maize	20
3	Frog	26
4	Roundworm	04
5	Potato	48
6	Human	46



16.3 Types of chromosomes

Deoxyribonucleic acid (DNA)

Chromosomes are mainly made up of DNA. This acid was discovered by the Swiss biochemist, Frederick Miescher in 1869 while studying white blood cells. Initially this acid was reported to be only in the nucleus of cells. Hence, it was named nucleic acid. However, it was later realized that it is present in other parts of the cell too. Molecules of DNA are present in all organisms from viruses and bacteria to human beings. These molecules control the functioning, growth and division (reproduction) of the cell and are therefore called 'Master Molecules'.

The structure of the DNA molecule is the same in all organisms. In 1953, Watson and Crick produced a model of the DNA molecule. As per this model, two parallel threads of nucleotides are coiled around each other. This arrangement is called a 'double helix'. This sturcture can be compared with a coiled and flexible ladder.

Each strand in the molecule of DNA is made up of many small molecules known as **'nucleotide'**. There are four types of nitrogenous bases adenine, guanine, cytosine and thymine. Adenine and guanine are called as **'purines'** while cytosine and thymine are called **'pyrimidines'**.

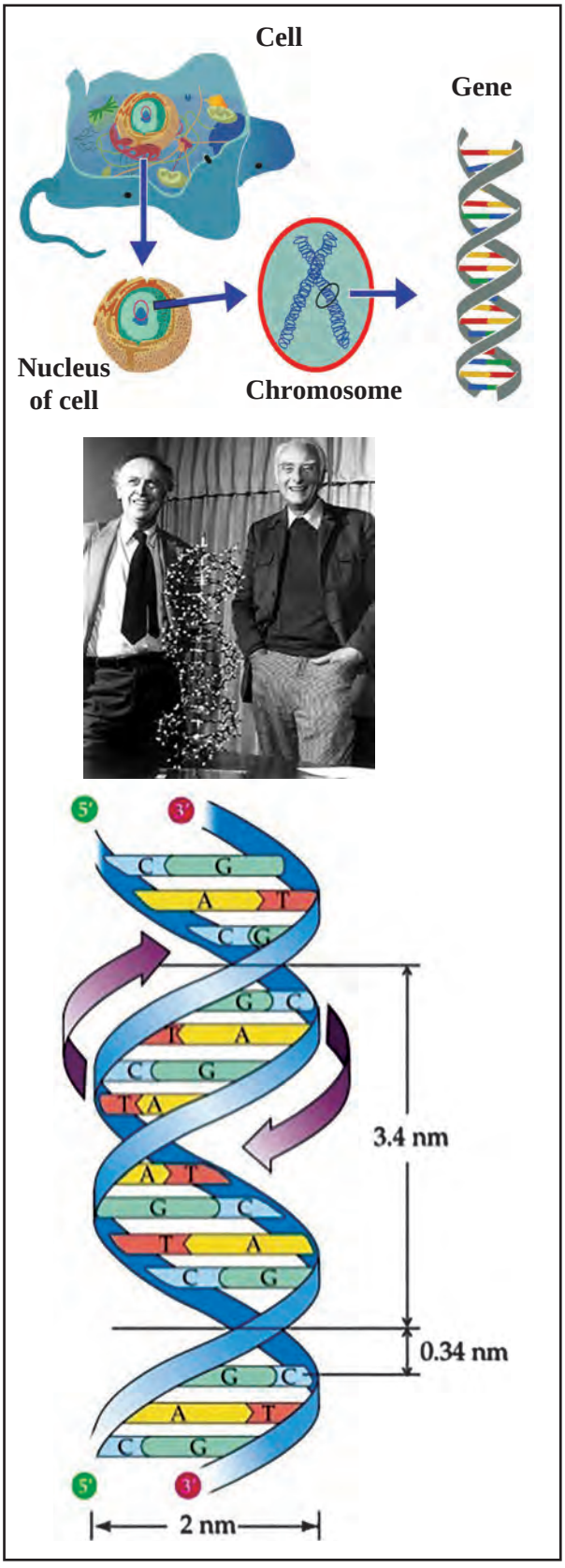
In the structure of the nucleotide, a molecule of a nitrogenous base and phosphoric acid are each joined to a molecule of sugar.

As there are four types of nitrogenous bases, nucleotides also are of four types.

Nucleotides are arranged like a chain, in a molecule of DNA. The two threads of the DNA molecule are comparable to the two rails of a ladder and each rail is made up of alternately joined molecules of sugar and phosphoric acid. Each rung of the ladder is a pair of nitrogenous bases joined by hydrogen bonds. Adenine always pairs with thymine and cytosine always pairs with guanine.

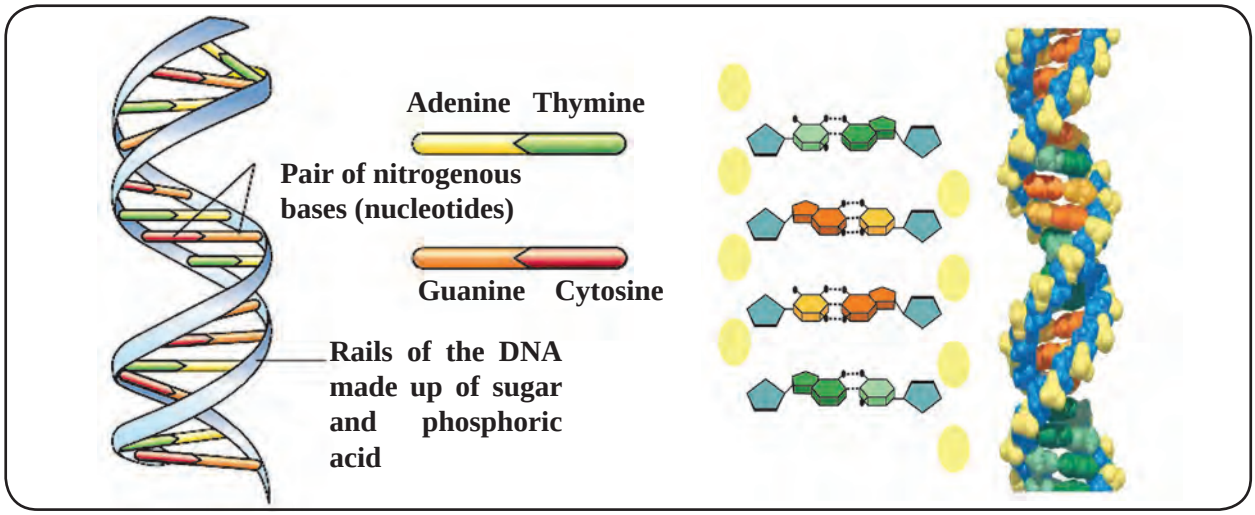
Gene

Each chromosome is made up of a single DNA molecule. Segments of the DNA molecule are called genes. Due to variety in the sequence of nucleotides, different kinds of genes are formed. These genes are arranged in a line. Genes control the structure and function of the cells and of the body. Also, they transmit the hereditary characteristics from parents to offspring. Hence, they are said to be the functional units of heredity. That is why, many similarities are seen between parents and their offspring. Information about protein synthesis is stored in the genes.



16.4 DNA (Watson and Crick's Model)

DNA fingerprinting : The sequence of the genes in the DNA of a person i.e. the genome of the person is identified. It is useful to identify the lineage and to identify criminals because it is unique to every person.



16.5 Structure of DNA

Seeds of technology :

In 1990, the **'Human Genome Project'** was together undertaken by all the geneticists of the world. In June 2000, scientists of this project and Celera Genomics Corporation (a private industry in USA) collectively announced the discovery of the complete DNA sequence of the human genome. Depending upon the findings of this project, scientists confirmed that the number of genes in the human genome is about 20,000 to 30,000. Later, scientists discovered the genomic sequence of many micro-organisms. Due to research in genomics, disease causing genes can be identified. If disease causing genes are identified, genetic diseases can be diagnosed and properly treated.

Website : www.genome.gov

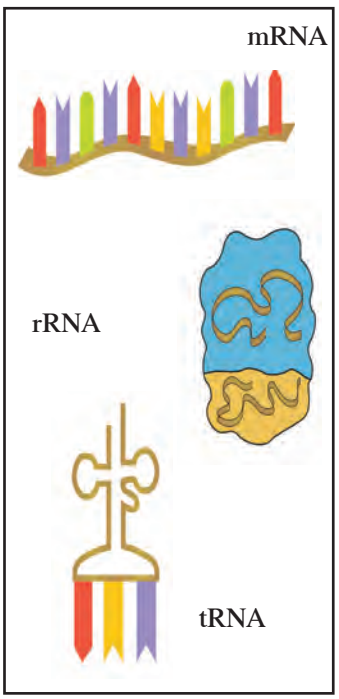
Ribonucleic acid (RNA) :

RNA is the second important nucleic acid of the cell. This nucleic acid is made up of ribose sugar, phosphate molecules and four types of nitrogenous bases adenine, guanine, cytosine and uracil. The nucleotide i.e. smallest unit of the chain of the RNA molecule is formed by combination of a ribose sugar, phosphate molecule and one of the nitrogenous bases. Large numbers of nucleotides are bonded together to form the macromolecule of RNA. According to function, there are three **types of RNA.**

1. Ribosomal RNA (rRNA) : The molecule of RNA which is a component of the ribosome organelle is called a ribosomal RNA. Ribosomes perform the function of protein synthesis.

2. Messenger RNA (mRNA) : The RNA molecule that carries the information of protein synthesis from genes i.e. DNA chain in the cell nucleus to ribosomes in the cytoplasm which produce the proteins, is called messenger RNA.

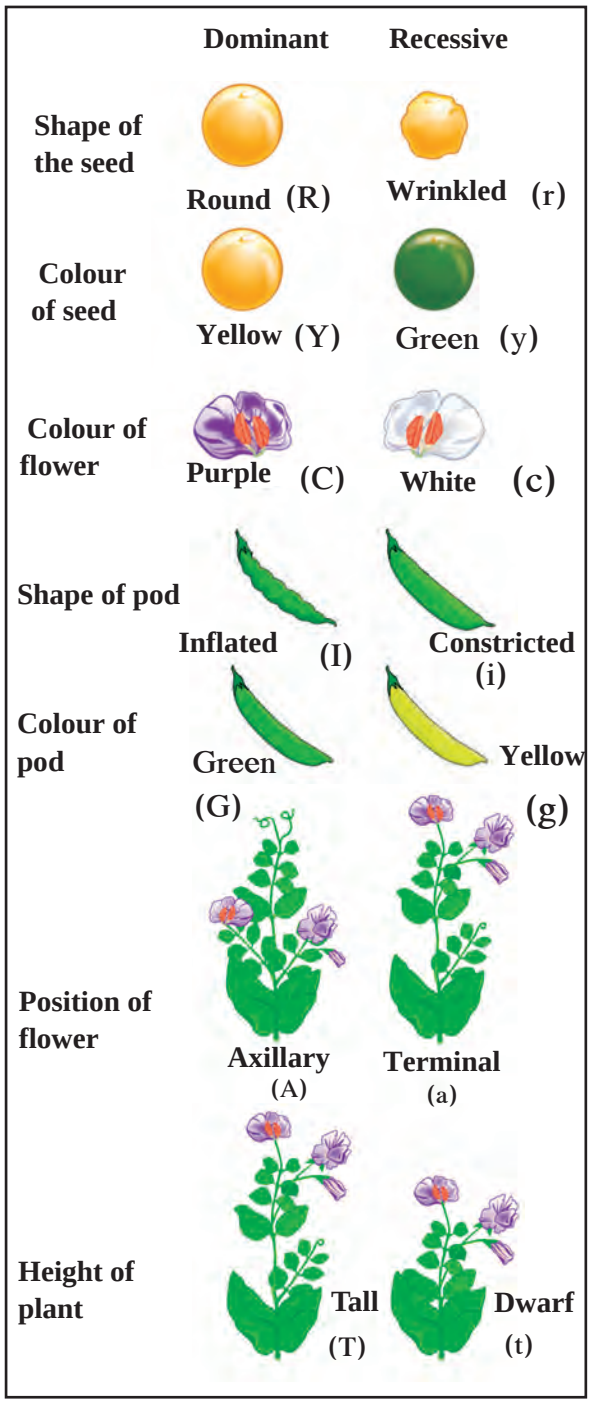
3. Transfer RNA (tRNA) : The RNA molecule which, according to the message of the mRNA carries the amino acid up to the ribosomes is called transfer RNA.



16.6 Types of RNA

Mendel's principles of heredity

Genetic material is transferred in equal quantity from parents to progeny. Principles of heredity are based upon this fact. If both the parents make equal contribution to inheritance of characteristics, which characteristics will appear in the progeny? Mendel carried out research in this direction and put forth the principles of heredity responsible for such inheritance. The experiments performed by Mendel, almost a century ago are quite astonishing. All of Mendel's experiments were based upon the visible characteristics of the pea plant (*Pisum sativum*). These characteristics are as follows -



16.7 Seven mutually contrasting visible characteristics

An introduction to scientists

Gregor Johann Mendel

(Birth: 20th July 1822, Death: 6th Jan 1884)

Gregor Johann Mendel was an Austrian scientist. He studied the inheritance of some characteristics of the pea plant. He showed that inheritance of these characteristics follows certain principles. Later, these principles becomes popular by his name. Mendel's work was recognized only in the 20th century. After a reconfirmation of these principles, the same principles now form the basis of modern genetics.

Do you know?

Some dominant and recessive characteristics of human beings

Dominant	Recessive
Rolling tongue	Non-rolling tongue
Presence of hair on arms	Absence of hairs on arms
Black and curly hair	Brown and straight hair
Free earlobe	Attached earlobe

We shall study the following crosses to clearly understand the conclusions of Mendel's experiments.

Monohybrid cross

In this experiment, Mendel brought about the cross between two pea plants with only one pair of contrasting characters. This type of cross is called a monohybrid cross.

So as to study the monohybrid ratio, let us consider the characteristic 'plant height' with a pair of contrasting characteristics tall plant and dwarf plant.

Parental generation (P_1) :

Tall pea plants and dwarf pea plant were used in this cross. Hence, this is parent generation (P_1). Mendel referred to the tall and dwarf plants as dominant and recessive respectively. The tall plant was referred to as dominant because all the plants in the next generation were tall. The dwarf plant was referred to as recessive because this characteristic did not appear in next generation at all. This experiment has been presented by the **'Punnet Square'** method as shown below.

Mendel's experiment of the Monohybrid Cross

Parental Generation (P_1)

Phenotype: Tall Dwarf

Genotype: T T t t

Gametes: T t

First Filial Generation (F_1)

Tt

Phenotype: Tall

Parental Generation (P_2) Selfing in F_1

Phenotype: Tall Tall

Genotype: Tt Tt

Gametes: T and t T and t

First Filial Generation (F_2)

Male gamete / Female gamete	T	t
T	TT (Tall)	Tt (Tall)
t	Tt (Tall)	tt (Dwarf)

Depending upon these observations, Mendel proposed that the factors responsible for inheritance of characteristics are present in pairs. Today, we refer to these factors as genes. Dominant genes are denoted by capital letters whereas recessive genes are denoted by small letters. As genes are present in pairs, tall plants are denoted by TT and dwarf plants are denoted by tt. During gametogenesis, these genes separate from each other. Due to this, two types of gametes one containing factor T and other containing factor t are formed.

First filial generation (F_1) :

In this experiment, Mendel observed that all plants of first filial generation (F_1) were tall. But, he realised that tall plants of F_1 generation were different from the tall plants of P_1 generation because parents of F_1 tall plants are tall as well as dwarf plants. Depending upon observations of F_1 generation, Mendel concluded that factors of tall plants are dominant over the factors of dwarf plants. Though all the plants in F_1 generation were tall, they contained the factor responsible for dwarfness. i.e. though the phenotype of F_1 plants is tall, their genotype is mixed. Phenotype means external appearance or visible charactersistics of organisms, for example, tallness or dwarfness of plants whereas genotype means the pairs of genes (factors) responsible for the visible characteristics. Genotype of P_1 tall plants is TT and produces only one type of gametes (T). Genotype of F_1 tall plants is Tt and it produces two types of gametes, T and t. Thus, based on this, we can say that in case of tall plants of F_1 and P_1 generations, though they show similar phenotype, their genotypes are different. Mendel further continued this experiment and brought about self-fertilization in F_1 plants from which a second filial (F_2) generation was produced.

Second filial generation (F_2):

In the second filial generation (F_2), both i.e. tall and dwarf types of plants appeared. According to the data collected by Mendel, out of 929 pea plants, 705 were tall and 224 were short. Thus, the phenotypic ratio of these plants is 3(tall):1(dwarf) and genotypic ratio is 1(TT):2(Tt):1(tt). Thus, it can be inferred that in the F_2 generation, phenotypically there are two types of plants whereas genotypically there are three types. These types are shown in the following table.

F_2 Pure dominant (TT) - tall plants	Homozygous
F_2 Pure recessive (tt) - dwarf plants	Homozygous
F_2 Hybrid plants (Tt) –tall plants	Heterozygous

Mendel's experiment on dihybrid cross:

In the dihybrid cross, two pairs of contrasting characteristics are under consideration. Mendel performed more experiments on hybridization in which he considered more than one pair of contrasting characteristics. He brought about a cross between a pea plant producing rounded and yellow coloured seeds and a pea plant with wrinkled and green coloured seeds. In this cross, two pairs of contrasting characteristics were considered colour of seeds and shape of seeds. Hence, it is called a dihybrid cross.

Parental generation (P_1) :

Mendel selected the pea plants producing rounded yellow seeds and wrinkled green seeds as parent plants, as shown in the chart -

Mendel's experiment of dihybrid cross

Parental Generation (P_1)

Phenotype: Rounded-yellow seeds Wrinkled-green seeds

Genotype: RRYY rryy

Gametes RY ry

First Filial Generation (F_1) RrYy

Phenotype: (Rounded-yellow seeds)

Parental Generation (P_2) Selfing in F_1

Phenotype: Rounded-yellow seeds Rounded-yellow seeds

Genotype: RrYy RrYy

Gametes RY, Ry, rY, ry RY, Ry, rY, ry

Second Filial Generation (F_2)

Female gamete \ Male gamete	RY	Ry	rY	ry
RY	RRYY	RRYy	RrYY	RrYy
Ry	RRYy	RRyy	RrYy	Rryy
rY	RrYY	RrYy	rrYY	rrYy
ry	RrYy	Rryy	rrYy	rryy

During gamete formation in P_1 generation, the pair of gametes separate independently i.e. in RRYY plants, only RY type gametes are formed and not RR and YY. Similarly, in rryy plants, only ry gametes are formed. Thus we can say that each pair of genes is represented in the gamete by only one gene from that pair.

Use your brain power !

Phenotypic ratio:

1. Round-Yellow:
2. Wrinkled-Yellow:
3. Round-Green:
4. Wrinkled-Green:

Genotypic ratio :

Genotypic ratio :

RRYY -
RRYy -
RRyy -
RrYY -
RrYy -
Rryy -
rrYY -
rrYy -
rryy -

Ratio = : : : : : : : :

1. Show the monohybrid cross between (RR) and (rr) and write the phenotypic and genotypic ratio of F_2 generation.
2. Why did the characteristic of the Rounded-Yellow seeds alone appear in the F_1 generation but not the characteristic of the wrinkled-green seeds?

Based on the conclusions from the monohybrid cross, Mendel expected that in the F_2 generation of dihybrid cross, plants would produce rounded-yellow seeds. He was proved right. Though the genotype of these plants was RrYy, their phenotype was like the parents producing rounded-yellow seeds, because yellow colour is dominant over green and round shape is dominant over wrinkled. Due to the combination of two different characteristics in the F_1 generation of the dihybrid cross, these plants are called dihybrid plants.

Plants of the F_1 generation of dihybrid cross produce four types of gametes RY, Ry, rY, ry. Of these gametes, RY and ry are similar to those of the P_1 generation.

F_2 generation is formed through the selfing of F_1 plants. The pattern of inheritance of charactistics from F_1 to F_2 is shown in brief in the table given on page 187 and an activity about its presentation in the form of a ratio has been given in a box, beside it. The 16 different possible combinations through the union of 4 types of male gametes and 4 types of female gametes are shown in a chess-board like table (Punnet Square / Checker board) on page 187. Male gametes are shown at the top of table and female gametes are shown in left column. Observations based on a study of the F_2 generation will be according to the table on page 187.

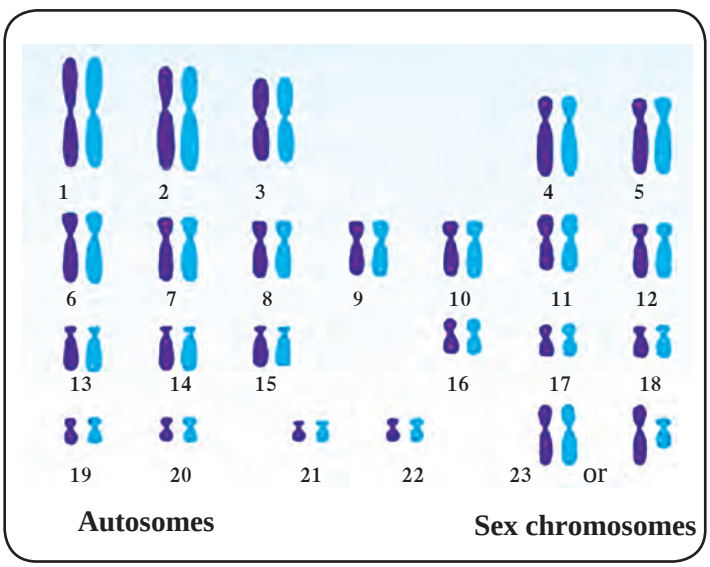
Genetic disorders

Diseases or disorders occurring due to abnormalities in chromosomes and mutations in genes are called genetic disorders. Chromosomal abnormalities include either increase or decrease in numbers and deletion or translocation of any part of the chromosome. Examples are physical disorders like cleft lip, albinism and physiological disorders like sickle cell anaemia, haemophilia, etc.

Human beings have 46 chromosomes in the form of 23 pairs. There is great variation in the size and shape of these chromosomal pairs. These pairs have been numbered. Out of 23 pairs, 22 pairs are autosomes and one pair is of sex chromosomes (allosomes). Chromosomes in women are represented as 44+XX and in men as 44+XY.

Mendel has shown in his experiments that there exist two type of genes, dominant and recessive.

If we take into account the number of chromosomes in human cells, their sex-related types, the types of genes on the chromosomes - dominant and recessive - we can see where genetic disorders originate and how they are inherited.



16.8 Human karyotype (Chromosome chart)

A. Disorders due to chromosomal abnormalities:

Following are the disorders that occur due to numerical changes in chromosomes. Offspring are not sterile if there is change in the number of autosomes is less. Instead, if there is an increase in number of any autosomal pair, physical or mental abnormalities arise and the lifespan is shortened with a shortened life span. Following are some disorders.

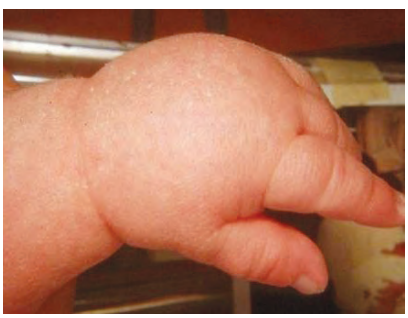
1. Down syndrome (46+1, Trisomy of 21st Chromosome) :

Down syndrome is a disorder arising due to chromosomal abnormality. This is the first discovered and described chromosomal disorder in human beings. This disorder is characterised by the presence of 47 chromosomes. It is described as trisomy of the 21st chromosome. Infants with this disorder have one extra chromosome with the 21st pair in every cell of their body. Therefore they have 47 chromosomes instead of 46. Children suffering from Down's syndrome are usually mentally retarded and have a short lifespan. Mental retardation is the most prominent characteristic. Other symptoms include short height, short wide neck, flat nose, short fingers, scanty hair, single horizontal crease on palm, and a life expentancy of about 16–20 years.

16.9 Child with Down syndrome

2. Turner syndrome (Monosomy of X chromosome) :

As with autosomes, abnormalities in sex chromosomes also cause some disorders. Turner syndrome (or 44+X) arises due to either inheritance of only one X chromosome from parents or due to inactivation of the gender-related part of X-chromosomes. Instead of the normal 44+XX condition, women suffering from Turner syndrome show a 44+X condition. Such women are sterile i.e. unable to have children due to improper growth of the reproductive organs.



16.10 Hand of a child with Turner syndrome

3. 3. Klinefelter syndrome (44+XXY) :

This disorder arises in men due to abnormalities in sex chromosomes. In this disorder, men have one extra X chromosome; hence their chromosomal condition becomes 44+XXY. Such men are sexually sterile because their reproductive organs are not well developed.

National Health Mission

Under the National Health Mission, the National Rural Health Mission has been started since April 2005 and the National Urban Health Mission since 2013.

The main objectives of this mission are strengthening of the rural and urban health facilities, controlling various diseases and illnesses, increasing public awareness about health, and offering financial assistance to patients through various schemes.

B. Diseases occuring due to mutation in single gene (monogenic disorders) :

Disorders or diseases occurring due to mutation in any single gene into a defective one are called monogenic disorders. Approximately 4000 different disorders of this type are now known. Due to abnormal genes, their products are either produced in insufficient quantity or not at all. It causes abnormal metabolism that may lead to death at a tender age. Examples of such disorders are Hutchinson's disease, Tay-Sachs disease, galactosaemia, phenylketonuria, sickle cell anaemia, cystic fibrosis, albinism, haemophilia, night blindness, etc.

1. Albinism :

This is a genetic disorder. Our eyes, skin and hair have colour due to the brown pigment, melanin. In this disease, the body cannot produce melanin. The skin becomes pale, hairs are white and eyes are usually pink due to absence of melanin pigment in the retina and sclera.

16.11 Hair and eyes of child with albinism

2. Sickle-cell anaemia :

Even minor changes in molecular structure of proteins and DNA may lead to diseases or disorders. Normal haemoglobin has glutamic acid as the 6th amino acid in its molecular structure. However, if it is replaced by valine, the shape/structure of the haemoglobin molecule changes. Due to this, the erythrocytes or red blood corpuscles (RBC), which are normally biconcave become sickle-shaped. This condition is called 'sickle-cell anaemia'. The oxygen carrying capacity of haemoglobin in such individuals is very low.

In this condition, clumping and thereby destruction of erythrocytes occurs most often. As a result blood vessels are obstructed and the circulatory system, brain, lungs, kidneys, etc. are damaged. Sickle-cell anaemia is a hereditary disease. It occurs due to changes in genes during conception. If the father and mother are both affected by sickle-cell anaemia or if they are carriers of this disorder, their offspring are likely to suffer from this disease. Hence, marriages between the persons who are carriers of or suffering from sickle-cell anaemia should be avoided.

There are two types of persons affected by sickle-cell anaemia :

1. Sickle-cell anaemia carrier (AS)
2. Sufferer from sickle-cell anaemia (SS)

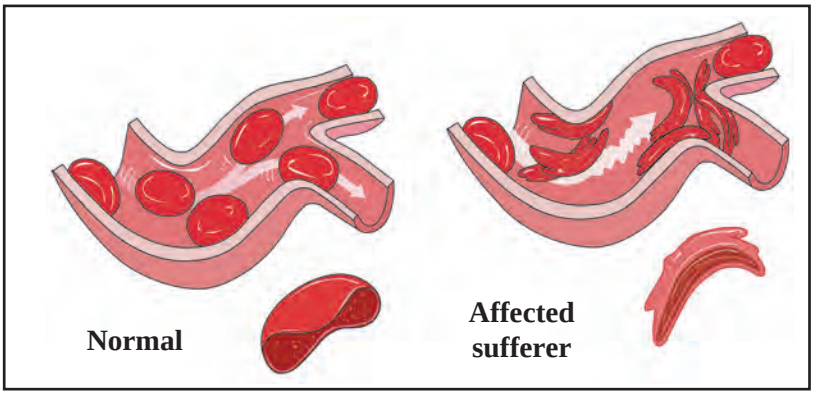
Symptoms of sickle-cell anaemia :

Swelling of hands and legs, pain in joints, severe general body aches, frequent colds and cough, constant low grade fever, exhaustion, pale face, low haemoglobin content.

Do you know?

In Maharashtra, there are more than 2.5 lakh people suffering from sickle-cell anaemia and about 21 districts including 11 districts from Vidarbha are affected by this disorder.

Let's get our blood tested !
Let's overcome sickle cell anaemia !



16.12 Sickle cells

Sickle cell anaemia occurs as follows :

Symbols: AA = Normal, AS = Carrier, SS = Sufferer

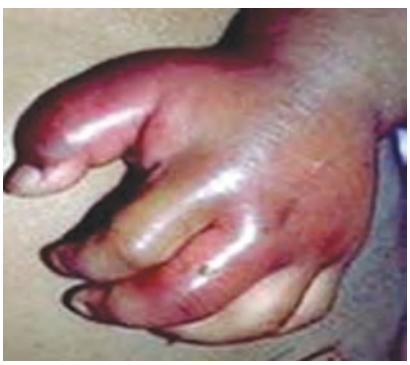
Sr. No.	Man	Woman	Progeny
1	AA	AA	Normal progeny if both parents are normal.
2	AA or AS	AS or AA	50% progeny normal and 50% carrier, if one parent is normal and one is a carrier.
3	AA or SS	SS or AA	All progeny will be carrier, if one parent is normal and one is a sufferer.
4	AS	AS	25% progeny normal, 25% sufferer and 50% carrier if both parents are carriers.
5	AS or SS	SS or AS	50% progeny carrier and 50% sufferer if one parent is carrier and one is a sufferer.
6	SS	SS	All progeny will be sufferers if both parents are sufferers.

Diagnosis of sickle-cell anaemia : Under the National Health Mission scheme, the 'Solubility Test' for diagnosis of sickle-cell anaemia is available at all district hospitals. Similarly, the confirmatory diagnostic test- 'Electrophoresis' is performed at rural and sub-district hospitals.

Remedies :

This disease is spread in only one way i.e. reproduction. Hence, husband and wife should get their blood exmined either before marriage or after it.

1. A carrier or sufferer should avoid marriage with another carrier or sufferer.
2. A person suffering from sickle cell anaemia should take a tablet of folic acid daily.



16.13 Hand of a child with sickle-cell anaemia

C. Mitochondrial disorder :

Mitochondrial DNA may also become defective due to mutation. During fertilization, mitochondria are contributed by the egg cell (ovum) alone. Hence, mitochondrial disorders are inherited from the mother only. Leber hereditary optic neuropathy is an example of a mitochondrial disorder.

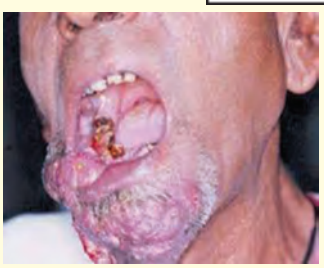
D] Disorders due to mutations in multiple genes : (Polygenic disorders)

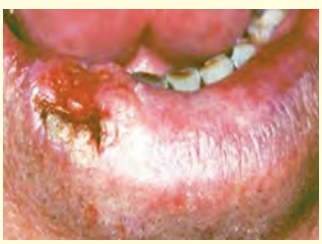
Sometimes, disorders arise due to mutations in more than one gene. In most such disorders, their severity increases due to effects of environmental factors on the foetus. Common examples of such disorders are cleft lip, cleft palate, constricted stomach, spina bifida (a defect of the spinal cord), etc. Besides, diabetes, blood pressure, heart disorders, asthma, obesity are also polygenic disorders. Polygenic disorders do not strictly follow Mendel's principles of heredity. These disorders arise from a complex interaction between environment, life style and defects in several genes.

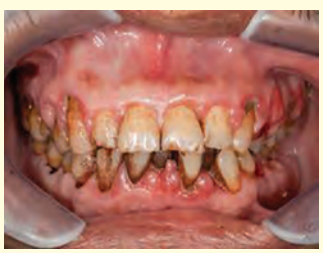
78GD2L

Always remember

Inter-relationship between tobacco addiction and cancer (Uncontrolled growth of cells)







Many people consume tobacco, either by smoking or by chewing. Consumption of tobacco in any form can cause cancer. Smoking of cigarettes and *bidi* adversely affects the process of digestion. It causes a burning sensation in the throat and a cough. Excessive smoking causes instability and trembling of fingers. A dry cough causes sleeplessness. Tobacco consumption can also lead to shortening of life span, chronic bronchitis, pericarditis, cancer of the lungs, mouth, larynx (voice box), pharynx, pancreas, urinary bladder, etc.

Harmful effects of smoking are due to the nicotine present in tobacco. It affects the central and peripheral nervous system. Arteries become hard i.e. it causes arteriosclerosis and hypertension.

Tobacco smoke contains harmful chemicals like pyridine, ammonia, aldehyde furfural, carbon monoxide, nicotine, sulphur dioxide, etc. They cause uncontrolled cell division. Tobacco smoke is full of minute carbon particles which causes normal tissue of the lung to transform into thickened black tissue. This causes cancer. While chewing tobacco or tobacco products much of the extract is absorbed into the body. Excessive tobacco consumption may cause cancer of lips or tongue, visual disorders or tremors.

To protect one's body from cancer one must avoid smoking and consumption of tobacco and tobacco products in any form.

Compose and present a street play against tobacco consumption and participate in a drive against tobacco.

Exercises

1. Complete the following sentences by choosing the appropriate words from the brackets.

(Inheritance, sexual reproduction, asexual reproduction, chromosomes, DNA, RNA, gene)

a. Hereditary characters are transferred from parents to offsprings by ....., hence they are said to be structural and functional units of heredity.
b. Organisms produced by ..... show minor variations.
c. The component which is in the nuclei of cells and carries the hereditary characteristics is called .....
d. Chromosomes are mainly made up of .....
e. Organisms produced through ..... show major variations.

2. Explain following.

a. Explain Mendel's monohybrid progeny with the help of any one cross.
b. Explain Mendel's dihybrid ratio with the help of any one cross.
c. Distinguish between monohybrid and dihybrid cross.
d. Is it right to avoid living with a person suffering from a genetic disorder?

3. Answers the following questions in your own words.

a. What is meant by 'chromosome'. Explain its types.
b. Describe the structure of the DNA molecule.
c. Express your opinion about the use of DNA fingerprinting.
d. Explain the structure, function and types of RNA.
e. Why is it necessary for people to have their blood examined before marriage?

4. Write a brief note on each.

a. Down syndrome
b. Monogenic disorders
c. Sickle cell anaemia: symptoms and treatment.

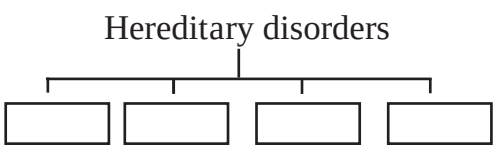
5. How are the items in groups A, B and C inter-releated?

A	B	C
Leber hereditary optic neuropathy	44+XXY	Pale skin, white hairs
Diabetes	45+X	Men are sterile
Albinism	Mito-chondrial disorder	Women are sterile
Turner syndrome	Polygen-ic disorder	This disorder arises during development of zygote.
Klinefelter syndrome	Mono-genic disorder	Effect on blood-glucose level.

6. Filling the blanks based on the given realationship.

a. 44+X:Turner syndrome: :44+XXY:- .....
b. 3:1 Monohybrid: : 9:3:3:1 : .....
c. Women : Turner syndrome : : Men : .....

7. Complete the tree diagram below based on types of hereditary disorders.



Activity

a. Prepare a model of the DNA and give a presentation based on it.
b. Prepare a power point presentation on awareness about tobacco consumption and cancer and present it in the class.