Rao IIT Academy
Symbol of Excellence and Perfection

XII - ISC BOARD

Date: 25.03.2015 **BIOLOGY - SOLUTIONS**

PART I

Question 1

(a)

(i) **Heterosis :** Heterosis means hybrid viger or Heterosis or outbreeding enhancement is the improved or increased function of any biological quality in a hybrid offspring.

(ii) In non-cyclic photophosphorylation, transfer of high energy electrons emitted by chlorophyll a molecule do not return to it, but electrons which are received by chlorophyll a molecule from water. Hence it is known as non-cyclic pathway.

(iii) **Test cross :** Cross between F_1 offspring with recessive parent is known as test cross.

(iv) **Introns :** Are the intervening sequences. Introns are non coding sections of a RNA transcript or the DNA encoding it that are spliced out before the RNA molecule is translated into a protein.

(b)

1. Triple fusion involves fusion of second male gamete with two polar nuclei.
2. Brain
3. 44 + XO
4. Transcription is the transfer of genetic code from a DNA molecule to RNA molecule.

(c)

(i) The first formed category of photosynthetic organisms – Cyanobacteria

(ii) Tubectomy

(iii) Altruism.

(iv) Turgor pressure

(d)

(i) STD : Sexually transmitted diseases

(ii) NADP : Nicotinamide Adenine Dinucleotide phosphate

(iii) MRI : Magnetic resonance imaging

(iv) DDT : Dichloro diphenyl trichloro ethane

(e)

(i) Raymond Dart

(ii) Microspheres - Sidney walter fox

(iii) B.S. Meyer (1938)

(iv) Godfrey Housfield, Allan Cormack

Part - II

Section - A

Question 2

(a) **Following morphological characters have evolved during human evolution:**

- Bipedal locomotion.
- Straight posture.
- Development of distinct lumbar curve.
- Development of broad basin-shaped iliac bones in the pelvic girdle.
- Acetabular cavities shifted inward to give straight posture.
- Increase in the size of brain and cranial cavity.
- Flattening of face.
- Loss of supraorbital ridges.
- Straightening of forehead.
- Formation of chin.
- Opposable thumb in the hands for grasping.
- Sparse body hair.
- Narrowing of nose.
- Thining of jaw bones.
- Reduction in the jaw musculature.
- Reduction in the size of canines.
- Increase in intelligence
- Social and cultural organisation

(b) Chemogeny or Chemical Origin of Life (Abiotic Synthesis of Macromolecules)

About 4 billion years ago, earth's atmosphere had ammonia, methane and water vapours. There was no free oxygen. Formation of various simple and complex organic molecules from these gases involved following steps:

Formation of Simple Organic Compounds: The primitive inorganic molecules interacted and combined to form simple organic compounds like alcohols, aldehydes, glycerol, fatty, acids, amino acids, sugars and nitrogenous bases.

Formation of Complex Organic Compounds: Simple organic molecules underwent condensation, polymerisation and chance chemical reactions forming new and complex organic macromolecules such as polysaccharides, fats, proteins, nitrogenous bases, nucleosides and nucleotides.

In living organisms, biological reactions are sped up by enzymes, but in primitive sea, these enzymes were absent. So such reactions occurred far more slowly. Therefore, nature could synthesise all the compounds known to exist in the present day living beings but at a very slow pace.

(c) Dryopithecus

It is a group of apes whose fossils were obtained from rocks of Miocene (about 20-25 million years old) from Africa and Asia. Their fossils from the rocks of Bilaspur (India) have been named Sivapithecus and from East Africa Dryopithecus africanus.

Dryopithecus resembled great apes. Their arms and legs were of almost equal length. They had semi-erect posture and large canines like those of modern apes. They are supposed to be the **common ancestors of apes and men**.

Question 3

(a) Evolution of long neck in Giraffe

Darwin explained evolution of long neck of modern giraffe by presuming existence of variability in the length of neck and legs in the ancestral population of giraffe. The longer-necked giraffe with longer forelegs were more successful in reaching the soft leaves of trees for feeding. Therefore, natural selection favoured longer-necked progeny generation after generation. Selection of longer neck for innumerable generations resulted in the evolution of present day longer-necked modern Giraffe.

(b) Chromosomal similarities between ape and man - Chromosome no 2 of human and 2A and 2B of apes.

(c) Notochord and Pharyngeal gill slits.

Question 4

(a) Sickle-cell Anaemia: Sickle-cell anaemia is a genetic disorder of human beings, found specially in Blacks. In a sickle-cell anaemic person, normal haemoglobin (HbA) is replaced by HbS whose oxygen-carrying capacity is less than HbA. The RBCs in this disease become, sickle- shaped in venous blood owing to the lower concentration of oxygen. This causes rupture of RBCs and severe haemolytic anaemia. Individuals homozygous for abnormal haemoglobin(Hb^sHb^s) die at an early age. In heterozygotes (Hb^AHb^s), the RBCs containing Hbs become sickle-shaped and unable to bind oxygen, and with HbA remain normal.

Why has this character not been eliminated from human population by natural selection? The geographical distribution of sickle-cell anaemia provides answer to the above question. It is found in tropical Africa where malaria is widespread. Malarial parasites that live in RBCs are unable to grow in sickle-shaped RBCs. It means individuals heterozygous for sickle-celled gene are able to cope with malarial infection whereas the normal person with normal RBCs suffers from severe malarial infection in malaria infested areas. This shows that natural selection favoured the sickle-celled character and gene controlling is fixed by natural selection, because of its survival value in malaria-infested regions. Therefore, this character is found in blacks living in malaria- infested belt of the world.

(b) Gene flow: It is the elimination or addition of the genes of certain characters when some animals in population migrate or dies or immigrate. It changes the gene frequency of remaining population.

(Change in frequency of genes in a gene pool is called genetic flow)

(c) Analogous Organs and Analogy: Analogous organs perform the same function and have atmost similar appearance, but they develop in totally different groups and are different in fundamental structure. Therefore, analogy is the superficial similarity in appearance between organs of different animal groups because they carry out the same function.

Potato and Sweet Potato have similar tuberous appearance due to storage of food, but Potato is stem and Sweet Potato is root.

Section - B

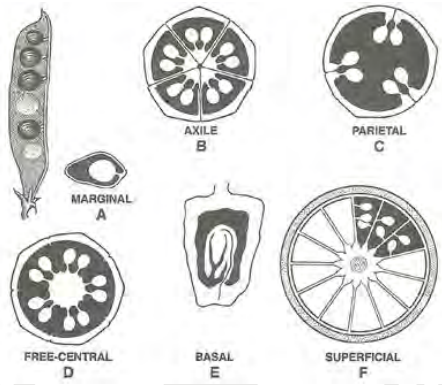
Question 5

(a) Different types of placentation seen in angiosperms.

Marginal Placentation : In this type, the gynoecium is monocarpellary, the ovary is unilocular and placenta are borne on the fused margins of the same carpel. The ovules are borne along the ventral suture of the carpel. This condition is found in legumes.

Axile Placentation : In this type of placentation the gynoecium is multicarpellary, syncarpous and the ovary is multilocular. The placenta are borne on fused margins of the same carpel. The ovules are borne on confluent margins which meet on the central axis. This type of placentation is found in tomato, *Citrus*, china rose, etc.

Parietal Placentation : In this type, the gynoecium is multicarpellary, syncarpous and the ovary is unilocular. The placenta are borne on fused margins of the same carpel. This type of placentation occurs in watermelon and other cucurbits.



Free-central Placentation : In this type, the gynoecium is multicarpellary, syncarpous, and the ovary is unilocular. The ovules, appear to arise from the central column. This type of placentation is found in *Dianthus Primula*, etc.

Basal Placentation : In this type, the ovary is unilocular and the solitary ovule appears to arise from the base of the ovary as in sunflower.

Superficial Placentation : In this type of placentation, the gynoecium is multicarpellary and syncarpous and most of the internal surface of the ovary wall is covered with ovules, as in water lily.

(b) Anatomical differences between a monocot stem and a dicot stem.

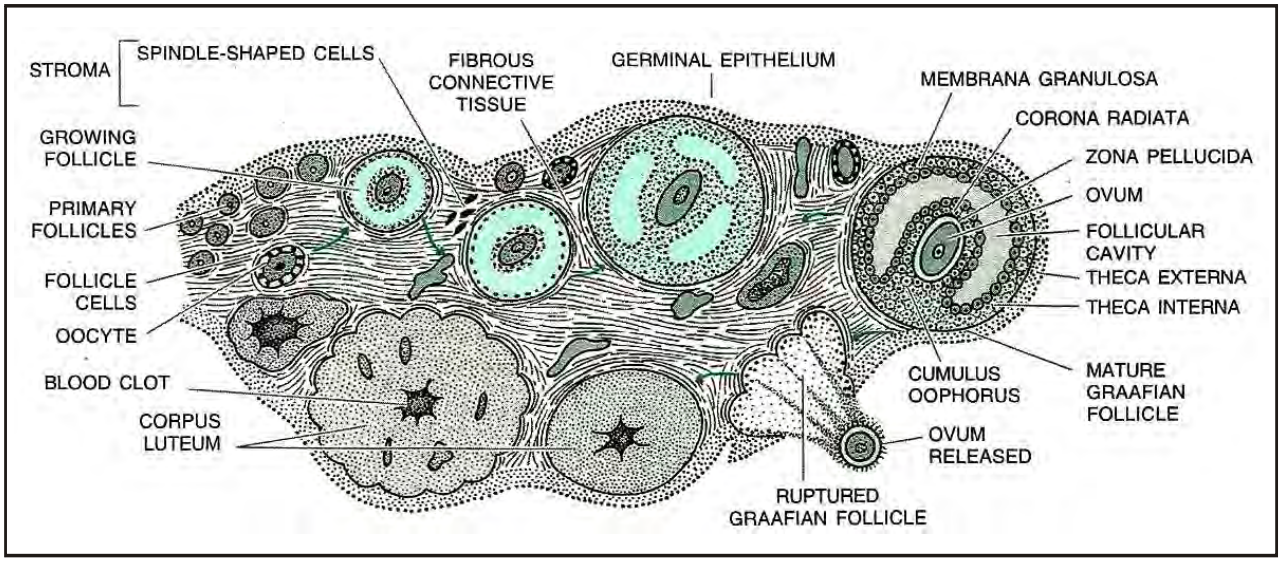
	Dicotyledonous stem		Monocotyledonous stem
1.	Ground tissue is usually differentiated into collenchymatous hypodermis, parenchymatous middle cortex and pith.	1.	Ground tissue is usually undifferentiated.
2.	Vascular bundles are conjoint, collateral, endarch and open.	2.	Vascular bundles are conjoint, collateral, endarch and closed.
3.	Vascular bundles are arranged in a ring and are of nearly the same size.	3.	Vascular bundles are scattered and are of various sizes, usually larger towards the centre.
4.	Vascular bundle is not surrounded by a sclerenchymatous sheath.	4.	Vascular bundle is surrounded by a sclerenchymatous sheath.
5.	Phloem is composed of sieve tubes, companion cells and phloem parenchyma.	5.	Phloem is composed of only sieve tubes and companion cells, phloem parenchyma is absent.
6.	Medullary rays occur in the form of strips of parenchymatous cells in between the vascular bundles.	6.	Medullary rays are not marked out.
7.	Pith present.	7.	Pith absent.
8.	Secondary growth occurs.	8.	Secondary growth usually does not occur.

(c) (i) Racemose inflorescence : The inflorescence in which the floral axis shows indeterminate growth producing flowers in an acropetal order i.e. the oldest flower is the lowest and the youngest uppermost is known as racemose inflorescence.

(ii) Osmotic Pressure : The hydrostatic pressure which balances and prevents the osmotic inflow of water into concentrated solution is called osmotic pressure.

Question 6

(a)



(b) Water potential :

The chemical potential of water is said to be water potential OR

A measure of energy available for reaction of or movement of water OR

The tendency of water to leave a system.

Components :

Water potential of a cell is the sum of the solute potential of the cell sap and the pressure potential of the cell wall.

$\psi_w = \psi_s + \psi_p$

ψ_w = Water potential of cell

ψ_s = Solute potential of cell sap

ψ_p = Pressure potential

ψ_p : A pressure built up inside the cell making the cell thrgid is called pressure potential.

ψ_s : The component of water potential that is due to the presence of solute molecules is called as solute potential.

(c)

(i) **Imbibition :** It is a phenomenon of absorption of water molecules or any liquid molecules by hydrophilic or lipophilic substances of the cell making them swell.

Importance :

- Imbibition plays a very significant role in the life of plants. The first step in the absorption of water by the roots of plants is the imbibition of water by the cell wall of the root hair.
- Dry seeds imbibe water before they start germination.

(ii) Parturition is an act of expelling the full term foetus from mother's uterus at the end of gestation. Parturition involves forceful muscular contractions of uterine wall called **labour.**

Importance :

- Child delivery and placental delivery.

Question 7

(a) Adaptations in flowers pollinated by insects :

- Large and brightly coloured petals, scent or nectar.
- Small flowers (eg. Asteraceae) grouped into conspicuous in florescence to attract insects.
- Emission of strong odour at night. e.g. *Cestrum nocturnum* - Queen of night
- Pollengrains are sticky or have spinous outgrowths on the exine.
- The stigmas are also sticky.
- Position of antners and stigma are such that insects while visiting the flower for food (pollen, nectar etc) get dusted with pollen grains and when the same insect visits another flower its body comes in contact with the stigma of that flower with almost unerring certainty.

(b) The mass flow Hypothesis for translocation of organic solutes (food) in plants.

- Hypothesis was put forward by Munch.
- According to this, mass flow of organic solutes takes place from site of higher concentration (source) to the site of lower concentration (sink)
- As glucose is prepared at the source (by photosynthesis) it is converted to sucrose (a dissacharide).

The sugar is then moved in the form of sucrose into the companion cells and then into the living phloem sieve tube cells by active transport.

- This process of loading at the source produces a hypertonic condition in the phloem. Water in the adjacent xylem moves into the phloem by osmosis.
- As osmotic pressure builds up the phloem sap will move to areas of lower pressure.
- At the sink osmotic pressure must be reduced. Again active transport is necessary to move the sucrose out of the phloem sap and into the cells which will use the sugar – converting it into energy, starch, or cellulose.
- As sugars are removed, the osmotic pressure decreases and water moves out of the phloem.
- The movement of sugars in the phloem begins at the source, where sugars are loaded (actively transported) into a sieve tube. Loading of the phloem sets up a water potential gradient that facilitates the mass movement in the phloem.

(c) INFERTILITY

Definition: Infertility is the inability to conceive or produce children in spite of unprotected sexual cohabitation. The term is not synonym of sterility which means complete inability to produce children.

Reasons: There may be several reasons for infertility in males and females. These reasons could be physical, congenital diseases, drugs, immunological or even psychological.

➢ **Infertility in Males :**

A fertile male deposits about 3-4 mL semen per ejaculation, which contains over 200 million normal, motile sperm. A man is infertile if the semen has low sperm count or abnormal sperm structure or poor sperm motility.

The various causes of male infertility may include **cryptorchidism** (failure of testes to descend into scrotum), **hyperthermia** (higher temperature in scrotal sac due to tight undergarments), blockage of vas deferens, alcoholism (inhibits spermatogenesis), infection with mumps virus after puberty, deficiency of gonadotropin, ejaculation defect, exposure to radiation, etc.The condition of low sperm count is called **oligospermia,** near absence of live sperm as **azospermia,** low sperm motility as **asthenozoospermia** and defect in sperm structure as **teratozoospermia .**

➢ **Infertility in Females**

Infertility in females may be due to irregular ovulation or no ovulation or defect in the genital tract like impaired motility of fallopian tube, defective uterine endometrium, defects in the cervix, defective vaginal growth or deficiency of sex hormones.

Section - C

Questions 8

(a) ➢ **Reasons for Mendel's Success**

A combination of luck, foresight, mathematical approach and scientific aptitude contributed to the success of Mendel's experiments.

➢ **Method of Working**

1. Mendel studied inheritance of one character at a time whereas earlier scientists had considered the organism as a whole.
2. Mendel carried out experiments up to the second and third generations.
3. He maintained the statistical records of all the experiments and analysed them carefully.
4. Cross-breeding was done between the parents of pure lines.

5. The pure lines of parent plants were ascertained by a series of self-crossing tests between progeny of each successive generation.
6. Mendel's experiments dealt with a large sample size.

➢ **Advantages of Selecting Pea Plant**

Mendel's selection of garden pea plant as experimental plant had following advantages:

1. It is an annual plant. Because of short life cycle, Mendel was able to study several generations of the plant within a short period.
2. Its flowers are complete and predominantly self-pollinating.
3. Because of self-pollination, plants are homozygous. Therefore, pure lines of pea plant were available.
4. Pea plant has a number of easily detectable contrasting characters, related as dominant and recessive.
5. Pea plant produces large number of seeds one generation.

(b) The technique employed in DNA fingerprinting.

- Extraction of DNA from the sample cells.
- Amplification : Making many copies of DNA is called amplification. It is done by a technique called polymerase chain reaction (PCR).
- **Restriction digestion :** DNA is then cut into sections by using restriction endonucleases.
- **Separation of DNA sequences :** In this process, DNA fragments are separated by using gel electrophoresis.
- **Southern blotting** (named after its inventor E. M. Southern). In this process, separated DNA sequences are transferred from gel onto a nylon membrane.
- **Hybridisation using labelled VNTR probe :** In this process, radiactive DNA probes are attached to specific portions of the DNA fragments. Thereafter any DNA not attached to the probes is washed off.
- **Detection of hybridised DNA fragments by autoradiography :** The remaining DNA is then exposed to X-ray film. The radioactive probes on the DNA are allowed to expose the film, which, when developed reveals a unique pattern of dark and light bands. These bands give a characteristic pattern for an individual DNA. It differs from individual to individual in a population except in the case of monozygotic (identical) twins. The sensitivity of the technique can be increased by use of polymerase chain reaction. Consequently, DNA from a single cell is enough to perform DNA fingerprinting analysis. Currently many different probes are used to generate DNA fingerprints.

(c) Feature of genetic code:

- The codon is triplet. 61 codons code for amino acids and 3 codons do not code for any amino acids, hence they function as stop codons.
- One codon codes for only one amino acid, hence, it is **unambiguous** and **specific**
- Some amino acids are coded by more than one codon, hence the code is **degenerate**.
- The codon is read in mRNA in a continuous fashion. There are no punctuations.
- The code is nearly **universal**: for example, from bacteria to human UUU would code for Phenylalanine (phe). Some exceptions to this rule have been found in mitochondrial codons, and in some protozoans.
- AUG has dual functions. It codes for Methionine (met) , and it also act as **initiator** codon.

Question 9

(a) **Mechanism of Action of T-cells:** Like B-lymphocytes, T-cells are also antigen specific as each T-cell recognises a specific antigen. Thus, different types of T-cells are stimulated by different types of antigens.

When a T-cell comes in contact with an antigen, the T-lymphocyte divides rapidly to form a clone of T-cells. A clone of T-cells has four types of cells. These are **helper T-cells, killer T-cells, supressor T-cells and memory T-cells.** Out of these, the first three are also called **effector cells.**

Cytotoxic T-cells or Killer T-cells (T_c cells) destroy infected cells having foreign antigens attached to their surface. They become active on receiving signal molecules from helper T-cells and antigen-presenting cells or by foreign antigen. They secrete perforinmolecules and granzymes.

(a) **Perforins** form pores in the cell membrane of infected cells. Water and ions enter the infected cells through these pores and cause their bursting.

(b) **Granzymes** enter the infected cells by endocytosis and initiate its apoptosis (cell death) leading to fragmentation of its nucleus and cytoplasm.

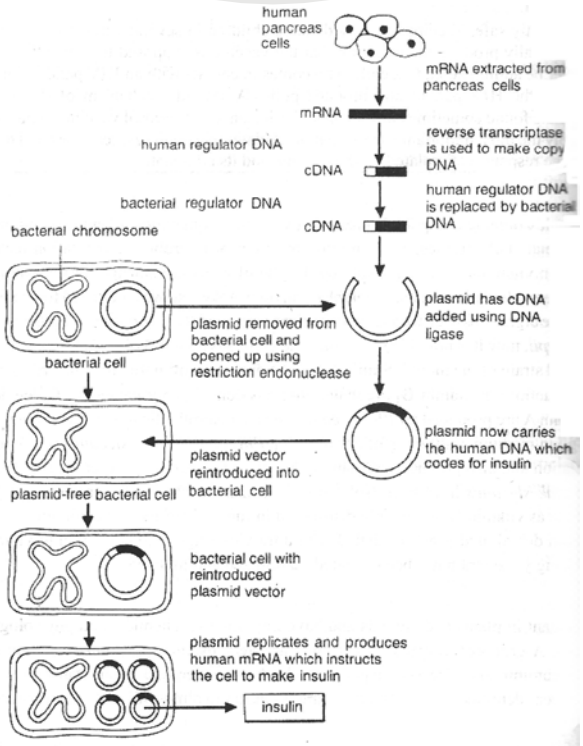
Memory T-cells are sensitised by antigens and retain sensitisation for the future.

Suppressor T-cells inhibit immune response by releasing cytokines that suppress activity of other T-cells and B-cells.

Helper T-cells secrete substances that enhance or activate immune response.

(b) **Production of insulin using recombinant DNA technology:**

- Extraction of mRNA (coding for insulin) from pancreas cell from human (donor)
- With the help of reverse transcriptase making copy of DNA (c DNA) (coding for insulin)
- Extraction of plasmid from bacterial cell.
- Opening plasmid using restriction endonuclease.
- Insertion of cDNA in plasmid and sealing it using DNA ligase.
- Reintroduction of plasmid vector (recombinant vector) into bacterial cell (a competent host cell)
- Culturing these cells to obtain multiple copies or clones of derised fragmant of DNA (cDNA).
- Replication of plasmid and production of human mRNA which instructs the cell to make insulin (Humulin)



(c) Pisciculture is the production and breeding of fishes by man in ponds.

Advantage : Fish oils are employed in leather industry for chamoising. Fish body oils are also employed in the manufacture of candles, etc.

Question 10

(a)

	CAUSATIVE ORGANISM	PREVENTIVE MEASURES
i.	Swine Flu - H1N1 – influenza strain	**Prevention:** Good hygiene is the most important for prevention. Washing hands, using alcohol-based hand oil and keeping surfaces and bathrooms clean can keep away from the disease. Anyone with flu-like symptoms, such as a sudden fever, cough or muscle aches, should stay away from work in public, transportation, and should contact a doctor for advice.
ii.	Typhoid – Salmonella typhi	These measures include proper community sanitation, cleaned and chlorinated water supply system and personal cleanliness. Prevention of food contaminated by flies and dust. Cooks and food handlers in eating establishments should be pressed upon to wash their hands with soap and water before food handling.
iii.	Filariasis – Wuchereria Bancrofti	**Control Measures:** Destruction of mosquitoes and their breeding places and protection against mosquito bites can prevent filarial infection.
iv.	Syphilis – Treponema Pallidum	Sexual habits should be changed immediately. Strict to monogamy.

(b) **Reasons for High Population Growth**

- **Increase in longevity.** Decline in death rate, **maternal mortality rate** (MMR), and **infant mortality rate** (IMR).
- **Decrease in death rate.** An increase in number of people in reproductive age.
- **Role of Reproductive and Child Heath Care (RCH) Programmes.** RCH programmes could bring down the population growth rate but it was only marginal.
- **Control of diseases.** Control of diseases has reduced the death rate.
- **Improvements in medical facilities.** Better public health care and greater medical attention.
- **Advancement in agriculture, improvement in food storage conditions and better means of transport.** These means decrease death rate.
- **Protection from natural calamities.** This has decreased death rate.
- **Role of certain religions**.Certain religions are against family planning.

Consequences of Over Population

Poverty. In a family if there are more persons but the income is less, so naturally it becomes poor. With the addition of every child, the poverty increases.

Food Supply. If the population increases and the production of food does not increase, this will lead to a shortage of food supply.

Hygenic condition. More people in a small area generally make the hygenic conditions bad.

Unemployment. More number of people means more jobs and if sufficient number of jobs are not available, it leads to unemployment.

Housing problem. For more people, more houses are required and the houses are not built at high rate.

Pollution. There will be an added problem of population. As every thing is taken from environment in excess, so it will result in pollution.

Education problem. It becomes difficult for the government to provide education to all.

(c) **(i)** **Barbiturates:** Barbiturates are synthetic drugs derived from barbituric acid. They are general depressants and are popularly called sleep- ing pills. They lesson functional activity, decrease anxiety and induce sleep. Their repeated use causes psychological dependence. It is very difficult for the addict to withdraw from them. Withdrawal causes depression and restlessness. Repeated use leads to barbiturism involving skin eruption accompanied by chill, fever and headache. Barbiturates are. not preferred these days.

Cannabinoids are group of chemicals, which interact with cannabinoid receptors present mainly int he brain.

- Cannabinoids are obtained from the inflorescences of plant *Cannabis sativa*.
- Leaves, flower tops, resins of C. sativa in various combinations produce hashish, charas, marijuana and ganja.
- These are inhaled or ingested orally.
- These drugs affect cardiovascular system of the body.

(ii) Biotic potential is the maximum number of individuals a female can produce in her reproductive life. Carrying capacity is the maximum number of individuals earth can support. It is denoted by K.