16. Heredity and Variation

EXTRA QUESTIONS

1. What is meant by heredity?
   - The transfer of characteristics from parents to offspring is called heredity

2. What is meant by genetics?
   - 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

3. What is meant by genetic disorder?
   - The diseases or disorders occurring due to abnormalities in chromosomes and mutations in genes are called genetic disorders

4. What is meant by chromosomes?
   - The structure in the nucleus of cells that carries the hereditary characteristics is called the chromosome

5. Why DNA is called as the master molecules?
   - DNA means Deoxyribonucleic acid. 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

6. What is meant by gene?
   - Each chromosome is made up of a single DNA molecule and these segments of the DNA molecules are called genes. They transmit the hereditary characteristics from parents to offspring. Hence, they are said to be the functional units of heredity

7. What is the use of DNA fingerprinting?
   - The sequence of the genes in the DNA of a person that is 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

8. What are the objectives of the 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

9. Which facilities are available in the hospitals for the 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

10. What is meant by 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. This is known as mitochondrial disorder. Leber hereditary optic neuropathy is an example of a mitochondrial disorder

11. State true or false for the following statements:

a. Mendel said tall height is an recessive characteristic of pea plant
- False. Mendel said tall height is an dominant characteristic of pea plant

b. Adenine pairs with cytosine
- False. Adenine pairs with thymine

c. Marriage should be avoided with person suffering from sickle cell anaemia
- True

12. Match the pairs

Organism	Number of chromosomes	Answer
Crab	200	**004**
Roundworm	004	**200**
Frog	026	**026**

13. Fill in the blanks based on the given relationship

a. 44 + X : Turner syndrome :: 44 + XXY : _____
- Klinefelters syndrome

b. Hybrid tall plants : Heterozygous :: Pure tall plants : _____
- Homozygous

c. Chromosomes in men : 44 + XY :: Chromosomes in women : _____

- 44 + XX

14. Differentiate between mendels Monohybrid cross and Dihybrid cross

Monohybrid cross	Dihybrid cross
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	Mendel brought about the cross between two pea plants with two pairs of contrasting characteristics. Hence, it is called a Dihybrid cross
Ratio in this cross is about 3:1	Ratio in this cross is about 9:3, 3:1
Genotypic ratio in this cross is 1:2:1	Genotypic ratio in this cross is 1:4:1:1:2:2:2:1

15. Genes are called functional units of heredity

- 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

16. Marriages between the persons who are carriers or sufferers from sickle-cell anaemia should be avoided.

- 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

17. What is the mechanism of heredity?

- Every gene is not a part of the thread like structure of DNA but it is a separate piece of it. These pieces are called as chromosomes. One piece comes from the chromosome of mother and one piece comes from the father. Every gamete consists of one chromosome from the pair. When these gametes come together during reproduction, then the progeny has same number of chromosomes. This is known as mechanism of heredity

18. Offspring produced through sexual reproduction show greater variations

- Sexual reproduction occurs due to combination of gametes from mother and father. The DNA structure of both mother and father are different. Also there are other variations in the parents which affect the DNA structure of the offspring. Hence, offspring produced through sexual reproduction show greater variations

19. Why ineffective factors are seen in second generation F_2?

- In the first generation F1, the effective factors are far more than the ineffective factors. But still F_1 contains some ineffective factors. These are then passed onto F_2 generation. In F_2 the genes get divided further. Hence, after the reproduction this ineffectiveness is seen more in F_2 generation

20. Which steps should be taken to avoid cancer in humans?

- Smoking is the main reason for occurrence of cancer in humans. Harmful effects of smoking are due to the nicotine present in tobacco. 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. Hence, to protect one's body from cancer one must avoid smoking and consumption of tobacco and tobacco products in any form

21. Write short note on Down syndrome.

- Down syndrome is a disorder arising due to chromosomal abnormality. This disorder is characterized by the presence of 47 chromosomes. Mental retardation is the most prominent characteristic. Other symptoms include short height, short wide neck, flat nose, short fingers, and scanty hair. Also people suffering from these are not sexually mature and do not possess reproduction ability. They have life expectancy of about 16–20 years. In the 21^{st} pair, they have 3 chromosomes instead of 2 and hence these are also called as trisomy of the 21^{st} chromosome

22. Write a note on monogenic disorder

- The disorders or diseases occurring due to mutation in any single gene into a defective one are called monogenic disorders. 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. Example; Hutchinson's disease, Albinism and sickle cell anaemia

23. Write the symptoms and remedies to cure sickle cell anaemia

- Symptoms: Swelling of hands and legs,
  Pain in joints,
  Severe general body aches,
  Frequent colds an cough,
  Constant low grade fever,
  Exhaustion,
  Pale face,
  Low hemoglobin content

  Remedies: 1. Husband and wife should get their blood examined either before marriage or after it.
  2. A carrier or sufferer should avoid marriage with another carrier or sufferer.
  3. A person suffering from sickle cell anaemia should take a tablet of folic acid daily

24. Why did the characteristic of rounded-yellow seeds alone appear in the F_1 generation but not the characteristic of the wrinkled-green seeds?

- Both rounded seeds(R) and yellow colors of seeds(Y) are dominant characteristics whereas wrinkled seeds(r) and green color(y) are recessive characters. Therefore, characteristics of rounded yellow seeds RRYY appear in F1 generation. That is why rounded yellow seeds appear in F_1 generation

25. Write the structure and types of 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. The nucleotide i.e. smallest unit of the chain

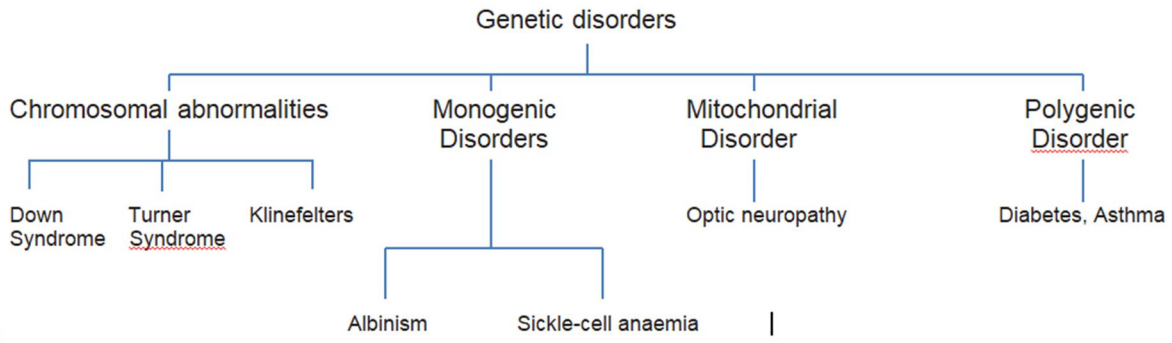
of RNA molecule is formed by combination of the above mentioned compounds. Large numbers of nucleotides are bonded together to form the macromolecule of RNA
According to function, there are three types of RNA,

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

26. Write the structure of DNA in detail.

➢ 1. The structure of the DNA molecule is the same in all organisms. Watson and Crick produced a model of the DNA molecule
2. Every molecule of DNA consists of two parallel threads of nucleotides which are coiled around each other
3. Each strand in the molecule of DNA is made up of many small molecules known as 'nucleotide'
4. In the structure of the nucleotide, a molecule of a nitrogenous base and phosphoric acid are each joined to a molecule of sugar.
5. There are four types of nitrogenous bases adenine, guanine, cytosine and thymine
6. Each rung of the ladder is a pair of nitrogenous bases joined by hydrogen bonds
7. As there are four types of nitrogenous bases, nucleotides also are of four types
8. Adenine and guanine are called as 'purines' while cytosine and thymine are called 'pyrimidines'
9. Adenine always pairs with thymine whereas guanine pairs with cytosine

27. Draw a flow chart based on the information on genetic disorders



28. Match the pairs of the group A, B and C

A	B	C
1. Leber hereditary optic neuropathy	a. 44 + XXY	i. Pale skin, white hairs
2. Diabetes	b. 45 + X	ii. Men are sterile
3. Albinism	c. Mitochondrial disorder	iii. Women are sterile
4. Turner syndrome	d. Polygenic disorder	iv. This disorder arises during development of zygote
5. Klinefelter syndrome	e. Monogenic disorder	v. Effect on blood-glucose level

➢ Answer:

A	B	C
1. Leber hereditary optic neuropathy	a. Mitochondrial disorder	i. This disorder arises during development of zygote
2. Diabetes	b. Polygenic disorder	ii. Effect on blood-glucose level
3. Albinism	c. Monogenic disorder	iii. Pale skin, white hairs
4. Turner syndrome	d. 45 + X	iv. Women are sterile
5. Klinefelter syndrome	e. 44 + XXY	v. Men are sterile

29. Explain Mendel's monohybrid progeny with the help of any one cross

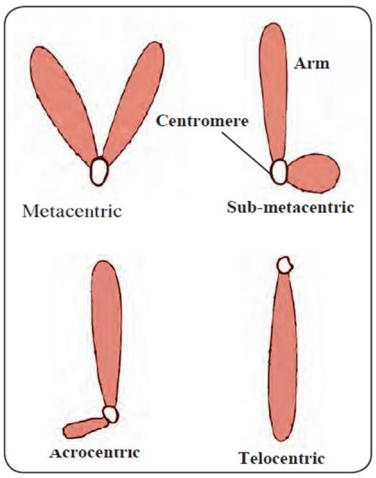
- 1. The cross between two pea plants with only one pair of contrasting characters. This type of cross is called a monohybrid cross
  2. For this cross, red flowered and white colored pea plants were used
  3. These are called as parental generation (P_1). Red flowers are dominant where as white flowers are recessive
  4. Red flowers were called dominant because the next generation all the flowers obtained was of red color so they were considered dominant
  5. Genes are always in pairs, hence the red flower is shown as (RR) and white flower is shown as (rr)
  6. When red flowered plants were crossed with white flowered, all the plants produced in F_1 generation are hybrid red flowered
  7. When F_1 plants are self-crossed, the phenotype ratio obtained in F_2 generation is 3:1

30. Explain Mendel's Dihybrid progeny

- 1. Crossing of two pure individual plants involving two pairs of contrasting characters or traits is called as Dihybrid cross
  2. Mendel crossed pea plants having round and yellow seeds with plants of wrinkled and green seeds
  3. The gametes obtained from (RRYY) plants were (RY) plants whereas from (rryy) plants were of (ry) gametes
  4. Even though the first generation genetics were of form RrYy, the obtained flowers were of yellow color
  5. In F_1 generation 4 genetic ratios are obtained
  6. When F_1 hybrids are self-crossed, then F_2 generation is obtained. In this 4 male gametes and 4 female gametes are obtained. From this 16 matches are obtained are their phenotypic ratio is 9:3:3:1

31. What is meant by chromosomes? Explain their types

- 1. Every animal and plant consists a thread like structure in their nucleus which is known as chromosome
  2. Chromosomes are mainly formed of nuclei and proteins
  3. Each chromosome is made up of different pigments
  4. Each chromosome consists of a compressed part in the center known as centromere
  5. Chromosomes are mainly of 4 types:
  a. Metacentric: The centromere is exactly at the mid-point in this chromosome, and therefore the chromosome looks like the English letter 'V'
  b. Sub-metacentric: The centromere is somewhere near the mid-point in this chromosome which therefore looks like English letter 'L'
  c. Acrocentric: The centromere is near one end of this chromosome which therefore looks like the English letter 'j'
  d. Telocentric: The centromere is right at the end of this chromosome making the chromosome look like the English letter 'i'.



32. Write short note on Polygenic disorder.

- 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 fetus. Common examples of such disorders are cleft lip, cleft palate, constricted stomach, spinal 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

33. Should living with people having genetic disorders be avoided?

- Genetic disorders can cause of many reasons. Main reasons of genetic disorders are as follows:

1. Disorders due to chromosomal abnormalities

a. Down syndrome b. Turner syndrome c. Klinefelters

2. Diseases occurring due to mutation in single gene (monogenic disorders)

a. Albinism: In this disorder, the body does not produce the brown pigment melanin

b. Sickle-cell anaemia: In this, if both mother and father are carriers or sufferers of it then the progeny will also suffer from it

c. In Mitochondrial disorder, the person will suffer from Leber hereditary optic neuropathy

d. Polygenic disorders causes cleft lip, cleft palate, constricted stomach, spinal bifida

From all these disorders it is concluded that, these conditions are caused after the reproduction process. These are transmitted only through sexual medium and living in them will not cause any harm to people around it. Hence, living with people having genetic disorder is acceptable and should not be avoided

34. Draw diagram of organization of chromosome and name it.

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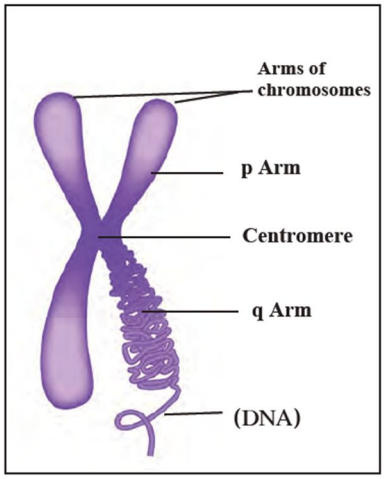

35. Differentiate between Turner syndrome and Klinefelters syndrome

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Turner syndrome	Klinefelters syndrome
1. In this syndrome the women are sterile	1. In this syndrome men are sterile
2. In this, number of chromosomes are 45 instead of 46	2. In this, number of chromosomes are 47 instead of 46
3. In this, one x chromosome is less	3. In this, one x chromosome is more

4. This syndrome shows 44+X condition	4. This syndrome shows 44+XXY condition
5. This syndrome occurs only in women	5. This syndrome occurs only in men

36. Differentiate between DNA and RNA

➢

DNA	RNA
DNA is the first most important nucleic acid of the cell	RNA is the second important nucleic acid of the cell
DNA carries the genetic information	RNA carries hereditary information
DNA consists of cytosine and thymine as nitrogenous base pyridimine	RNA consists of cytosine and uracil as nitrogenous base pyridimine
In DNA, thymine pairs with adenine	In RNA, thymine pairs with uracil
DNA consists of deoxyribose sugar base	RNA consists of ribose sugar base

37. Parents and their offspring show a lot of similarity

➢ The transfer of physical and mental traits from parents to their offspring is known as heredity. The offspring produced after the reproduction gets the features from their parents. Though some features are different than their parents, but most of their features are similar to parents. According to the mendels principles of heredity, the features of parents are transferred to their offspring hence the offspring shows a lot of similarity to their parents

38. The offspring of some organisms show dominant characteristics whereas some offspring show recessive characteristics.

➢ 1. According to the Mendels principles of heredity, even if the offspring has ability to carry dominant as well as recessive characteristics. The offspring will carry dominant characteristic.
2. But if both the parents carry recessive characteristics, then the offspring will also have recessive character
3. Recessive characters are seen in homozygous condition whereas dominant character are seen in heterozygous condition.

39. Leber hereditary optic neuropathy are inherited from the mother only

➢ 1. Leber hereditary optic neuropathy is an example of Mitochondrial disorder
2. Mitochondrial DNA may also become defective due to mutation
3. During fertilization, mitochondria are contributed by the egg cell (ovum) alone
4. That's why, Leber hereditary optic neuropathy are inherited from the mother only

40. Why do we see a variation in the skin color in humans, even though we belong to same species?

➢ 1.The skin color in humans is an hereditary property
2. The skin color is caused due to the brown pigment present known as Melanin. The color is affected by the melanin producing genes
3. If the melanin producing genes are more, then the color of skin is darker. If the melanin producing genes is less, then the color of skin is lighter. That is why we see a variation in skin color.

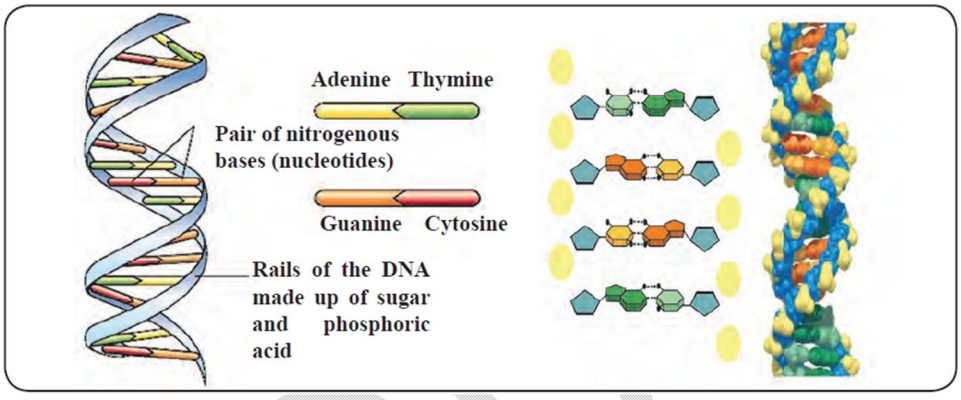
41. What do we observe when we see earlobes of our friends and people around us?

➢ If we go by the principle of heredity, then free earlobe is a dominant character in humans whereas attached earlobe is a recessive characteristic in humans. If we observe people around us then most of the people have free earlobes. Hence, we see free earlobes most often in the people and friends around us

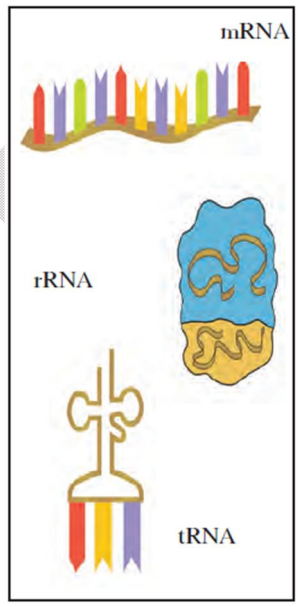
42. Why is it necessary for people to have their blood examined before marriage?

- If people have their blood examined before marriage then they can avoid genetic disorders being transmitted to their offspring. The test will be used to conclude whether to not have offspring or to not marry the partner. The couple could consult doctor and necessary advice could be given to them. Also, examining blood can avoid any other sexually transmitted diseases. That is why the people should have their blood examined before marriage

43. Draw the diagram showing the structure of DNA molecule

- 

44. Draw the diagram of RNA.

- 

45. Write the seven characteristics of pea plant as given by Mendel

Characteristics	Dominant	Recessive
1. Shape of the seed	Round	Wrinkled
2. Color of seed	Yellow	Green
3. Color of flower	Purple	White
4. Shape of pod	Inflated	Constricted
5. Color of Pod	Green	Yellow
6. Position of Flower	Axillary	Terminal
7. Height of plant	Tall	Dwarf

46. Show the monohybrid cross between (RR) and (rr) and write the phenotypic and genotypic ratio of F_2 generation.

➢ Round pea plant – RR
Wrinkled pea plant – rr

- Parental generation (P_1):

Phenotype: Round pea plant Wrinkled pea plant
Genotype: RR rr
Gametes: R r
First Filial Generation (F_1): Rr
(Round pea plant)

- Parental Generation (P_2): Selfing in F_1

Phenotype: Round pea plant x Round pea plant
Genotype: Rr x Rr
Gametes: R r R r

- Second Filial Generation (F2):

Male gamete / Female gamete	R	r
R	RR (round)	Rr (hybrid round)
r	Rr (hybrid round)	Rr (wrinkled)

From this, the phenotypic ratio = 3 round pea plant: 1 wrinkled pea plant
That is 3:1
Genotypic ratio = 1 RR: 2 Rr: 1 rr
That is = 1: 2: 1
From this we can conclude that round shape of pea plant is a dominant characteristic and wrinkled shape of pea plant is a recessive characteristic

47. The tall plants of F_1 and P_1 generation are phenotypically same but genotypically different

- 1.The plants in F1 generation are hybrid where one part comes from a dominant characteristic of homozygous tall (TT) genotype and other from a recessive characteristic of homozygous dwarf (tt) genotype
  2. The factors of tall plants are dominant over the factors of dwarf plants that are why in F_1 generation we see this factor as a dominant characteristic. Hence, even though we see the hybrid genotype (Tt) in pea plant, they have the factors for tall plants. That is why; the tall plants of F_1 and P_1 generation are phenotypically same but genotypically different

48. How do specific traits or characteristics appear in organisms?

- 1. The information for a specific trait is stored in the DNA
  2. This information is basically necessary for protein synthesis in the cell
  3. The segment of DNA which contains all the information for synthesis of a particular protein is called a gene for that protein
  4. Hormones are basically proteins which control the growth related reactions
  5. Efficient enzymes produce a greater quantity of the hormone due to which the more traits and characteristics are seen. However, if the enzymes are less efficient, a smaller quantity of hormone is produced leading to less traits and characteristics
  6. This is how the genes produced by proteins and relationship of these proteins with the characteristics of organisms are related

49. Write in detail about 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

50. Write the relation between tobacco consumption and cancer

- 1. 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.
  2. 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
  3. 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.