State Institute of Education & Trainings Kashmir .

STUDY MATERIAL BASED ON

JKBOSE SYLLABUS

CLASS 12TH

SUBJECT : ZOOLOGY

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Preface

The study material has been prepared and developed as part of the vision and the mentorship of worthly Director , School Education , Kashmir , Mr Mohammad Younis Malik. It is he who wanted to provide a quality matrial to the students , keeping inview the situation from last couple of years wherein the Education sector has been badly hit, the intiative will prove to be great significance .

We are indeed vey fortunate to have had the help of of some very able and devoted team of experts. The combined efforts of these people plus the professionalism of the support staff helped to present what I belive is a very valuable study matrial.Incase there is any omission, typing /printing mistakes , or any other errorwhich may have crept inadvertmently, the same is requrested to be communicated at principalsiekashmir@gmail.com .

This sudy matrial prepared will guide the students in Learning about. We belive in the power of the formative assessment process as a tool to assist and empower the students in learning. While the study material focuses on building students "Skills of self study, most important, perhaps, it provides effective strategies for building habits that serve teaching and learning.

We think students will find this study matrial to be a refreshing change from the standarad testing apparoches of most books on assesement. We banded together to develop this study matrial because matrial available in market is too costly that every student is enable to get it but we provide it free of cost with the aim of ***" NO CHILD LEFT BEHIND " .***

Coordinator ***(Mis Suriya Akhter)***
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Chapter 1st Reproduction

INTRODUCTION:-Each and every organism lives only for a certain period of time and have a definite life span, after which it meets a natural death. The life span varies from few hours to more than four thousand years.

Life span is not related with the size and complexity of an organism.

Organism	Life span
May-fly	**1 day**
Butterfly	**1-2 weeks**
Crow	**15 years**
Parrot	**140 years**
Dog	**25 years**
Horse	**50 years**
Tortoise	**100-150 years**
Sequoia(red wood Tree)	**3000-4000 years**

Functions of reproduction

1.Continuity of race.

2.Replacement of dead ones.

3.Maintainance of population organization.

4.Introduces variation in population.

BASIC FEATURES OF REPRODUCTION:-Although

The different organisms adopt different modes of reproduction but all follow some common basic

Features which are as:-

1.DNA replication i,e DNA synthesis.

2.Transcription (RNA synthesis),synthesis of protein and other biomolecules for multiplication of cellular structures.

3.Growth and division of cells.

4.Formation and separation of reproductive unit.

5.Develpment of new individual from reproductive unit.

REPRODUCTION

Reproduction:- The process of producing young ones for the continuity of race is called reproduction. Reproduction is considered as an answer to death.

Types of reproduction:- there are two types of reproduction:-

A:- Asexual reproduction:- The kind of reproduction in which the young ones are formed without the involvement of sex cells is called asexual reproduction. It is a uniparental process and the young one is formed from somatic part of parent hence also called somatogenic reproduction. The young ones are genetically similar with one another and with their parent,. So it results in the formation of clones. Asexual reproduction is also called natural cloning.

B:- Sexual reproduction:- the kind of reproduction in which the young one is formed with the involvement of sex cells is called sexual reproduction. It is usually a biparental process, but can be sometimes uniparental also. It is also called gamatogenic reproduction. This kind of reproduction introduces genetic variation in young ones.

ASEXUAL REPRODUCTION

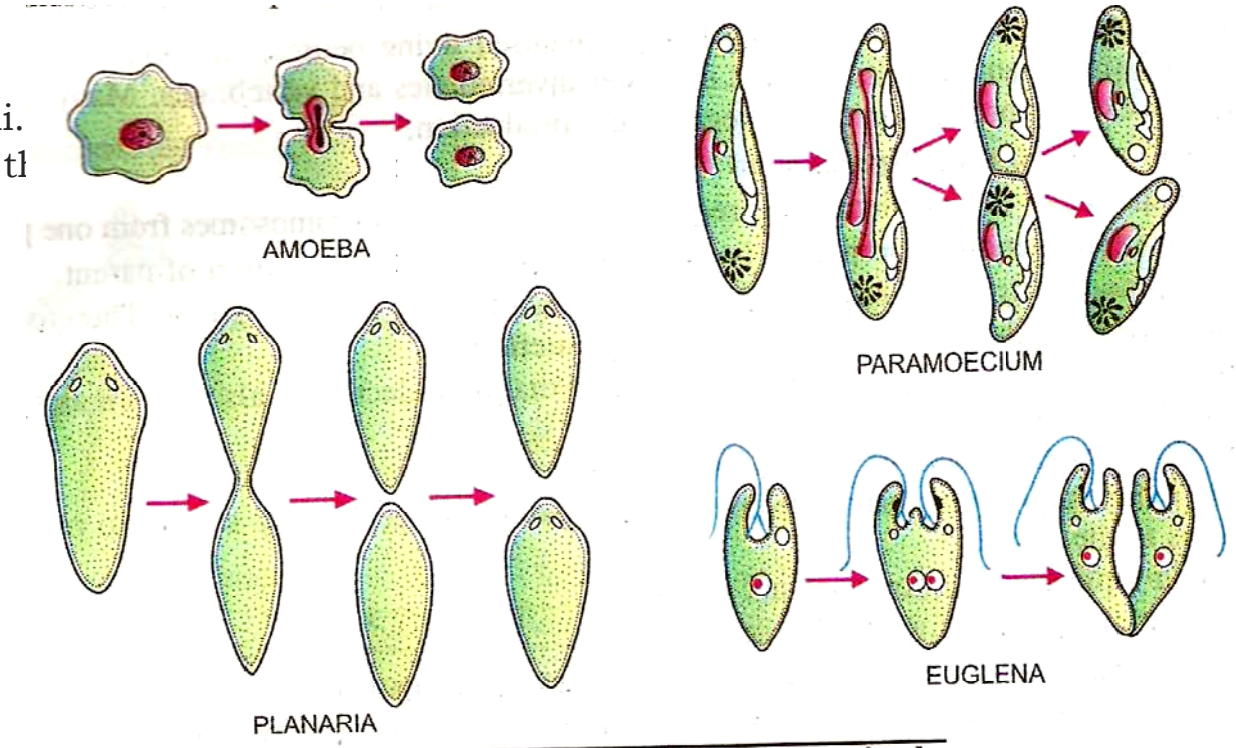
Asexual reproduction:- In case of animals the asexual reproduction is limited to lower animals only and occurs by following means.:-

1. **Fission:-**Here the body of a mature individual divides into two or more daughter individuals. It occurs in unicellular organism. It is of following types:-

a. **Binary fission:-** it is the division of body of an individual into two equal halves which develop into new daughter individuals. On the basis of plane of division, binary fission is of following types:-

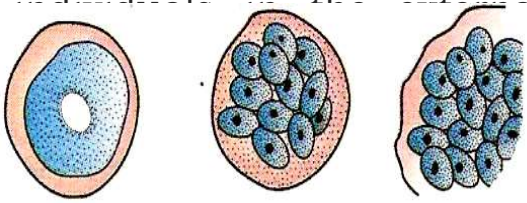
i. **Simple binary fission:-** the division can occur in any plane e.g. amoeba it is also called irregular binary fission

ii.
tl

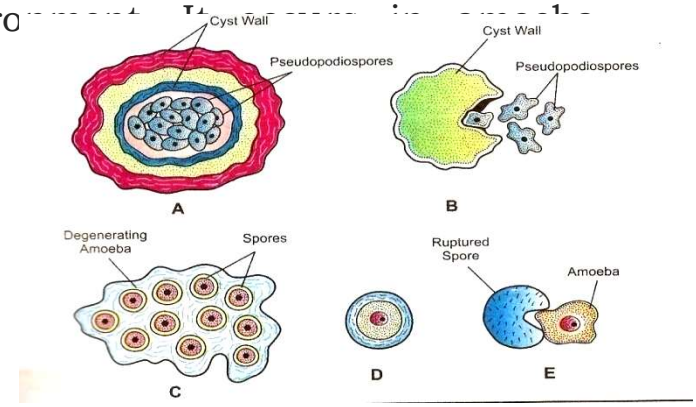


♦ **Fig. 1.2. Binary fission in some animals.**

B. Multiple fission:- it is a kind of fission in which the nucleus of parent individual divides repeatedly to form large number of daughter nuclei and the cytoplasm cleaves in such a way that small amount of cytoplasm gather around each nuclei. Finally these nuclei surrounded by little cytoplasm come out form parent individual by rupturing its membrane and develop into new individuals in the external enviro ı.



Multiple fission in Plasmodium

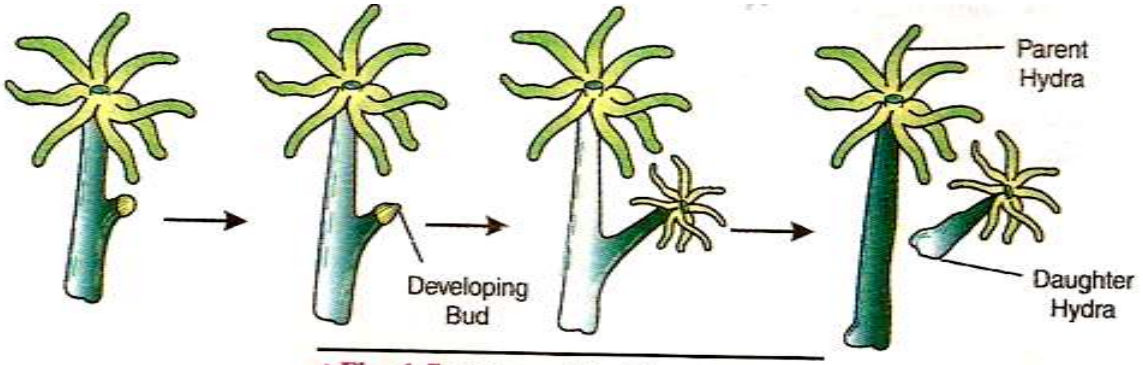


Multiple fission in Amoeba

c. Plasmotomy:- it occurs in multinucleated protozoan's like opalina,pelomyxa here the parent individual divides into two or many parts without undergoing the nuclear division so the daughter individuals formed each with less number of nuclei. Therefore in order to restore the normal no., of nuclei. They (the nuclei) undergo karyokinesis in the daughter individuals.

2. BUDDING :- It is of two types:-

a. **EXOGENOUS BUDDING:-** In this method a small outgrowth



♦Fig. 1.7. External budding in *Hydra*.

b. Endogenous budding (gemmulation):- This kind of budding occurs in sponges. Here the outgrowth (bud) is formed inside the parent body such internal buds are also called gemmules (composed of archeocytes) During favorable conditions the gemmule come out from parent body through micropyle and later on develops into new individual.

3. Fragmentation:- in this type of asexual reproduction the body of parent organism breaks into two or many parts called fragments and later on each fragment develops into new daughter individual. It occurs in sponges, coelenterates, flatworms and echinodermates.

Fragmentation can also be called regeneration however it is not necessary that regeneration can always act as a method of reproduction Regeneration is of following types:-

i. **Morpholaxis:-** in this type of regeneration the new daughter individual is formed form a small part of the parent body. E.g the arm of starfish can form the whole individual. This kind of regeneration is also called morpholactic regeneration and act as a method of reproduction.

ii. **Epimorphosis:-** also called epimorphic regeneration .It is of two types:-

a)Reparative regeneration:-It is the regeneration of damaged tissues e.g,Healing of wound.

b)Restorative regeneration:-It is the regeneration of a severed body part like regeneration of lost limb in wall lizard and regeneration of damaged part of liver.

4.**SPORULATION**:-Spores are minute thin walled single celled structures meant for dispersion and propagation.It is a common method of reproduction in monera,protista ,algae and fungi.

Spores are of following types:-

Zoospores-motile spores found in chlamydamonas,ulothrix etc.

Conidia-They are non motile spores formed exogenously as in Pencillium.

Sporangiospores-They are non motile spores formed endogenously as in the sporangia of Rhizopus and Mucor.

Advantages of asexual reproduction:-

1. No need to find a mate.
2. Quick mode of reproduction.
3. Young ones are photocopies of their parents (clones)
4. It is simpler than sexual reproduction.
5. Resource consumption is low

Disadvantages:-

1. It leads to overcrowding.

2. It increase homozygosity which cause loss of vigour.
3. Variation is not introduced
4. No evolutionary significance
5. Power of adaptation is low.

Embryogenesis:- The process of development of embryo from the zygote is called embryogenesis.
Blastogenesis:- The process of development of new individual from buds, fragments and other asexual propagules is called blastogenesis.

SEXUAL (GAMATOGENIC) REPRODUCTION

The kind of reproduction in which the young one is formed from a diploid single celled structure called zygote which is the fusion product of haploid male and female gamete respectively called sperm and ovum is known as sexual reproduction. It is also called syngamy,syngenesis,amphigony and amphimixis.

Sexual reproduction is a complex process and involves the following events:-

A .Pre-fertilization events

B .Fertilization

C. Post-fertilization events

A.<u>Pre-fertilization events</u>:-They include

1.**Gamatogenesis**:-It is the process of formation of male and female gamete called spermatogenesis and oogenesis respectively.

<u>Isogametes</u>:-The gametes (sperm and ovum) are structurally and functionally similar.They are also called homogametes.eg.Cladophora,Ulothrix.Both the gametes are equally active and store equal Amount of nutrients.Both the gametes are produced in equal number.

<u>Anisogamates</u>:-The gametes which are morphologically similar but differ in size are called Anisogametes.eg Chlamydamonas.

Heterogametes;-The gametes which are morphologically and physiologically different are called Heterogametes.eg Man. The phenomenon of having morphologically and physiologically different gametes is called heterogamety.

In heterogamety the male gamete is active and motile but smaller in size and do not store food,while as female gamete is larger in size,store food but is passive and non-motile.

2. **Gamete transfer**:- Male and female gamete must be physically brought together to facilitate their fusion (Fertilization). In animals male gamete is motile and the female gamete is non motile. A large number of male gametes however fail to reach the female gamete. To compensate this, a huge number of male gametes are released, so that the chance of fusion with female gamete may increase.

B**. FERTILIZATION**:- The process of fusion of gamete is called fertilization. This is the most important event of sexual reproduction.

On the basis of site of fertilization , it is of two types :-

i) External fertilization:- It occurs outside the body of female. It takes place in aquatic medium e.g. Frog, Bony fish etc.
ii) Internal fertilization:- It occurs inside the body of female.eg Reptiles, Birds Mammals etc.

External fertilization	Internal fertilization.
1.It occurs outside the body of female.	1.It occurs inside the body of female.
2.Both sperm and ovum need to be discharged.	2.Only sperm cells are discharged.
3.It is not a sure method of fertilization.	3.It is comparatively sure method.
4.The young ones develop in an unprotected environment.	4.young ones develop in a protected environment.
5.Both the gametes are produced in large numbers.	5.Only male gametes are produced in large numbers.

On the basis of source of gametes ,fertilization is of two types:-

i) Self fertilization:- Also called endogamy. The kind of fertilization in which both male and female gamete belong to same parent.eg Taenia, Fasciola.

ii)Cross fertilization:-Also called exogamy. Here the two gametes belong to two different parents.

Eg.Man,earthworm.

ENDOGAMY	EXOGAMY
1. Sperm & ovum belongs to a single parent.	1. They belong to two parents.
2. Occurs in hermaphrodites.	2. Occurs in both hermaphrodites & unisexuals.
3. It increases homozygosity.	3. It increases haterozogysity.
4. Less variations are introduced.	4. Variations introduced are more.
5. More number of young ones are produced.	5. Young ones produced are generally less.
6. Both the gametes are produced in large numbers.	6. Only male gametes are produced in huge numbers.

C.**POST FERTILIZATION EVENTS:-** The events which occur after fertilization are called post fertilization event. They include:-

i. Zygote:- It is the fusion product of sperm and ovum and is always diploid. It is the structure from which all sexually reproducing organisms start their journey of life.

ii.Embryogenesis:-It is the process of development of embryo from zygote. In embryogenesis, the zygote undergoes repeated division and results in the formation of an embryo. The embryo undergoing through different developmental stages like morulation, blastulation, gastrulation, morphogenesis and organogenesis develops into young one

ZOOSPORE	ZYGOTE
1. It is a reproductive unit in asexual reproduction.	1. It is formed in sexual reproduction.
2. It is a motile structure.	2. It can be motile or non motile.
3. It may be diploid or haploid.	3. It is always diploid.
4. It takes part in dispersal.	4. It has little role in dispersal.

Conjugation:- it involves temporary union of two parents of the same species which exchange their genetic material and then separate to produce daughter individuals e.g paramecium

Advantages of sexual reproduction:-

1. Due to mixing of genetic material in sexual reproduction the vigour and vitality of offspring is increased.
2. Itintroduces variation and thus contributes for evolution
3. The young ones have more potential to adopt in changing environment.
4. Caring of young ones occurs in sexual reproduction.

Disadvantages:-

1. It is slow process and consumes much time.
2. Resource consumption is more.
3. It is a biparental process.

4. Fertilization has a chance factor.

PARTHANOGENESIS:- (Gr. parthano – virgin genesis – produce) it is a kind of sexual reproduction in which the young one is produced from an unfertilized ovum. Parthenogenesis was discovered by Charles Bonet (1745) and the term was coined by Richard owen.

Occurance:- Natural parthenogenesis occurs in aphids, bees wasps, ticks, mites, rock, lizard,typlinabrahmina and some birds (e.g turkeys) etc.

Types:- Parthenogenesis is of two types:-

Natural parthenogenesis and artificial parthenogenesis.

A:- Natural parthenogenesis:- it occurs naturally in the life cycle of certain animals. It is of following types:-

1. **Complete or obligatory parthenogenesis:** it is the exclusive method of reproduction in some animals like laceratasexicolaarmaniaca(caucasion rock lizard) and typhlinabrahmina (water snake of India) as these animals do not have males in their population. So the only means of reproduction is parthenogenesis .
2. **Incomplete or cyclic parthenogenesis:** - Parthenogenesis occurs along with sexual reproduction in the life cycle of some animals.

e.g :- In honey bees the fertilized eggs develop into females while as the males are produced pathaneogentically.

3.Paedogenetic parthanogentis:- When the larval forms start to reproduce parthanogenetically,it is called paedogenetic parthanogenesis e.g Gall fly.

Natural parthenogenesis is also classified into following types on the basis of sex of offsprings:-

a. **Arrhenotoky:-** Gr (arrhen- male,tokos – birth) it is the production of male offspring's through parthenogenesis. It occurs in honey bee.

b. **Thelytoky:-** (Gr. Thelys – female,tokos – birth) :- it is the production of female offspring's through parthenogenesis e.g lacerate sexicolaarmaniaca.

c. **Amphitoky**:- (Gr amphi – both,tokos – birth) Here both males and female are produced through parthenogenesis e.gamphitoky occurs in aphids after a few cycles of thelytoky.

A. **Artificial parthenogenesis:-** In this type of parthenogenesis the ovum is induced to develop into new individual by artificial stimuli like change in temp and ph, electric shock,uv light, prick by a a needle (physical stimuli). Change in slat concentration, application of chloroform, ether, alcohol, urea, fatty acid, (chemical stimuli)

American physiologist Jacques loeb in 1900 stimulated the frogs egg by pricking it with a needle to develop parthanogenetically.

Advantages:-

1. It is simpler and easier means of reproduction.
2. It determines sex in some cases e.g honey bees.
3. it allows multiplication of those animals in which the males are absent.

Disadvantage:- it eliminates variation from the population

Conclusion:- occurrence of parthenogenesis shows that ovum has all the potential to develop into new individual and only needs a stimulus to activate it for development. In normal sexual reproduction this stimulus is provided by sperm.

EVALUATION

1.Which is a better mode of reproduction ;sexual or asexual?Why?

2.Why the offspring produced asexually are reffered to as clone?

3.Difference between asexual and sexual reproduction?

4.Define external fertilization?Mention its disadvantages?

5.Why the offspring of oviparous animals are at greater risk as compared to offspring of viviparous animals?

6.Is there a relationship between the size and life span of an organism?Give two examples in support of your answer?

7.Differentiate between ovipary and vivipary?

HUMAN REPRODUCTION

Human beings are sexually reproducing viviparous placental organisms. The different events involved in human reproduction are:-

a). Gametogenesis: It is the process of formation of gametes (sperm & ovum) in the primary reproductive organs of male and female i.e testis and ovaries respectively).

b). Insemination: It is the process of deposition of semen into the vagina of female during sexual intercourse.

c).Fertilization: It is the fusion of sperm and ovum to form zygote.It occurs at ampula-isthmus junction of fallopian tube.

d).Cleavage: As soon as zygote is formed it starts cleavage divisions to first form morula and then blastocyst.

e). Implantation: It is the attachment of blastocyst with the wall of uterus for nourishment.

f). Placentation: Establishment of faeto-maternal connection called placenta for carrying out various physiological functions of foetus.

g). Embryonic development: The embryo inside uterus undergoes gastrulation during which three germ layers are established . The gastrulation is followed by organogenesis during which various tissues,

organs and organ systems are formed.

h). Growth and Development of foetus: The different parts and systems of foetus grow in size and become functional. The foetus is then converted into young one. The total period of stay of embryo in the body of mother is called gestation period.

I).Parturition: The delivery of fully formed young one after the end of gestation period is called parturition.

CHARECTERISTICS OF HUMAN REPRODUCTIVE SYSTEEM

1. Sexes are separate and show sexual dimorphism.
2. Humans are non-seasonal breeders and breed throughout year.
3. Females are non-oestrus and instead have menstrual cycle.
4. Females remain reproductive from menarche (1st menstruation) to menopause.
5. In males testis descend into the scrotum during 7th month of embryonic life.
6. There is a common urinogenital duct in males whereas in females the urinary and genital ducts are separate.

REPRODUCTIVE SYSTEM OF HUMAN MALE

It is a system of sex organs and accessory glands specialized in formation, storage, nourishment and conduction of sperms. It is composed of following structures.

1. **A pair of testis:-** these are primary reproductive organs (i.e. they produce sex cells and sex hormones) in males. Each testis is somewhat oval shaped about the size of walnut present in the

scrotum sac which is a pouch like structure hanging between two legs. The germinal epithelium of seminiferous tubules form the sperm cells. The sperm cells are nourished inside the testis by sertolicells. The interstitial cells (Leydig cells of seminiferious tubules produces testosterone.

The formation and maturation of sperm cells occur at a temperature of 2 – 2.5°c lower than the body temperature in human males i.e why the testis are present outside the body.

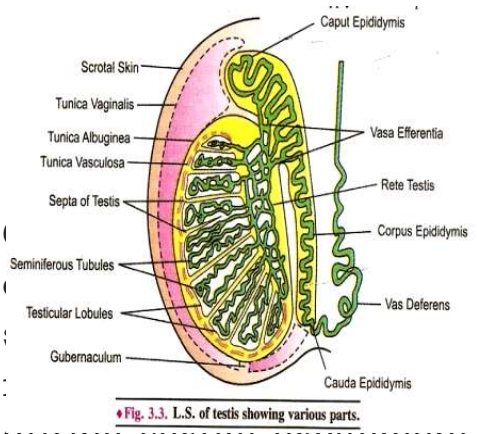
2. **Vasa efferentia** :- (ductuliefferentes) these are 10 – 20 small ductules which connect the testis with epididymis. The endocytic and ciliary cells in them help respectively in removing cellular debris and conduction of sperm cells.
3. **A pair of epididymis:-** the epidiymis is a long (about 6 mts) coiled tube present around the testis in scrotum. Each epididymis is divided into 3 parts.

a. Caput epididymis – it forms its head.
b. Corpus epididymis – it forms its body.
c. Cauda epididymis – it forms its tail.

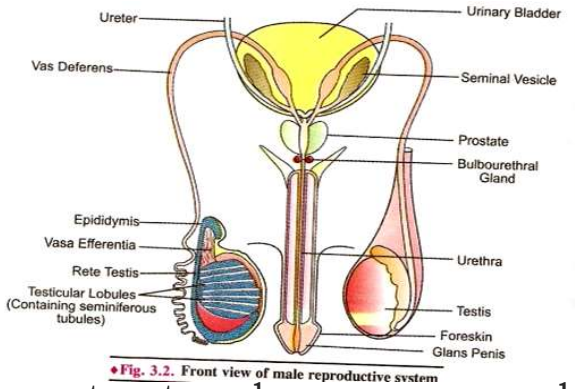
Epididymis secretes a nourishing fluid which is essential for maturation of sperm. It stores the sperm cells for 2 – 3 months or till they are ejaculated (whichever is earlier). The unejaculated sperm cells phagocytosised in epididymis.

The epididymis also produces glycerophosphocholine which prevents premature activation of sperm cells inorder to conserve their energy.

4. **A pair of vasa differentia**:- vasa differentia arise from cauda epididymis and are about 30 – 35 cm long. They conduct the sperm cells from scrotum to abdominal cavity, where it joins with the duct of seminal vesicle and form ejaculatory duct, which opens into urethra
5. **Urethra:-** The urethra is a long tube (20 cm) and provides a common pathway for the flow of urine and the secretions of male reproductive organs called semen. It is divided into four parts :-
    1. Urinary urethra .



♦Fig. 3.3. L.S. of testis showing various parts.



♦Fig. 3.2. Front view of male reproductive system

during sexual excitement these spongy structure becomes engored with blood and cause erection of penis.

Acessory male genital glands:-

1. **A pair of seminal vesicle**:- T-hey are musculogandular sacs of 5 cm length located in between urinary bladder and rectum. It produces seminal fluid which constitutes 60 – 70 % of semen. seminal fluid is alkaline in nature and contains fructose, citrate, inositol prostaglandins fibrinogen and proteins.
2. **Prostate gland**:- it is a large gland about 4 cm in with and 3 cm in height located around prostatic urethra . It produces a thin milky alkaline secretion which makes 20 – 30% of semen. Its secretion contains calcium, phosphate, bicarbonates, fibrinogen and fibrinolysin.

The secretion of seminal vesicle and prostate gland is essential for making sperm able to fertilize the ovum. Their removal leads to infertility.

Ascaris has amoeboid sperm devoid of flagella

3. Cowper's or bulbourethral gland :-They are a pair of small (about

1 cm diameter) gland located about 4 – 5 cm below the prostate gland.

They open into membranous urethra. Their secretion is alkaline and rich in mucus and makes about 5% of semen. Their secretion is ment for lubrication of genital tract and removing traces of urinary acidity.

MICROSCOPIC ANATOMY OF TESTS

MICROSCOPIC ANATOMY OF TESTS:-These are primary reproductive organs in males which usually lie in scrotum. Testis are oval , soft, smooth and pinkish. The size is 4-5 cm length , 2-3 cm thickness and 2-3 cm width, weight is about 12g. Testis are covered by three membranes. The outer one is called Tunicavaginals. the middle tunicaalbuginea and the inner one Tunica vasculosa

1. **Tunica vaginalis** is like a flat sac having a narrow coelomic cavity filled with fluid. Tunica Vaginalis helps the testis in frictionless sliding.
2. **Tunica vasculosa** is innermost layer which lines the testicular lobules inner to tunica albuginea. It is a delicate loose connective tissue and is richly supplied with blood vessels.
3. **Tunica albuginea**- it is the actual covering of the testis . The tunica albuginea also passes into testis to from incomplete vertical columns or mediastinum and a number of septa. The septa divide the testis into about 200-300 testicular lobules. Each lobule has one to three convoluted semniferous tubules also called crypts-which on inner side become straight called tubuli recti and open into a network of tubules called rete testis. The rate testis join to form bigger tubes called vasa efferentia.

Each somniferous tubule is lined by a germinal epithelium formed of two types of cells:-

1. Germinal or spermatogenic cells- produce sperm .
2. Sertoli or nurse cells- discovered by EnrichoSertoli . These are large , elongated cells and provide attaching sites to

spermatocytes and spermatids. Sertoli cells function in response to FSH. They secretespermatogenic substances for nourishing and differentiation of cells undergoing spermatogenesis.

Sertoli cells also secrete Androgen binding proteins (ABP) for concentrating testosterone and inhibin for opposing FSH synthesis.

Scattered in the connective tissue and lying between somniferous tubules, there are group of polyhedral endocrine cells called interstitial or Layding cells (discovered by German anatomist Franz von Laying). These secrete steroid male sex hormone called androgens - most important of which is testosterone. It controls the development of secondary sexual characters in males and spermatogenesis.

REPRODUCTION SYSTEM OF HUMAN FEMALE:-

It is a system of sex organs and accessory glands which is specialized in formation and fertilization of ovum, its nourishment and development of fetus and subsequent delivery of fully formed young one

It consists of following structures:-

1. **A pair of ovaries** :- ovaries are the primary reproductive organs. Each ovary is about 2 – 4 cm in length 1.5 cm in width and 1.0 cm in thickness. They are almond shaped, solid structures which lie on either side of pelvic cavity. The germinal epithelium of ovaries form oogonia which enter into the cortex of ovaries where they develop into secondary oocytes at regular interval of time.
2. **A pair of fallopian tube (oviducts)** :_ These are one pair (10 – 12 cm long) ciliated, muscular and tubular structures which extend from periphery of ovaries to uterus. An oviduct has four parts.

a. **Infundibulum:-** it is a funnel shaped fimbriated free end of oviduct which lies just above the ovary. Margins of funnel bears a

pore called ostium and finger like process (fimbrae) for catching released secondary oocyte during ovulation.

b. **Ampulla:-** it is the curved and dilated part of oviduct.

c. **Isthmus:-** it is the straight part of oviduct which connects ampulla with uterine part.

d. **Uterine part:-** it is the part which enters into uterus. Fallopian tube is involved in the conduction of secondary oocyte from abdominal cavity to site of fertilization (ampulla – isthmus junction). It also conducts fertilized egg towards uterus.

3. **Uterus:-** (Womb, Hystera , metra) :- It is an inverted pear shaped hollow muscular, highly, vascular structure present in pelvis between urinary bladder and rectum. It is about 8 cm in length, 5 cm in width and 2 cm in thickness. However its size is increased several times during pregnancy

The uterus is divided into three parts:-

a. **Fundus:-** it is upper dome shaped part of uterus and lies above the opening of fallopian tube.

b. **Body or corpus;-** it is middle and main part of uterus .

c. **Cervix:-** it is lower narrow part which opens in body of uterus by internal os and in vagina below by external os. The cavity of cervix is called cervical canal .

The wall of uterus in composed of three layers-the inner endomatrium, middle myomatrium and outer perimatrium.

Uterus is the site of implantation and fetal growth during pregnancy. It also takes part in placenta formation and expelling of baby during parturition.

4.Vagina:- It is the female copulatory organ and holds the penis during copulation. Its wall is devoid of mucus glands and contains traverse folds which form vaginal rugae. It is 8-10cm in length.The opening of vagina is often covered by a perforated membrane called hymen. The presence or absence of hymen is not a reliable indicator of virginity or sexual intercourse.

5. External genetalia(vulva or pudendum):- the external genetalia has a depression called vestibule. Vestibule has two opening the

upper urethral orifice for urine and lower vaginal orifice for sexual purpose. Vestibule is bounded by two pairs of moist skin folds with sebaceous glands .the inner smaller pair called labia minora and outer larger pair called labia majora. Labia minora fuse anteriorly to form a skin fold called prepuce in front of a small erectile organ called clitoris which is homologous to penis. There is a fleshy elevation above the labia majora and is known as mons pubis which is provided with pubic hair .

Acessory sex glands of female:-They are of two types :-

a. **Greater vestibular glands:-** (Bartholin's gland) they are small glands present on either of vaginal orifice. Their secretion is alkaline, thick and viscid and is meant for lubrication and nutralizing urinary acidity.
b. **Lesser vestibular glands :-**(Paraurethral glands or glands of skene). They are small mucus glands present between urethral and vaginal orifice.

MAMMARY GLANDS:-They are modified sweat glands present in breasts. A functional mammary gland is characteristic of all female mammals. The glandular tissue of each breast is divided into 15-20 mammary lobes containing clusters of cells called alveoli which secrete milk and is stored in the cavities of alveoli. The alveoli open into mammary tubules which join to form mammary duct. Several mammary ducts join to form a wider mammary ampula (lactiferous sinus). Lactiferous ducts arise from mammary ampula and they open at the nipple of breasts.

MICRO[illegible]Y OF OVARIES:-

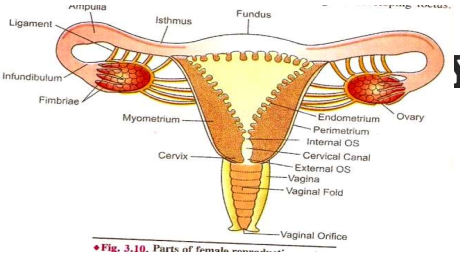


Fig. 3.10. Parts of female [illegible]

The ovaries are the primary organs of reproduction in the female and may be considered both endocrine and cytogenic (cell producing) in nature. The ovaries are solid structures lying on the sides of vertebral column behind the kidney in the pelvic cavity. They are almond shaped and graeyish pink in colour. Each ovary is about 2-4 cm in length, 1.5 cm in width and 1.0 cm in thickness. Each ovary has a depression called hilus from where nerves and blood vessels pass.

Anatomically the ovary is differentiated into four parts:-

1. **Germinal Epithelium:-** It is the outermost layer of ovary compsed of squamous and cuboidal epithelial cells. It forms oogenia (ovum mother cells)
2. **Tunica Abbuginea:-**It is poorly differentiated sheath of dense connective tissues and lies beneath the germinal epithelium and above the cortex. It is protective in function, and nourishes germinal epithelium.
3. **Cortex:-**It is wide layer of connective tissue having a large number of spindle shaped fibroblasts, reticular fibres and ovarian follicles at different developmental stages.
4. **Medulla:-**it is the innermost and central part of ovary made of less dense connective tissue. It is richly supplied with blood vessels. It helps in the dispersion of ovarian hormones to control secondary sexual characters' in females.

There are a number of(60,000 to 80,000) small, oval or rounded developing ovarian follicles in different stages of oogenesis like primary, secondary, tertiary and Graffian follicles in the cortical and meduallary regions of the ovary. Only about 450 ovarian follicles develop into mature Graffian follicles .The rest degenerate and such degenerated follicles are called atretic follicles and the process of degeneration is called follicular atresia.

Every month, a primary follicle under the stimulation of FSH is transformed into mature or Graffian follicle. A Graffian follicle is about 2.5cm in diameter and has a secondary oocyte surrounded by a few layer of follicular cells-the discus proligerous. It is suspended in a small cavity-the antrum by a

stalk of follicular cells called the germ hill or cumulus oophorus or cumulus ovaricus, from a multilayered membrena granulosa of follicular cells whose outer most layer is called Theca externa and inner one Theca interna. Antrum is filled with a semi viscous fluid called liquor folliculi secreted by follicular cells. The follicular cells also secrete estrogen hormone. The mature Graffian follicle under LH surge ruptures in the middle of menstrual cycle (14th day) and releases the secondary oocyte.The process is called ovulation.

The ruptured empty Graffian follicle is changed into a yellowish conical, progesterone secreting endocrine gland called ation does not cans.

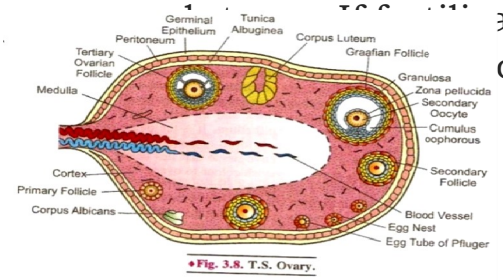


Fig. 3.8. T.S. Ovary.

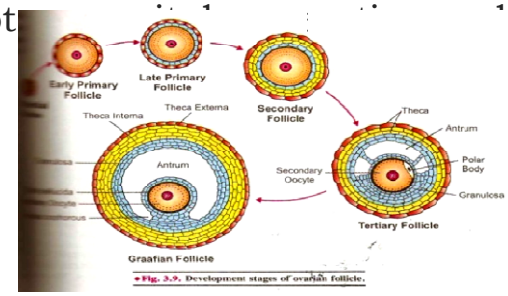


Fig. 3.9. Development stages of ovarian follicle.

GAMATOGENESIS

Gamatogenesis:- (Gr gamatos – gamete , genesis – production) The process of formation of gamtes is known as gamatogeneis . the functional gamates are formed only after attaining the age of puberty (12 – 14 years for boys and 11 – 13 years for girls)

On the basis of type of gamete the gamatogenise is of two types :-

a. Spermatogenesis
b. Oogenesis.

SPERMATOGENESIS:- The process of formation of sperm is called spermatogenesis.It occurs in the seminiferous tubules of testis. It starts at puberty and continues throughout life however in older age (after 68 years which is called climacteric) the rate of spermatogenesis is decreased. About 120 -170 million sperm cells are produced per day. The human sperm is tadpole shaped (about

60 μm long) and is divided into head (4.5 μm) neck (0.3 μm) middle piece (5-7 μm) and tail (60 $\mu minlength$). After ejaculation the sperm can remain alive for up to 72 hours but its fertilization capacity decreases after 24 hours.

The entire process of spermatogenesis is completed in four stages which are described below.

1. **Multiplication phase:-** In this phase the primary germ cells present in germinal epithelium of semniferious tubules divide mitotically and form spermatogonia . thespermatogenia are of two types – spermatogonia. A (which act as stem cells) and spermatogonia (which functions as precursors of spermatozoa)
2. **Growth phase:-** It is also called spermatocytogenesis . in this phase the sermatogonium B grows in size, accumulate nutrients and meiotic factors to form nearly double sized cells of primary spermatocytes.
3. **Maturation phase**:- in this phase meiosis takes place. The primary spermatocyte undergoes ist meiotic division to form two haploid secondary spermatocytes of two types, one with 22+x and another with 22+y chromosome combination.

The secondary spermatocytes undergo 2^{nd} meiotic dividion to form four spermatids.

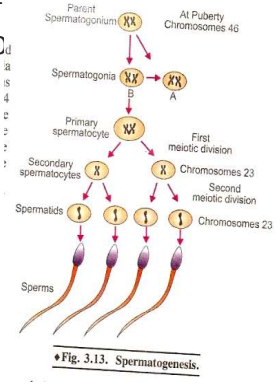
4. **Differentiation phase**:- In this phase the non motile spermatids are converted into tadpole shaped motile spermatozoa. The conversion of spermatids into spermatozoa is called spermiogenesis. The different changes which occurs in this phase are

a. Formation of acrosome by Golgi complex.
b. Formation of axial filament from distal centriolex
c. Formation of mitochondrial spiral (Nebenkern) around axial filament in middle piece.
d. Elongation and condensation of nucleus.

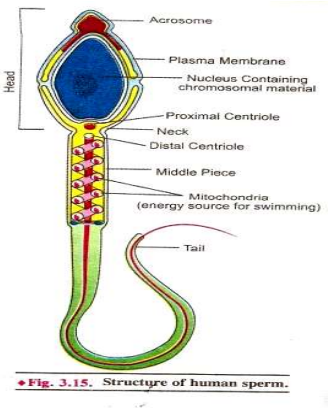
The differentiation phase occurs on Sertoli cells. After its completion the spermatozoa are detached from sertolicells(spermiation) and enter into the lumen of seminiferous tubules. The entire process of spermatogenesis is completed in 64 days

STRUCTURE OF SPERM:

Sperm is a dart like flagellated structure and is about 60µm long and with a maximum breadth of 3.5µm.It is t cell in human bo parts viz head and tail.



♦Fig. 3.13. Spermatogenesis.



♦Fig. 3.15. Structure of human sperm.

1.Head:- It is the anterior most part and is about 4.5µm in length.Head contains nucleus and acrosome. Acrosome is a special

lysosome formed from Golgi apparatus and contains sperm lysins (hydrolytic enzymes) which hydrolyse the different membranes of ovum and help the sperm to enter into it for fusion.

2. Neck:- It lies between head and middle piece. It is 0.3µm long. It contains two centrioles. A band of microtubules called manchette occurs around the neck which helps in elongation of sperm tail.

3. Middle piece:- It is 5-7µm long and lies between neck and tail. Axial filament of flagellum runs through it which is covered by a mitochondrial spiral of 10-14 turns called NEBENKERN. Nebenkern provide energy for sperm motility.

4. Tail:- It is the longest part of sperm (50µm long). Axial filament occurs throughout. It is the vibratile part. Tail has two parts-

a).Main piece: Contains cytoplasm and plasma membrane like other parts of sperm.

b). End piece: It contains only axial filament (Axoneme).

Semen:-It is an alkaline (7.4 PH) milky fluid ejaculated at the time of male orgasm. IT contains sperm cells and secretions from seminal vesicles, prostate and Cowper's gland. The different substances present in semen are fructose.fibrinogen,profibrinolysin,calcium,bicarbonates,prostaglandin

and amines(spermine, spermadine & putrisine).

Male ejaculates about 3-4 ml of semen and each ml contains 80-100 million sperm cells.

OOGENESIS

Oogenesis:- The process of formation of ovum from ooogonia is called oogenesis. The process starts at the fetal stage but is also stoped at embroyonic life. The stoped process is resumed at the age of puberty. In the entire reproductive life of human female only about 450 egg cells are formed one in per month and alternatively in two ovaries.

The process of oogenesis is completed in three phase:-

1. **Multiplication phase:-** the germ cells of germinal epithelium of ovary undergo repeated mitotic dividions to form diploid ooogonia. Initially the oogonia occur in group and in the form of a chord called egg tube of pluger which later forms a rounded mass called egg nest.
2. **Growth phase:-** it is of very long duration, during this phase one oogonium of egg nest is transformed into diploid primary

ooocyte while other oogonia of the egg nest form a single layered nutritive follicular epithelium around it. The structure so formed is called primary follicle.

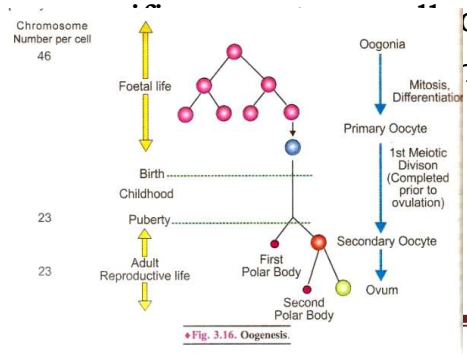
3. **Maturation phase:-** the primary ooocyte thus formed under goes meiosis or maturation division. The miosis1st isreductional and results in the formation of two haploid daughter cells. Due to unequal division of cytoplasm the daughter cells are unequal in size, one with almost no cytoplasm is term as first polar body (polocyte) the other cell is large and practically with all the cytoplasm, it represents the secondary oocyte.

The secondary oocyte undergoes 2nd maturation division with unequal cytokinesis result in in the formation of a large ovum and a smaller 2nd polar body. In the mean time the first polar body may divide to form two daughter polar bodies. Thus the products of oogenesis are:

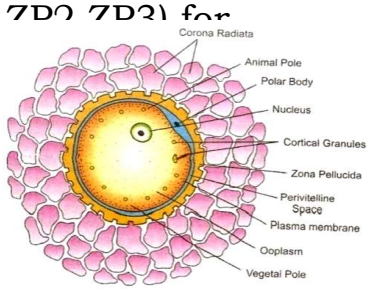
a. Single functional haploid ovum and
b. Two haploid polar bodies,, which later on degenerated.

Structure of ovum:- (L.ovum-egg) It is a non-motile female gamete. The ovum of human female is non-cleidoic and alecithal and is 100µm in diameter.Its cytoplasm called ooplasm contains all the cell organelles and its nucleus is in metaphase 2nd stage prior to fertilization.Its plasma membrane is called oolema.The outer part of ooplasm contains a number of mucopolysaccharide cortical granules.

Ovum has two additional coverings in the form of non-cellular glycoprotein layer called zona pellucid and outermost cellular layer called corona radiate.The zona pellucid contains spec d fertilizins (ZP1 ZP2 ZP3) for dete n-attachment of



♦Fig. 3.16. Oogenesis.



♦Fig. 3.18. Structure of Ovum.

Ovum has a sort of polarity,the end where polar bodies are present is called animal pole and the opposite end is called vegetal pole.The space where polar bodies occur is called perivitelline space.

MENSTRUAL CYCLE

MENSTRUAL CYCLE:-(Latin mensis-month)

The menstrual cycle is the cyclical physiological changes found in human females which are repeated in a cyclical manner after an average interval of 28days (lunar month) throughout their reproductive life from menarch to menopause except during pregnancy. The cycle is controlled by gonadotropins and ovarian hormones. The cycle is completed in three phases (a) mensis (b) proliferative and (c) Secretary phase.

1. **Menses or Bleeding phase:-**The menstrual cycle begins with this phases. In this phase, the degeneration of endometrial lining of uterus occurs. As a result the mixture of blood, mucosal fragments, serous fluid and unfertilized egg is slowly discharged from the genital tract of female. This phase lasts for 3-5 days.
Menses occurs when the titre of ovarian hormones and gonadotropins is low.
2. **Proliferative phase:-** This phase is also called follicular,estrogen and ovulatory phase. In this phase under the influence of FSH, new ovarious follicle develops into Graffain follicle. The endomatrium of uterus is regenerated and its thickness becomes about 3mm. At the end of the phase ovulation occur in response to high level of LH. The ovulation occurs in the middle of menstrual cyclei.e on 14thay of 28 days cycle. The next two days after ovulation represents fertility period as in these days fertilization can occur.

The proliferative phase lasts for 11 days

3. **Secretary phases:-**Also called luteal phase, progesterone phase and post ovulatory phase. This phase extends for 12 days. In this phase the following changes occur.

i. The rupturedGraffain follicle is converted into corpus luteum.
ii. Corpus luteum secretes large quantity of progesterone
iii. Under the influence of progesterone and LH, the endomatrium develops further and becomes 5-6 mm thick.
iv. Vascularisation of endomatrium increases and its gland become highly secretary.
v. The uterine wall gets fully prepared for nourshing and anchoring blastocyst, if fertilization has taken place.

However in absence of fertilization the corpus luteum degenerates and is converted into croups albicans this reduces the level of progesterone. In the absence of progesterone the uterine movements begin and its endomatrium starts to degenerate.

The degeneration of endomatrium is followed by menses or bleeding phases of menstrual cycle.

FERTILIZATION

FERTILIZATION:-The collection of events which leads to fusion of haploid gametes (sperm and ovum) to form a diploid zygote is known as fertilization. The fertilization is internal in human females and occurs inside the ampulla isthmus junction of fallopian tube. The different events which are necessary for fertilization are:-

1. **Arrival of Ovum:-** The secondary cocyte, after its release from Graffain follicle in ovary is conducted towards ampulla- Isthmus junction by slow ciliary currents of fallopian tube. It takes 12-24 hours for ovum to reach the fertilization site.

2. Insemination:-It is the injection of semen into vagina of female during copulation. About 3-4 ml of semen (containing 80-100 million spermatozoa per ml) is injected. In vagina, semen is converted into coagulum and the same gets dissolved after 15-30 minutes. Coagulum formation occurs becoz:-

a. To reduce phagocytosis of spermatozoa and
b. To conserve energy of spermatozoa.

3. Motility of sperm:-The sperm cells swim in a liquid medium at the speed of 1.5 – 3.0mm / minute. Prostaglandin present in semen induce contraction of genital tract of female, which helps in forwarded movement of sperm cells. It takes 5-6 hours for sperm to reach the site of fertilization. However during female orgasm (when oxytocin is produced) the sperm cells can reach the site of fertilization within minutes. It is due to the fact that oxytocin induce strong contraction of female genital tract which help in sperm movement.

4. Capcitation of sperms:-It is the phenomenon of activation of sperm cells and making them able to fertilize the ovum. It is due to inhibiting the effect of decapcitation factors present in semen. Capcitation occurs in female genital tract by following ways:

a. Dilution of inhibitory factors present in semen.
b. Washing of cholesterol and phospholipids from the sperm head.
c. Entry of ca++ into sperm. This changes sperm tail movement from slower undulation motion to rapid whiplash motion.

5. Fusion of Gametes:-After reaching the site of fertilization the two gametes fuse and form zygote. The following events occur during fusion of gametes:-

a. Acrosomal Reaction:- After coming in contact with secondary cocyte, the acrosome of sperm releases its hydrolytic enzymes (spermlysins) .The enzymes released are:

i. Hyaloronidase :-Dissolve hyalornic acid and seperates the corona cells.

ii. Corona penetrating enzyme:-It degenerates the corona radiata and helps sperm to penetrate it.

iii. Zona lysin (Acrosin):- It degenerates Zona pellucida. An optimum PH, Mg^{2+} and ca^{2+} are essential for these events to occur.

b. Sperm entry:-Now the sperm enters into secondary oocyte. It triggers a weak depolarization of oolema and ca++ wave inside the egg.

c. **Cortical Reaction:-**Ca++ wave causes removal of cortical granules from the secondary oocyte. They modify oolema and convert it into fertilization membrance, which is resistant to sperm lysins.

d. **Zona reaction:**-The chemical present in cortical granules destroy the fertilizin present on Zona pellucida. Therefore the Antifertilizin's of sperm could not recognize Zona pellucida.

The cortical and Zona reaction occurs to prevent polyspermy and promote monospermy

e. **Activation of Secondary oocyte:-**The sperm activates the secondary oocyte to complete its 2^{nd} meiotic division.It requires phospholipase c zeta protein (PCL-Zeta protein) from sperm.

After the completion of 2^{nd} meiotic division the secondary oocyte is converted into an ovum and a polar body.

f. Karyogamy:-finally the nuclear membrane of sperm and ovum breaks and their chromosomes mix up resulting in the formation of Zygote.

Significance of fertilization:

1. It stimulates the secondary oocyte to complete its meiosis II.
2. It restores the normal number of chromosomes in Zygote.
3. It initiates cleavage division.

4. It causes mixing of genetic material of two different individuals.
5. It introduces variation.
6. It determines the sex of the young one.
7. It modifies oolema and Zona pellcuida to prevent polyspermy.
8. It brings sperm centriole into the Zygote.

DEVELOPMENT OF ZYGOTE UPTO BLASTOCYST

As soon as the Zygote is formed it starts to undergo cleavage division. The cleavage division are mitotic division of Zygote charecterized by rapid DNA multiplication, increased O_2 consumption and absence of growth of daughter cells. The cleavage in human Zygote in holoblastic and unequal.

The early development in human Zygote occurs in following steps:

1. **Formation of morula:-**Cleavage occurs in fallopian tube during the conduction of embryo towards uterus. The first cleavage division divides the Zygote into two unequal daughter cells (blastomers), the larger one is called macromere and smaller one micromere. The first cleavage takes about 30 hours for completion and occurs along the primary axis of animal- vegetal poles). The 2^{nd} division is at right angles to the first and is completed earlier in one of the two blastomers. Therefore a transient 3 celled stage is produced. The second division is completed in 20-30 hours.

Subsequent cleavages proceed one after another on an orderly manner but are rapid and not accompanied by growth, so with cleavage the resultant blastomers become smaller and smaller in order to attain surface-volume and nucleocytoplasmic ratio to the level where metabolic efficiency becomes maximum.

These early cleavage divisions results in the formation of a solid ball of cells containing about 16 - 32 cells, which looks like little mulberry and is called as morula. Morula reaches in uterus on 4th day after fertilization. It is still covered by Zona pellucida which prevents its abnormal implantation and from being attacked by immune cells of female.

2. Formation of Blastocyst (Blastula):- As the morula enters into uterus it obtained enriched supply of nutrients from uterine milk. Therefore the blastomers start to grow and they start to stretch the Zona pellucida. The outer pheripharal cells enlarge and flatten and form trophoblast or trophoectoderm. The central cells are called inner cell mass. The trophoblast secretes a fluid into the interior, which push the inner cell mass on one side (embryonal knob / animal pole) and creates a cavity on another side (abembryona knob). The so formed cavity is called blastocoel. With the formation of blastocoels the embryo enlarges and takes the form of a cyst called blastocyst. (blastodermic vesicle).

This entire process is called blastulation. Due the pressure of growing blastocyst and production of trypsim like enzyme, a slit is produced in Zona pellucida through which blastocyst comes out in the form of letter 8 which occasionally breaks at the constriction and results in the formation of monozygotic twins. Faulty separation produces conjoined or siamese twins.

Sometimes twins are formed due to fertilization of more than one one egg. They are called fraternal or dizygotic twins.

Trophoblast cells in contact with inner cell mass are called cells of Rauber.

The trophoblast which is initially ment for nourishment does not participate in organogenesis rather it divides periclinally and becomes two layered. The outer syncytiotrophoblast and inner

cytotrophoblast. These two layers later form chorion, amnion and fetal part of placenta.

IMPLANTATION

Implantation:-(Latin in into , plantare-to set)

Definition:-The process of attachment of the blastocyst with the endomatrium of uterus is called implantation.

It occurs on the 7th days after fertilization and is completed within three days.

In this process the nlastocyst comes in contact with the endomatrium in the region of embryonal knob and adheres to it . Adherence of blastocyst to endomatrium, stimulates the uterine cells to undergo rapid divisions and these newly formed cells cover the part of blastocyst, which is in contact with them .it results in implantation .

Implantation leads to pregnancy.

GASTRULATION:

The stage of embryonic development which is characterised by the morphogenetic movements of cells so as to form primary germ layers i.e ectoderm,mesoderm and endoderm is called gastrulation.The product of gastrulation is called gastrula.

FATE OF GERM LAYERS;

Ectoderm derivatives: Epidermis of skin, cutaneous glands, hair, nails, lining of buccal cavity and anal canal, nasal chambers, enamel of teeth, salivary glands, external ear, mammary glands, central nervous system, adrenal medulla, retinal lens, cornea, conjunctiva of eye , ciliary and iridial muscles.

Mesoderm derivatives: All types of connective tissues, dermis of skin, all muscles except ciliary and iridial muscles, dentine of teeth, heart, blood vessels, lining of coelom, spleen, urinogenital system, sclera, choroid, iris and ciliary body of eye, adrenal cortex.

Endoderm derivatives: Epithelium of tongue, digestive tract except anal canal, Eustachian tubes, middle ear, epithelium of larynx, trachea, bronchi and lungs, gall bladder, liver, pancreas, urinary bladder except trigone, vagina, vestibule, prostate, vestibular glands, bulbourethral glands, intestinal and gastric glands, adenohypophysis, thymus, thyroid, parathyroid gland.

*EXTRA EMBRYONIC MEMBRANES :-*The extra embryonic membranes also called foetal membranes are formed from early embryonic structures but do not form any future tissue or organ of the fetus. However they are essential for the normal embryonic development. They are 4 in number viz. Chorion, amnion, allantois and yolk sac.

Chorion:-It is the external most foetal membrane . It is formed of trophoblast outside and somatopleuric extra embryonic mesoderm inside. It takes part in placenta formation.

Amnion:-It lies inner to chorion and is composed of trophoblast inside and somatopleuric extra embryonic mesoderm outside. The space between embryo and amnion amniotic cavity is filled with about 1 to 1.5 litre amniotic fluid. The amniotic fluid is secreted both by embryo and amnion. The amniotic fluid prevents desiccation of embryo and and acts as a protective cushion that absorbs shocks.

Allantois:-It is formed of endoderm inside and splanchenopleuric extraembryonic mesoderm outside. It is a sac like structure and arise from the gut of foetus.It forms the blood vessels of placenta.

Yolk sac:- It is formed of endoderm inside and splanchenopleuric extraembryonic mesoderm outside. It is haemopoitic in early embryonic stages and later becomes non functional .

PLACENTA AND ITS FUNCTIONS

PLACENTA AND ITS FUNCTIONS (Latin Placenta –flat cake)

Placenta is a physiological connection between fetus and mother which develops during pregnancy for supporting the development of fetus. The placenta is formed of both maternal and fetal structures. The futus is connected with placenta through umbilical cord, which contain two arteries (carrying deoxygenated blood from fetus to placenta) and one vain (carrying oxygenated blood towards fetus). The human placenta formation is completed in 10^{th} week of pregnancy and persists throughout gestation period. The human placenta is called:-

a. **Deciduate placenta-** As it falls –off and pass out at the time of parturition.
b. **Metadiscoidal placenta:-** As the chorion villi remain restricted to a small disc shaped area.
c. **Allantochorionic placenta**:- As chorionic and allantois of fetus participate in its formation.
d. **Chorionic placenta** :- As from fetal side, chorionic villi mainly takes part in its formation.
e. **Haemochorialplacenta :-** As the blood capillaries of chorionic villi are immersed in the blood sinus of diciduabasalis of endomaterium of uterus.

FUNCTIONS OF PLACENTA

1. Nourishment of fetus :- The pregnant female supplies all the nutrients to fetus through placenta.
2. Respiration :-the fetus exchange respiratory gases (O_2 and CO_2) with mother through placenta.

3. Storage and Degestion: - Placenta stores fats and glycogen and during starvation, it digestes these stored food materials and supplies them to fetus.

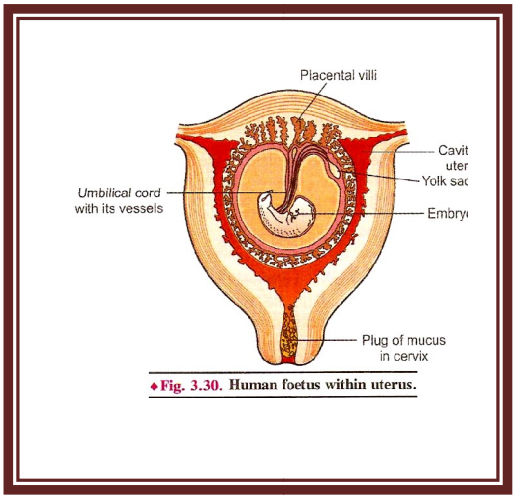
4. Excretion :-Thefetus eliminates its excretory wastes via placenta.

5. Protection ;- Placenta is permeable to anti-bodies of mother and thus protects the foetus from some infectious diseases like measls, small pox, diphtheria, scarlet fever etc

It also prevents the entry of mothers immune cells into fetal blood and thus protects the fetus from the deadly attacks of these cells.

6. Endocrine function :-Placenta is an important temporary endocrine gland and produces number of hormones which are essential for maintaining pregnancy, normal development and delivery of fetus. The important hormones produced by placenta are :-

1. Human chorionic gonadotropin (HCG). Its secretion starts just after implantation and its presence in urine confirm pregnancy. It is essential for growth and maintenance of corpus Luteum



♦Fig. 3.30. Human foetus within uterus.

2. Chronic thyrotrophin: - It stimulates thyroid gland of mother to produce more thyroxine.

3. Chronic corticotrophin:-It stimulates the mothers adrenal cortex to produce more hormones. Increased secretion of Aldosterone helps the mother to retain salts and fluid in the body.

4. Human placental lactogen (HPL):- Also called chrionicsomatomamotropin. It stimulates growth of breasts and inhabits utilization of glucose in mother and makes it available to fetus.

5. **Progesterone and oestrogen**:- These harmones cause development of uterus and maintain pregnancy.

6. **Relaxin:-** it softens the pubic symphysis, softens and dilates the cervix and thus reduce discomfort of carriage and facilitating easy child birth.

Major features of embryonic development at various months of pregnancy: The human pregnancy lasts 9 months. After one month , the embryo's heart is formed.By the end of 2nd month of pregnancy, the foetus develops limbs and digits.By the end of 1st trimester most of the major organ systems are formed including the genital organs. The 1st movement of the foetus and the appearance of hairs on the head are usually observed during the 5th month. By the end of 2nd trimester , the body is covered with fine hair ,eye-lids separate and eyelashes are formed. By the end of 9 months the foetus is fully formed and ready for ready.

PARTURITION-THE ACT OF BIRTH

The process of expulsion of baby from the mothers uterus through cervix and vagina after the end of gestation period (about 9 months) is known as parturition.

Mechanism:- parturition is induced by a complex neuro endocrine system. Towards the end of pregenancy, the fully formed foetus stretches the uterine muscles, which induces mild uterine contractions called **foetal ejection reflex**. The different factors responsible for parturition are:-

1. **Ratio of estrogen to progesterone is changed** :- Towards the end of gestation period, the secretion of estrogen is increased , while as progesterone secretion remains constant.
2. Oxytoxin secretion is increased from the neurohypophysis of mother that specifically cause uterine contractions.
3. The fetus's pituitary gland also secretes increasing quantities of oxytocin.

4. Stretching smooth muscle organs,usually increase their contractility. Due to increase in size of fetus the uterine muscles are stretched and contraction results. That is why twins are born about 19 days earlier than a single child.
5. The contraction of uterus causes increased secretion of oxytoxin.
6. Production of relaxin hormone which cause the dilation of birth canal.

The increased secretion of oxytoxin induces frequent and forceful contraction of uterus called labour pain, which pushes the baby through birth canal with the head foremost. Expulsion takes about 20-60 minutes within 10-45 minutes after parturition, the placenta also comes out which is called afterbirth.

LACTATION

LACTATION:-It involvesthe synthesis, secretion and ejection of milk by the mammary glands.

Lactation involves two phases:-

i. **Milk secretion**:- it occurs in the mammary glands under the influence of pitutary hormone called prolactin. The process of milk secretion starts at the end of pregnancy and continues up to 3years, provided the baby sucks the milk, otherwise an inhibitory protein is accumulated in the alveolar epithelium, which stops the secretion of milk.

Galactopoisis (secretion of milk)is also influenced by growth hormone, thyroxine, certisol and the diet of mother.

Milk ejection:- it involves discharge of milk from the mammary glands. Sucking stimulate the touch receptors on nipple, an impulse is initiated and is carried to hypothalamus and neurohypophysis which secrete and release oxytocin. Oxytocin cause the forceful contraction of mammary glands which results in ejection of milk from the alveoli.

So the lactation is controlled by a neuroendrocrine reflex, also called milk let-down reflex.

Composition of milk:-Human milk is formed of H_2O,minerals like ca, K, Na,P etc), fat droplets , proteins (especially caecin) and milk sugar lactose. It also contains anti-bodies thus provides passive immunity to child.

The fluid produced by mammary glands soon after birth is called colostrum. It is rich in nutrients and antibodies (IgA)

1. Sex of human baby is determined by the father and not by mother.
2. Golgi rest is the part of Golgi which is lost during spermiogenesis.
3. Oogonia are not formed after birth.
4. The pituitary hormones which regulate gamatogenesis are called gonadotropins (FSH & LH).
5. Human egg is alecithal and after fertilization undergoes holoblastic unequal cleavage.
6. Fructose is only present in semen and is used in rape test.
7. Uterine milk is the nutritive endometrial secretion.
8. The trophoblast cells don't express MHC antigens .

EVALUATION

Q. A) Answer briefly:

a). Write two major functions each of testis and ovary?

b). Define spermatogenesis, spermiogenesis and spermiation?

c). Draw a labelled diagram of human sperm?

d). Give the functions of the following:

I. Corpus luteum II. Endomatrium III. Acrosome IV. Fimbriae

e).Name the hormones involved in spermatogenesis and oogenesis?

f).How many times the process of spermatogenesis and oogenesis are required to take place to form 60 spermatozoa and ova respectively?

Q.B) Multiple choice questions:

1).The amnion of mammalian embryo is derived from;(NEET 2018)

a. ectoderm & mesoderm b. Endoderm & mesoderm

c. mesoderm & trophoblast d. Ectoderm & trophoblast

2). Capacitation occurs in:(NEET 2017)

a. rete testis b. Epididymis c.vas differens d. Female reproductive tract

3). Select the incorrect statement:(NEET 2016)

a. FSH stimulates the Sertoli cells which help in spermiogenesis.

b. LH triggers ovulation in ovary.

c. LH & FSH decreases gradually during the follicular phase.

d. LH triggers secretion of androgens from the Leydig cells.

4. Which is not the function of placenta (NEET 2013).

a. Secretes oxytocin during parturition
b. Supply O_2 and nutrients to embryo
c. Secretes estrogen
d. Facilitates removal of CO_2 and wastes from embryo.

Q.C) Fill in the blanks and true/false questions:

a. Gestation period of dog-------cat------and elephant----------?

b. zygote is ----------(diploid/haploid)

c. Menstrual cycle ceases during pregnancy (T/F)

d. Sertoli cells secrete androgens (T/F).

e. The process of release of ovum is called----------.

f. Gametes are always haploid(T/F)

g. Progesterone is called pregnancy hormone (T/F)

Q.D) Differentiate between:

a. Menarche and Menopause.

b. Spermatogenesis and oogenesis.

c. Follicular phase and luteal phase.

d. Sperm and ovum.

e. Menstrual cycle and oestrus cycle.

f. Progesterone and testosterone.

NEED FOR REPRODUCTIVE HEALTH

The world health organisation (WHO) has defined reproductive health as the total well being in all aspects of reproduction i,e physical, emotional, behavioural and social.Briefly speaking, reproductive health refers to healthy reproductive organs with normal functions. A society is said is to be reproductively healthy only when its members have physically and functionally normal reproductive organs and have normal emotional and behavioural interactionsamong them in all sex related issues.

Problems associated with reproductive health:-

1. Lack of awareness in the people
2. A numberof myths andmisconceptions about sex related aspects.

3. Early marriage results in kid parents,which are not aware about to maintain reproductive health.
4. Deformities are in children of early marriage.
5. Maternal and infant mortality rates (MMR and IMR) are high.
6. Common occurrence of sexually transmitted diseases.
7. Rapid increases in population (population explosion)
8. Congenital or acquired infertility.
9. Early marriage also results in ruination of career.

To address these problems , and make the society free from these adversities, there is need for reproductive health.

The aims and objectives of reproductive health programmes are:-

1. To ensure a responsible, safe and satisfying reproductive life.
2. To create awareness among people about various reproduction related aspects. The audio-visual aids, print media, primary health centres, parents, teachers and elders can play an important role in imparting information about reproductive health.
3. To provide sex education in the schools to save the young school-goers from myths and misconceptions about the sex related issues.
4. To prevent and control sexually transmitted diseases by providing adequate information about them.
5. To educate the fertile couples and those in marriageable age-groups about birth controls measures, prenatal and post-natal care of mothers and child, importance of breast feeding, and gap maintenance between two successive births.
6. To provide awareness about hazardous effects of population explosion and sex-related crimes.
7. To provide medical facilities in order to decrease MMR and IMR.

8. To raise the marriage age.
9. To develop new techniques and improve the existing ones.
10. To lessen the problems of infertility by promoting assisted reproductive techniques like artificial insemination (AI), in vitro fertilization (IVF), embryo transfer (EF) etc.
11. Ban on improper use of amniocentesis, USG and medical termination of pregnancy (MTP).
12. Immunization of child should be strictly followed.

The reproductive health of the people of our country has improved in the past 50 years as evident from the following data.

a. By adopting family planning measures, the birth rate is decreasing rapidly. It was 36 per 1000 persons in 1981, 30.5 per 1000 in 1991 and only 26 per 1000 in 2001.
b. Due to better health care and medical facilities, the average life span of Indians has increased from 50 years in 1970-71 to 64 years in 2001.
c. Due to control of various bacterial and viral diseas with the help of effective antibiotics, medicines and surgical methods, There is rapid decline in deathe rate from 13.8 per 1000 in 1981 to 8 per 1000 in 2001.

SEXUALLY TRANSMITTED DISEASES (Venereal diseases) and their prevention

Sexually transmitted diseases are those infections and communicable diseases which are transmitted from an infected to healthy person during unprotected vaginal, oral and anal sexual contact. These are generally acquired diseases and usually affect the reproductive system of the person but may spread to other body parts as well.

STDs have become an increasingly serious threat to public health due to following reasons:

1. Changing pattern of sexual behaviour.

2. Increasing resistance in the pathogens to antibiotics.
3. Long incubation period.
4. Due to social stigma attached to STDs, the infected persons do not go in for timely detection and medical treatment.

So STDs are easier to avoid than to treat and cure. These disease can be prevented through.

1. Use of condoms.
2. Avoid sex with multiple and unknown partners.
3. Promote monogamy.
4. For any doubt a specialist Doctor should be consulted

The various sexually transmitted diseases are briefly described below:-

(A) STDs caused by Bacteria:-

1. **Chlamydiosis**

Causative agent _____ Chlamydia trachomatis

Epidemiology _____ spreads by sexual contact.

Incubation period _____ one week.

Symptoms ___urithritis with pus discharge from penis and painful urination in males.

In females, it causes inflammation of cervix, uterus and oviducts. If remains untreated, it may transform into pelvic inflammatory Diseases (PID) causing sterility.

Prophylaxis:-Avoid to visit prostitutes, Avoid polygamy and use of condom.

Therapy:-Antibiotics like tetracycline, erythromycin and rifampacin.

2. Gonorrhoea:-

Causative agent _____ Neisseria gonorrhoea.

Epidemiology _____ Spreads by sexual contact.

Incubation period _____ 2 to 10 days.

Symptoms _____ Inflammation of urinogenital tract causing burning sensation during urination. It may also cause arthritis, female sterility and also eye infection in neonate during their passage through birth canal.

Prophylaxis:-Avoiding prostitutions and homosexuality use of condoms.

Therapy:-Ceftriaxone, ampicillin and penicillin antibiotics.

3. Syphilis:-

Causative agent _____ Treponemapallidum

Epidemiology _____ Spreads via sexual contact. It is also transmitted to fetus from inflected mother through placentra(Congenital syphilis)

Incubation period ____ About 3 weeks.

Symptoms:-Progresses through following stages.

a. **Primary stage:-**Within 1- 6 weeks of incubation, hard, dry and bacteria filled sore called chancre appears on the genetalia in 90% cases and on lips and fingers in 10% cases.
b. **Secondary stage:-** Within 3-8 weeks of incubation, there occurs, multiple lesions on lips, mouth, genitalia, other symptoms include white patches on tongue, cheeks and gums, low grade fever and anorexia (loss of appetite)
c. **Teritary stage:-**In this stage the bacteria spreads to internal organs like heart and brain causing paralysis and mental disorders.

Prophylaxis:-Avoid prostitutes and homosexuality,use of condoms.

Therapy:-Tetracycline and penicillin are most effective.

(B). STDs caused by viruses:-There are four major STDs caused by viruses.

1. Heratitis B:- (serum hephatities)

Causative agent ___ hepatitis B virus (HBV) a double stranded DNA virus.

Epidemiology:-Transmitted by blood, body fluids and sexual contact. It is about 100 times more infectious than HIV.

Incubation period ___ 20 -35 days.

Symptoms :-Fatigue, nausea, abdominal pain, arthritis, damage to liver cells, Jaundice . The infection may lead to cirrhosis.

Prophylaxis:-avoid unprotected sex and polygamy. Proper sanitation, proper covering of food, water, milk etc. use of boiled water.

Therapy:-hepatitis B-vaccine and interferon injections.

2.Genital herpes:-

Causative agent- type- 2 herpe simplex virus.

Epidemiology- Through sexual intercourse.

Symptoms - watery blisters on the genitalia, buttocks, fever, painful urination and swelling of lymph nodes in groin.

Infection spreads by rupture of blisters and release of viruses. Herpes infection is very devastating in the new born baby who comes in contact with open sores during the birth process. About 50%of such infected babies may die.

Prophylaxis:-Avoid prostitution, polygamy and homosexuality use of condoms.

Therapy:-acyclovir drug-gives only symptomatic relief but can't completely cure the disease.

3. Genital warts:-

Causative agent- human papilloma virus. (HPV)

Epidemiology:- through sexual contact.

Symptoms:-appearance of warts on the genital organslike penis, labia, vagina, cervix and anus**.**This infection is nowassociated

withcancer of cervix (about 90-95%) and tumours of vulva, vagina and anus.

Prophylaxis:- Avoid prostitution, polygamy, homosexuality and use of condoms.

Therapy:-warts can be removed with the drug candylox, freezing with liquid nitrogen, laser surgery and treatment with alpha-interferon (Alferon).

4. AIDS (acquired immum deficiency syndrome) described in detail in unit-iii

C. STD CAUSED BY OTHER ORGANISMS.

1. Candidiasis:-

Causative agent:- Candida albicans (a yeast)

Epidemiology:- Through sexual contact, shearing common toilet and deep lip kissing.

Symptoms- Painful virginitis with thicky cheesy discharge. Painful urithritis in male

Prophylaxis:- avoid unprotectedsexual contact.

Therapy:-Nystatin, clotrimazole and miconazole antibiotic therapy.

2.**Trichosomiasis(Vaginitis)**

Causative agent- trichomonasvaginalis (protozoan)

Epidemiology:-spreads through sexual intercourse.

Symptoms:- burning sensation, itching and inflammation of vagina with whitish frothy discharge from vagina so is called leucorrhoea.

Generally the males remain asymptomatic, but occasionally the protozoa spreads to seminal vesicles and prostate gland and cause painful swelling in them.

Therapy:-Auromycin, terrymycin and matronidazole antibiotic and arsenic and iodine drugs.

3.**Chancroid:-**caused by a bacterium haemophilusducrey.

Epidemiology:- spreads via sexual contact.

Symptoms:-painful bleeding ulcers develop over the external genitalia and swelling of nearby lymph nodes.

Prophylaxis:-avoid sexual contact with infected persons and use of condoms.

Therapy:-Antibiotic like erythromycin, tetracycline, and ceftriaxone

BIRTH CONTROL-NEED AND METHODS

The birth control has become a necessity for every responsible citizen of the world; because the world population is increasing at an alarming rate.

The tremendous increase in the population is called population explosion. The population explosion results in :-

I. Shortage of food and shelter.
II. More pressure on natural resoures.
III. Increase poverty.
IV. Housing shortage.
V. Inflation.
VI. Lack of better hygienic and sanitation faculties
VII. Un employment
VIII. Environmental degradation .

So in order to get rid from these hazardous effects of population explosion, there is an immediate need of adopting birth control measures.

"BIRTH CONTROL METHODS"

The main aim of birth control measures is to check the population growth rate. These include the using of various types of contraceptive

(devices which prevent pregnancy). An ideal contraceptive should be :-

a. User friendly b. easily available and cheaper.
c. effective but also reversible d. With no or least side effects.

The different methods of contraception's are:-

A) Natural or traditional methods

1. Abstinence:-it involves refraining from doing sexual intercourse.

Drawback:-can't be practised by everyone .

2. Coitus interruption :-it involves withdrawal of penis by male just before ejaculation **f**rom the vagina.

Drawbacks':- i. Some sperms may be deposited in the vagina even before the sexual climax**.**

ii. It may develop psychological and physiological problems to both the partners.

3. **Rhythm method:-**it involves to avoid sexual intercourse a few days before and after the ovulation. It reduces the chances of pregnancy by about 80%. It is so because:

I) Ovulation occurs on 14th day of menstrual cycle(but can vary from 13-16th day)

II) Viability of sperm and ovum is limited.

The period from 10th to17th day: (both days inclusive) of the menstrual cycle is called fertile period and unprotected sexual intercourse should be avoided during this period. During fertility period, the cervical mucus is slippery and can be drawn into a thread (spinnbarkittest) when stretched between two fingers.

Drawback:- Not 100% safe, because irregularity in menstrual cycle is common.

This method is also called as periodic abstinence.

4. Lactational amenorrhoea:- The intense lactation after parturition, stops the menstrual cycle and ovulation in females for about six months because of hyperprolactenemia which inhibits FSH and LH secretion. So the chance of conception during this period is nil.

Drawbacks:-it is effective only for a short period of time.

B .**Surgical methods**

These methods block the gamete transport and so prevent conception. These methods are highly effective ,but they are either irreversible or with very low reversibility .

1. **Vasectomy**:-In this method the vasa differentia are cut the cut ends are tied to prevent reunion
2. **Tubactomy:-**in this method, the fallopian tubes are cut and cut ends tied to prevent reunion**.**
3. **Tubal ligation:-**it involves the blocking of fallopian tubes by an instrument called laparoscope**.**

Drawback:- Although the surgical methods are very effective (100%) birth control measures, but they have some drawbacks' like
irreversible or low reversibility chances.
can cause nausea, abdominal pain, breakthrough bleeding, irregular menstrual flow etc.

BARRIER METHODS

These devices prevent the fusion of sperm and ovum, by not allowing them to come closer with one another. It is of fallowing methods:-

1. **Condoms:-** these are rubber sheaths which are put on penis before starting copulation. Use of condoms prevents the deposition of semen in the vagina.
Female condoms are also available now which act as a clip on the vagina wall and blocking the passage to the uterus.
Drawback:- sometimes condom ruptures and leakage of semen takes place.
2. **Diaphragms and cervical caps:-**these are made of rubber and are fitted in vagina or cervix. They prevent the entry of sperms into uterus and thus fallopian tubes. They are reusable.
3. **Intra uterine devices (IUDS):-** These are devices made of plastic, metal or combination of two, which are inserted into the uterus to prevent conception. IUDS are called loops, spiral, rings, bows, shields, depending upon the shape.

IUDS are of following types:-

i. **Inert or non –medicated IUDS:-** It prevents conception by:-

a. Creating obstruction in sperm ascent.

b. Increase phagocytoses of sperms

c. There is quick tubal motility resulting in premature migration of embryo into uterus before it is ready for receiving it.

ii. **Copper releasing IUDS:-**These release CU ions at therate of 50 micro gm/day, which decrease the sperm motility and make them unable to fertilize the ovum.

Copper IUDS are designated by the area in sq mm having copper e.g.cuT 200, multiload cuT 280, multi load cuT 375, cuT 380, cuT 7. The device is to be replaced after 3-10 years depending on the content of copper it contains.

iii. **Hormone releasing IUDS:-** They include progesterone IUD and levonorgestel IUD. These device release small quantities of hormone which disturb endometrial changes, cervical mucus production, cause anovuolation and insufficient luteal activity.

Drawbacks:-occasional haemorrhage, chance of infection and spontaneous expulsion can occur.

CHEMICAL METHODS

B. **Chemical methods:-**these include utilization of chemical agent for preventing conception.

a. Spermicidal tablets**(**Chlorimin-T or Contab**),** creams (e.g Delfin), jelly(Percepin) are introduced in the vagina before sexual intercourse. These kill sperms.Common spermicidal chemicals are lactic acid, citric acid, potassium permanganate, zinc sulphate etc.

b. **Physiological (oral) devices:-** Also called as oral contraception. These oral pills contain a combination of progesterone and oestrogen. These pills inhibit secretion of FSH and LH from pituitary gland so inhibit ovulation. These also retard the entry of sperms in the uterus by forming cervix plug

e.g Mala-D (daily) and Saheli(weekly). Saheli contains a non-steroidal preparation called centchromn. It has high contraceptive value and few side effects (Saheli blocks estrogen receptors in the uterus ,preventing eggs from getting implanted).

Drawbacks:-cause nausea, breast tenderness, weight gain, breakthrough bleeding and prolonged use can even cause cancer.

C . Implants:-They are hormone containing(progesterone-estrogencombination) devices which are implanted subdermally for long term contraception.

EMERGENCY CONTRACEPTION

It is a treatment for unprotected sex , sexual assault, missed oral pills and other reasons which have risk of pregnancy. E.g. i pill (mifepristone), unwanted 72(Levonorgesterol). Unwanted 72 comes both in the form of tablets and injections. They can prevent pregnancy if taken within five days of unprotected sexual act.

Drawbacks:-cause nausea, abdominal pain, bleeding etc.frequent use of them causes cancer.

= insertion of IUD within five days of unprotected sex prevents implantation.

"Scientist have produced a genetically modified corn crop which produces anti sperm antibodies, so can be used as a birth control method".

MEDICAL TERMINATION OF PREGNANCY (MTP)

MTP also called as induced abortion is the termination of pregnancy before the completion of full term.

'Period':- the safest period for MTPs is upto 12weeks of pregnancy (ist trimester). It is so because, after the first trimester, the fetus becomes increasingly intimately associated with the endometrium.

Incidence:- About 45 to 50 million MTPs are done every year all over the world. (Highest cause of death in 2018)

In India there is a proper act, Medical Termination of pregnancy act, 1971, ment for preventing unnatural deaths due to unsafe MTP. However this Act has been amended in 2002 Under this act termination of pregnancy can be done upto 20 weeks(now upto 24 weeks- Amendment Bill passed in parliament on 29th January

2020) if pregnancy is likely to produce a malformed child, is a result of rape and contraceptive failure or is likely to harm the mother.

"Methods of abortion"(MTPS):- there are three methods of abortions:-

i. **Dilation and curettage:-**in this method the vagina and cervix are dilated and implanted embryo is removed.

ii. **Vacum aspiration:-**it involves the aspiration of the implanted embryo with the helps of vacuum aspirator. This can be done upto 12 weeks of pregnancy.

iii. **Administration of prostaglandins and oxytocin:-** They are taken orally or intravenously. They stimulate strong uterine contraction and cause abortion.

Significance of MTP:- 1. Plays a role indecreasing population growth.

2. Helps in getting rid of unwanted pregnancy and such pregnancies which may be harmful or even fatal to mother or fetus or even both.

"drawbacks":-

1. It has raised many religious, emotional, ethical and social issues.
2. It is being misused to abort even the normal female foetuses i,e it increases the incidence of female feticide.
3. It increases the incidence of illegal sexual enjoyment.
4. Majority of abortions are performed by unqualified quacks which may be fatal even.

AMNIOCENTESIS

It is a pre-natal diagnostic technique, which aims at to determine the

i. Sex of the developing baby (Banned
ii. Congenital genetic and metabolic disorders.

Procedure:-it involves following steps.

a. Determination of location of fetus with the help of ultrasonograpy (USG) technique.

b. A fine hollow needle is passed through the abdominal and uterine wall of pregnant female (About 14th or 15th week after conception) into the amniotic cavity.

c. A small amount of amniotic fluid is withdrawn and the fetal cells contained in it are cultured in vitro for further **e**xamination.

"**Drawbacks":-**the technique is being misused. it has increased the incidence of female feticide.(Punjab, Haryana, and Delhi is at top). So the Govt of India enforced the pre-natal diagnostic techniques.(regulation and prevention of misuse) Act;1994, under which all genetic counselling centres and laboratories are required to apply for registration. It is illegal to disclose the sex of the developing fetus. The violation of this act can bring a fine ofRs 50,000/and imprisonment for two years. The doctors registration is also cancelled if found guilty.

INFERTILITY AND ASSISTED REPRODUCTIVE TECHNOLOGIES(ART)

Infertility:-(L. In – not, fertilis- fruitful) is the failure of producing young ones after regular unprotected sex. The term is not synonyms of sterility which means complete inability to produce young ones. Infertility can best be defined as relative sterility. It is of two types:

Primary infertility:- found is persons who have never conceived.

Secondary infertility:- found is persons who have previously conceived.

Infertility in males:- it is due to following reasons:-

a. No sperms (azoospermia) or low sperm count (oligospermia) in semen.
b. Low sperm motility(asthenozoospermia).
c. Defective sperm morphology (Teratozoospermia)
d. Cryptorchidism.
e. Blockage of semen ducts.
f. Kartagener's syndrome-an autosumal recessive disorder in which sperm motility is reduced.

g. High scrotal temperature due to varicocele, hydrocele filariasis, orchitis, tight and warm under garments or working in hot environment causes oligospermia.
h. Inflammation of seminal vesicles, prostate gland and urethra also causes oligospermia.
i. Alchollism inhibits spermatogenesis
j. Kelnefelter's syndrome
k. Gonadotropin deficiency
l. Failure to deposit sperm high in vagina due to abnormally short penis or importancy.
m. Low fructose content, high prostaglandins, high viscosity and low volume of ejaculate leads to male infertility.

"infertility in females":-The various causes of female infertility are:

a. **An ovulation:-**also callednon-ovulation-caused by abnormal functioning of hypothalamus, pituitary gland, thyroid and adrenal glands.
b. Inadequate growth and functioning of corpus luteum. Major reason for this is decrease in FSH and LH level and increase in prolactin level.
c. Failure of ovulation due to hyperprolactenaemia
d. Loss of cilia or blocked lumen in fallopian tube
e. Cysts in ovaries and uterus.
f. Defective uterineendomatrium.
g. Cervictitis, scanty or excess mucus in cervix and presence of antispermantibodies.
h. Defective vaginal growth like imperforated hymen

⇨ Dextamethasone can corest infertility caused by antisperm antibodies.
⇨ Hyperthermiaoligospermy can be corrected by taking regular cold water baths and avoid tight and warm undergarments.
⇨ Impotency can be corrected by taking sildenafil tablets.
⇨ Use of vitamin E,C,B1and folic acid improves sperm count.

ASSISTED REPRODUCTIVE TECHNOLOGIES(ART)

If the infertility is not corrected by the use of hormone therapy , drugs or other traditional treatments, then the childless couples can have the children through ART.the common ARTS are:-

i. IVF-ET (test tube baby)
ii. ZIFT-(zygote intra fallopian transfer)
iii. GIFT-(gamete intra fallopian transfer)
iv. AI- (artificial insemination)

TEST TUBE BABY

Difination:- the technique of in –vitro fertilization (IVF) and in-vitro development followed by the embryo transfer (ET) in the uterus of the normal female to start the development and finally leading to normal birth is called test tube baby.

"History":- An Italian Scientist Dr.Petruce (1959) made the first attempt to produce test tube baby. Although this human embryo survived only for 29 days. The first successful test tube baby named Louise Joy Brown (a baby girl) was born to Lesley and Gilbert Brown on July 25, 1978, in old-ham-England under the medical supervision of Dr.Patrick Steptoe and Dr. Robert Edwards. India's first testtube baby was born on 3rdoct. 1978 in Kolkata. Her name was KanupriyaAggarwal and was produced by Dr.SubashMukherji.

PROCEDURE:-

It involves the following steps**:-**

a. Removal of ovum from reproductive tract of female.
b. Ovum is kept under asceptic conditions.
c. Fusion of sperm of ovum in a culture medium to from the Zygote.
d. Zygote is stimulated to develop in vitro up 32 celled stage.
e. Developing embryo is implanted on the endomaterium of the uterus. So the pregnancy in the women starts and further development of the foetus continues in the womb till it is born.

Significance:-

a. It is a boon to infertile mothers.
b. It can be used for men with Oligospermia
c. Embro can be frozen in liquid nitrogen and preserved for more than 10 years (cryopreservation) for future use.

ZIFT:- (Zygote Intra-Fallopian Transfer)

The technique was developed by Devroey et al(1986).It involves the transfer of either Zygote or embryo at 8 – blastomers stage in the fallopian tube of female through laproscope.

GIFT:- (Gamete Intra-Fallopian Transfer) Asch et al (1984)

This technique is employed for the females whose fimbriae fail to capture ovum or have sperm antibodies in cervical secretion and whose husband is having oligospermia.

This technique involves transfer of washed sperm and harvested ova to the ampulla of the fallopian tube with the help of laproscope. Fertilization occurs in the fallopian tube.

ICSI (Intra-Cytoplasmic Sperm Injections)

In this technique, sperm is directly injected into the ovum in culture medium in the lab and then Zygote or embryo is transfered in the fallopian tube or uterus of the female.

"AI – (Artifical insemination)"

This technique is followed when either the male fails to inseminate or suffers from oligospermia, teratozoospermia or asthenozoospermia. In this technique the semen of male is collected and concentrated and finally introduced into the vagina of female or into uterus and are accordingly called intra- vaginal insemination and intra uterine insemination.

It is of two types:

1.**AIH**:- It is artificial insemination by husband. Here the semen belongs to husband.

2. AID:- It is artificial insemination by donor. Here the semen used belongs to some other person other than the husband. A semen bank is operated by all artificial insemination centres. Here semen of different ethnic groups with all types of blood grouping and Rh typing are kept in frozen state.

"Drawbackes of Assisted Reproductive technologies":-

1. Not possible in females with damaged uterine wall.
2. These techniques need extremely high precision, specialised professionals and expensive instrumentation, so are available only in a few centres of country and only few people can afford.
3. These have raised several ethical, emotional, religious and moral issues in the society.

AIT= Artificial Insemination Technique------ can be of two types; AID & AIH

IVF-ET= In Vitro Fertilization and Embryo Transfer

IUT= Intra Uterine Transfer

IUI= Intra Uterine Insemination

POST= Peritoneal Oocyte and Sperm Transfer

SUZI= Subzonal Insemination

ICSI= Intra Cytoplasmic Sperm Injection

TESE= Testicular Sperm Extraction

MESA= Microsurgical Epididymal Sperm Aspiration

Nullipara (Para O) A women who has not born a viable child.

Cryosurgery:- Destruction of a tissue by application of extreme cold. Instrument used to in providing extreme cold is called cryoscope

.Today in world population is not evenly distributed. Nearly 70% of it lives in less developed countries

EVALUATION

Q NO.1. Answer briefly:

a). Removal of gonads can not be considered as contraceptive option. Why?

b). Amniocentosis for sex determination is banned in our country. Is this ban necessary? Comment.

c). Suggest some methods to assist infertile couples?

d). What are the measures one has to take to protect from contracting STD's?

e). Differentiate between GIFT and ZIFT?

f). Differentiate between tubectomy and vasectomy?

g. Name two STD's which can be transmitted through blood?

h). What are ideal contraceptive methods? Name few.

Q No.2. Correct the following statements :

I). Surgical methods of contraception prevent gamete formation.

II). All STD's are completely curable.

III). In E.T. techniques , embryos are always transferred into uterus.

Q No.3. State true or false with explanation

a). Abortions could happen spontaneously too.

b). Infertility is always due to defects in the female partner.

c). Complete lactation could help as a natural method of contraception.

Q.No.4. Objective type questions:

I). The contraceptive SAHELI (NEET 2018)

a. blocks estrogen receptors in the uterus and prevents implantation

b. increases the concentration of estrogen and prevents ovulation.

c. is an IUD. d. Is a post coital contraceptive.

II). Which of the following STD is correctly matched with its pathogen (NEET 2017)

a. AIDS----------Bacillus anthracis
b. Syphilis----------Treponema pallidum
c. Gonorrhoea----------Leishmania donovani
d. Genital herpes----------Human papiloma virus

III).In context of amniocentosis, which of the following statement is incorrect (NEET 2016)

a. It is usually done when a woman is between 14-16 weeks pregnant
b. Can be used for prenatal sex determination
c. Can be used for detection of Down's syndrome
d. Can be used for detection of cleft plate.

Chapter 2nd Genetics and Evulotion

Determination of Sex:-

Members of almost all species are often divided into two sections according to the kind of gamete or sex cell produced by them i.e., male sex and female sex .The word sexhas been derived from a Latin word *sexus* meaning section or separation. The sex is hereditary difference between two individuals of some species. An animal possessing both male and female reproductive organs is usually referred to as a hermaphrodite. In plants where staminate (male) and pistillate (female) flowers occur on the same plant, the term of preference is monoecious. Most of our flowering plants have both male and female parts within the same flower (called perfect flower). The organisms in which both male and female gamets are produced by different individuals are called dioecious. The sex cells and reproductive organs form the primary sexual characters of the male and female sexes. Besides these primary sexual characters, the male and female sexes differ from each other in many somatic characters known as secondary sexual characters. The phenomenon of molecular, morphological, physiological or behavioral differentiation between male and female sexes is called sexual dimorphism.

The phenomenon of sexual dimorphism has been a biological riddle for the thinkers and biologists of all time. People always tried to know those factors which determine the male and female sexes of a species. Literally hundreds of mistaken hypotheses and wild guesses were proposed before 1900 C.E. in vain attempt to find out a solution to the problem of determination of sex. Modern geneticists have reported many different mechanisms of determination of sex in living organisms. Some important and common mechanism of sex determination are following:

Genetically controlled sex determining mechanism:

Most of the mechanism of determination of the sex are under genetic control and they may be classified into following categories:

1. Sex chromosome mechanisms or Hetero gamets.
2. Genic balance mechanism.
3. Male haploidy or haplodiploidy mechanism.
4. Single gene effects.

1. Sex chromosome mechanism: (heterogamesis):

Discovery of sex chromosomes: In sexually dimorphic dioecious organisms besides morphological and behaviorial differences between both sexes, the sexual diversity also occurs at the level of chromosomes. The chromosomal difference between the sexes of several dioecious species were found earlier in the course of cytological investigation. A German biologist, Henking in 1891 while studying spermatogenesis of the squash bug, *Pyrrhocoris* noted that the meiotic nucleicontained 11 pairs of chromosomes and an unpaired element is moved to one of the poles during the first meiotic division. Henking called this unpaired element a "X body" and interpreted it as nucleolus.

The significance of X body was not immediately understood, but in 1902, American Geneticist Clarance McClung who had made extensive observation of gametogenesis in grasshopper's (*Xiphidium fasciatum*) suggested that X body was involved in some way with determination of sex. He reported that the somatic cells of female grasshopper (Xiphidium fasciatum) contained 24 chromosomes whereas- those of the male had only 23 chromosomes. In 1905, Miss Nettie Stevens found that males and females of the beetle *Tenebrio* have the same number of chromosomes but one of the pairs in males is heteromorphic(of different size).One member of heteromophic pair appears identical to the member of a pair in the female. She called this the X- chromosome. Steven found a similar situation in *Drosophila melanogaster* which has four pairs of chromosomes, with one of the pairs being heteromorphic in males. Likewise Steven andWilson while working with milkweed bug *Lygaeus turicicus*found same number of chromosomes in both the sexes.In female all chromosomes were paired and homologues were equal in size. In the male all the chromosomes were paired, but the chromosomes identified as the homologue to the X- chromosome was distinctly smaller Y-chromosome.

Types of sex chromosomes: - In dioceious organism, thus, two types of chromosomes were recognized which are as follows:

i. Autosomes:- The chromosomes which have no relation with the sex and contain the genes which, determine the somatic characters of the individuals are known as autosomes.

ii. Sex chromosomes: - The chromosomes which are responsible for the determination of sex are known as sex chromosomes e.g., X and Y chromosomes.

Structure of sex chromosome:- The X and Y sex chromosomes exhibit structural differences. The cytological studies have shown that X chromosomes of most organisms are straight, rod like and comparatively larger than Y chromosomes. The Y- chromosome is smaller in size with one end slightly curved or bent to one side in

Drosophila;in human being and *Melandrium* no such curvature of Y-chromosomes occurs. The X- chromosomes have large amount of euchromation and small amount of DNA material, hence much genetic information. The Y-chromosome contains small amount of euchromatin and large amount of heterochramation. The Y- chromosome has little genetic information, therefore, sometimes it is referred to as genetically inert and inactive.

Types of sex chromosomal mechanism of sex determination:

In dioecious diploidic organisms following two systems of sex chromosomal determination of sex have been recognized.

a. Heterogametic males b. Heterogametic females

Heterogametic males:- in this type of sex chromosomal determination of sex, the female sex has two chromosomes while the male sex only one X chromosome. Since male, lacks a X-chromosome therefore during gemetogenesis produces two types of gemets, 50% gamets carry the X-chromosome while the rest 50% gamets lack in X-chromosomes. Such a sex which produces two different type of gamets in terms of sex chromosomes is called heterogametic sex. The female sex producing similar type of gamets is called heterogametic sex. The heterogametic males may be of following two types.

XX-XO type :- in 1902an American Mcclung reported that the somatic cells of female grasshoppers bears 24 chromosomes, whereas those of males had only 23. Thus in many insects there is a chromosomal difference between the sexes, female being referred to as XX having two chromosomes and males as XO. As a result of meiosis all the eggs of such species carry an X-chromosomes, whereas only half of the sperms have one, the other half having none. Since the males produce two types of gamets X or O on in XO type and X and Y in XY type, they are called heterogametic. Femalesare hamogametic producing inly one type of gamete with X- chromosome.

XX-XY type:- in human, other mammals certain insets includimg *Drosophila* and *Lygaeus turicicus* and in certain angiospermic plants such as *Melandriumalbum* (Lychis) *Humlus*l*upulus*, the female possesses two homomoraphic X chromosomes in their body cells (hence, referred to as XX) and they being homogametic produce one kind of eggs, each with one X-chromosome.The males of these organisms possessone X chromosome and one Y chromosom (hence referred to as XY) and they are heterogametic. The males having two heteromorphic sex chromosomes produce two kinds of sperms half with X – chromosome and half with Y- chromosome. The sex of the embryo depends on the kind

of sperm. Ann egg fertilized by an X- bearing sperm, produces a female but, if fertilized by Y-binding sperm, a male is produced.

Heterogametic females: In this type of sex chromosomal determination of sex, the male sex possess two homomorphic X-chromosomes, therefore it is hemogametic and produces single type of gamets (i.e., sperms) each carries a single X-chromosome.the female sex either consists of single X-chromosome or X- chromosome and are Y-chromosome. The female sexis , thus heterogametic and produces two types of eggs, half with a X- chromosome and half without a X-chromosome (with or without a Y-chromosome). To avoid confusion with that of XX_XO and Xy-Xy types of sex determining mechanism, instead of the X and Y- alphabets<,Z and W alphabets are generally used respectively.

The heterogametic females may be of following two types:

1. ZO-ZZ system: this system of sex determination is found in certain moths and butterflies. In this case the female possesses single Z chromosome in its body cells (hence it as referred as ZO) and in heterogematic producing two kinds of eggs, half with a Z chromosome and half without any Z chromosome. The male possesses two Z chromosomes (hence referred to as ZZ) and is homogametic, producing single Z chromosome. The sex of offspring depends on the kind of egg.

2. ZW-ZZ system:- this system of sex determination occurs in certain insects (gyphy moth) and vertebrates such as fishes, reptiles and birds (foul or gallis domestician) and plants such as fragarius elatior. Here the female sex has one chromosome and one W chromosome while rest 50% carry W chromosome.

   The male sex has two homomorphic Z chromosomes and is homogametic producing single type of sperms, each carries a Z chromosome. The sex of the off sprigs depends on the kind of egg, the Z bearing eggs produce males but the W bearing eggs produce females.

   Genic Balance Mechanism:-By studying sex chromosomal mechanism of sex determination, it may appear at first glance that some genes carried by the sex chromosome (X and Y) were entirely responsible for sex. But this is not the case. Extensive experimentation of different workers (Wilson 1909, Bridges 1921) and Goldschmidt,1934) on different organisms generally have revealed the fact that most organisms have rervealed the fact that most oorganisms generally have inherent potentialities for both sexes and each individual is found to be more or less intermediate betweenmale and female sexes(Hence may be referred to an intersex).There seems to exist a delicate balance of masculine and feminine tendencies in the hereditary compliment of an individual and mechanisms like the XY, ordinarilyserve to trip the

balance is one direction or another. Such genic balance mechanism of determination of sex was first of all studied in *Drosophila*by C.B.Bridges in 1921.

Sex determination in human beings:-

In human beings like drosophila XX-YY type sex determination mechanism occurs but here the Y- chromosome contains potent male sex- determining genes which can almost completely overcome the feminizing action of the rest of the genotype. The conclusive evidence that Y-chromosome is a determine of frequently and sex of male individual came from

certain abnormal conditions called syndromes which contained aneuploidic sex-chromosomal abnormalities.For instance turners syndrome XO are sterile females individuals having certain abnormalities such as short stature,congenital malformations,shield chest,pronounced webbing of the neck,short fourth metacarpal,colour blindness etc.Similarly Klinefelters syndromes (XXY) are males,despite the presence of two two X chromosomes.. A person with extra one X and Y chromosomes display true hermaphroditism having both ovarian and testicular tissues and variable degrees of intersexual development of the genitals.

DOSAGE COMPENSATION OF GENES:

The term dosage compensation was coined by Muller (1932) and this phenomenon was originally discovered in Drosopila. Dosage compensation of the genes is done either by hypo production due to inactivation of one X chromosome in homogametic female sex, as observed in mammals, or by the hyperproduction due to hyperactivity of X- chromosome in the heterogametic male sex as observed in *Drosophila*.

In homogametic XX female individuals, one x gets characteristically condensed and inactivated.Such chromatin materialis called facultative heterochromatin ,since it becomes inactive in certain part of the life cycle and resumes activity before entering the germ line.The phenomenon of inactivation of x chromosome was confirmed by the observation of the Barr Body. Human females have the Barr body in the nuclei of their body cells in higher proportion than males and are,

therefore referred to as Sex chromatin positive .the human males are called Sex chromatin NegativeFormation of sex chromation is a mechanism of dosage compensation in females to equalize gene expression similar to males who have only one X- chromosome. However any of the two X-chromosomes can become heterochromatic. So that at time a mosaic pattern of development can occur in females. The number of Barr body is one in normal females. It is one

less than the number of X- chromosomes(e.g. two in XXX super female.)In males Y chromosome is also largely heterochromatic in its long arm. It can be stained with quinacrine mustard. The stained Y chromosome is called Y spot. Its number is equal to Y chromosome i.e. one in normal male and two in XYY super male.

Sex determination in Honey Bee: Male haploidy or arrhenotkous parthenogenesis is particularly common in a hymenopterous insects such as ant , bees, warps. In these insects since fertilized eggs develop into diploid females and unfertilized one into haploid males, so arrhenotoky is both a form of reproduction and means of sex determination. Meiosis is normal in females but crossing over and reduction in chromosome number fail to occur during spermatogenesis in males due to their haploidy.

For example, a honey bee queen whose diploid number is 32 can lay two types of eggs. By controlling the sphincter of her sperms receptacle which holds sperm previously obtained in mating with males during nupital flight, she produces a fertilized egg (a diploid zygote having 32 chromosomes and developing into female) or an unfertilized egg (a haploid zygote having 16 chromosomes and developing into a male). The diploid female zygote can differentiate into either workers (sterile) or queens (fertile) depending on pheromones and diet they consume during their development.

Sex determination in human beings:

Sex has the genetic basis. Genes determining the sex in human beings are located ona special pair of chromosomes. They are called sex chromosomes. Accordingly, the 23 pairs of human chromosomes can be divided into two groups:

1. **Autosomes**:- the 22 pairs of chromosomes carry genes for body characters and general physiology.
2. **Sex chromosomes**: - One pair of chromosome carries genes for the determination of the sex. These are represented by X and Y chromosomes. X chromosomes contains gene that determine female sex. Y chromosome contain gene for male sex. In humans, sex determination is of XX-YYtype. female is homogametic producing only one type of gametes (ova) each containing one X chromosome male is heterogametic, producing two types of sperms, half carry X and other half carry Y chromosomes.

Man (heterogametic)	Woman (homogametic)
44A +XY	44A+XX
Sperm 22A+X	ova 22A+X
22A+Y 22A+X	

Sperm		Ova
	22A+X	22A+X
22A+X	44A+XX Girl	44A+XX Girl
22A+Y	44A+XY Boy	44A+XY Boy

Role of Y chromosomes:-

For a long time there had been a search for a single gene, a **testis determining factor(TDF)** located on Y chromosome that acts as a sex switch to initiate male development. Human embryologists had discovered that during the first month of embryonic development, the gonads that develop are neither testes nor ovaries but instead indeterminate.At about six or seven weeks of development, the inter determinate gonads become either ovaries or testes.

In 1991,Robin Lovell- Badge and Peter Goodflow isolated a gene called sex-determining region--- (SRY) sry in mice- adjacent to ZFY gene.Sry has been positively identified as the testis- determining factor because when injected into normal XX female mice, it caused them to develop as males. Although these XX males were sterile,they appear as normal males in every other way.

The Sry protein appears to bind to at least two genes. One, the P450aromatase gene has a protein product that converts the male hormone testosterone to a female hormone estradiol, the Sry protein inhabits production of P450 aromatase enzyme. The seconD gene affected by the Sry protein is the gene for the Mullerian inhIbiting substance which induces testicular devevelopment and the degression of female reproductive duct; this gene's activity is enhanced by the Sry protein. Thus the SrY protein points an indifferent embryo toward maleness and maintenance of testosterone production.

In humans the key gene for the testis determining factor resides on the short arm of Y- chromosomes. The position of this testis- determining gene has been narrowed down to a 35000 base pair region of Y- chromosome located near the top of the short arm.In this region Sinclair and colleagues 1990 found a male specific DNA sequence that could encode a peptide of 223 aminoacids. This peptide is probably a transcriptional factor, since it contains a DNA- binding domain called HMG (high modality group) box. This domain is found in several transcription factors and nonhistone chromatin proteins and it induces bending in the region of DNA to which it binds. This gene is Called SRY (sex determining region of Y- chromosome). Other gene found involved in determination of human male sex include SOX9 autosomal gene,SF1 gene and DAX1 gene.

GENETIC DISORDERS:

(Mendelian Disorders)

In Mendle's crosses it was observed that the progency of a cross between two individuals of pure lines is the same regardless of which individual is female and which individual is male or we can say that sex makes no difference in Mendle's crosses. Mendle's laws are not applicable on those genes which are located either in X or Y chromosomes. The genes occurring in only X chromosomes are represented twice in females (because female contains 2 x chromosome)and once in male because male has only one x chromosome.Moreover if the recessive type of genes occur In X chromosome of males, they express themselves phenotypically. In such a case Y chromosome contains no dominant allelomorph or gene to overcome the recessive gene of X chromosome. The genes which occur exclusively on the X chromosome are called X linked genes. The genes which exclusively occur in Y chromosome are called Holandric genes. The inheretence of X or Z linked and holandric genes is called Sex linked inheritance.Any gene mutation on such chromosomes leads to the disorders called as Mendelian disorders .Some of them found in humans are mentioned here. In the XX –XY type organism, sex linked genes can be classified into three types:

1. X linked
2. Y linked
3. XY linked

X- Linked recessive gene Inheritance:

In human beings more than 150 confirmed orhighly probable X linked traits are known, most of these are recessives. Certain well known examples of X linked recessive gene in human beings are those for red-green colour blindness, haemophilia and Duchenne's muscular dystrophy. Some other examples of X linked recessive traits include:

1. Deficiency of enzyme glucose 6 phosphate dehydrogenase(G6PD deficiency) in erythrocytes causing haemolytic anemia during allergy reaction of persons for the drugs such as sulphonamides.
2. Two forms of diabetes insipidus.
3. One form of anhidrotic ectodermal dysplasia (absence of sweat glands and teeth).
4. Absence of central incisors.
5. Certain forms of deafness.
6. Spastic paraplegia. i.e(tetanoid or partial paralysis of lower extremities with increased irritability and spasmodic contraction of muscles.
7. Un controllable rolling of the eye ball (nystagamus).
8. A form of cataract.
9. Night blindness.
10. Optic atrophy.

11. Juvenile muscular dystrophy.
12. White frontal patch of hair.

1. Colour blindness:- In human beings, a dominant X-linked gene is necessary for the formation of the colour sensitive cells, the cones in the retina of eye. According to trichomatic theory of colour vision there are three different types of cones, each with its characteristic pigment that reacts most strongly to red, green and violet light. The recessive form of this gene (i.e. presence of recessive X linked allele for colour blindness) is incapable of producing the colour sensitive cones and the homozygous recessive females(x^cx^c) and hemizygous recessive males (X^cY) are unable to distinguish between these two colours. However the frequency of colour blind women is much less than colour blind men.
2. Deutan colour blindness: - Also known as Deuteranopia. There are two closely linked gene loci each with several multiple alleles controlling the colour blind trait. Lack of the chloroble pigment in the retinal cones result in an inability to discriminate green colours. This defect is known as Deuteranopia or Deutan colour blindness. It affects about8% of human males but only 0.7% of females.
3. Protan colour blindness:- Lack of erythrolable pigment necessary for discrimination in red end of the spectrum results in protanopia. This abnormality is much less, than Deutan type occurring in only about 2% males and in only 4% women out of 10,000.
4. Haemophilia: It is the most serious and notorious disease which is more common in men than women. This is also known as bleeder's disease. The person which contains the recessive gene for hemophilialacks in normal clothing substance(thromboplastin) in blood so minor injuries causes continuous bleeding and ultimate death of the person due to haemorrhages. The hereditary disease was reported by John Cotto of Philadelphia in 1803 in man. Recently two types of X linked hemophilia have been recognized.

    a. Hemophilia A: - It is characterized by lack of antihaemophilic globulin (Factor V111).About four-fifths of the cases of haemophilic are of this type.
    b. Hemophilia B:- It is also called as 'Christmas disease' after the family in which it was first described in detail. Hemophilia B results from a defect in plasma thromboplastic component(factor IX) .This is milder form of hemophilia

        Wouldliff and Jackson in 1966 have found the occurrence of the both types of hemophilia in an unusual family, both segregating independently therefore they concluded that the twoloci (i.e., hemophilia A and hemophilia B) were far apart on the X chromosome that is having a distance of more than 40 map units between them.

        Hemophilia is well known in the royal families of Europe, where it is traceable to Queen Victoria of England who must have been heterozygous (carrier). No hemophilic is known in her ancestory, hence it is concluded that her hemophilia allele

arouse form a mutant gamete. Since it is caused by recessive X linked gene, a lady may carry the diseases(i.e. she is carrier but not sufferer and would transmit it to 50% of her sons even if the father is normal.

Parents XX^h (mother)x XY(father)

Normal carrier Normal father

Gametes X X^h X Y

Progeny ¼ XX = normal daughter

¼ XX^h = normal but carrier daughter

¼ XY = normal son

¼ X^hY= haemophilic son

HUMAN GENETIC DISORDERS

Genetic disorders are the defects which are caused by a one or more abnormalities in the genome. They are caused by a mutation in a single gene or multiple genes or by a chromosomal aberration. Several human genetic disorders seem to be inherited like mendalian genes thus called as Mendelian disorders. They are caused by mutations in their genes with pathological consequences. The other genetic disorders caused by chromosomal aberration and anomalies are known as chromosomal disorders. They do not follow mendelian pattern and are caused by mainly defectivesynapsis and disjunction during meiosis.

Some of the chromosomal disorders/aberrations are briefly mentioned as:

A. Autosomal Trisomy:
   1. Downs syndrome (Ds or tresomy-21)

   Down's syndrome is named after the physician J. Langdon Down who first described this genetic defect in 1866 and it was formerly called mongolism or mangolian idiocy. It is usually associated with a trisomic condition for one of the smallest human autosome (i.e. chromosome 21). It is the most common chromosomalabnormality in live births (1/650 births). There are about 50 physical characteristics known by DS infants soon after birth.

These include mild and moderate mental retardation . Eyes that slant up and out with internal epicenthal folds, a tongue that is large swollen and protruding, small and under developed ears, a single palmar crease, short stature, stubby fingers, an anlarged liver and spleen. Women over 45 years of age are about twenty times more likely to give birth to a child with DS than women aged 20. Non disjunction of chromosomes pair 21 during oogenesis is the main cause of occurrence of trisomy- 21. This event is found to be affected either by senescence of oocytes virus infection, radiation damage etc(e.g mothers who has had infectious hepatitis prior to pregnancy may have three times more chances to give birth to DS infants. Non- disjunction of chromosomes pair 21 during spermatogenesis can also produce children with DS, but paternal age does not seem to be associated with its incidence.

B. Sex Chromosomal Trisomy:

1. Turners syndrome: (XO females):- A female with 44 autosomes and only with one X chromosome in her body cells exhibits symptoms of turners syndrome. Such females are sterile and have short stature webbed neck, a low hairline on the nape of the neck, broad shield shaped chest, low intelligence, underdeveloped breasts, poorly developed ovaries sparse pubic hairs and no axillary hair.

2. Klinefelter'sSyndrome-(XXY males) When an abnormal egg with XX chromosomes is fertilized by a sperm carrying Y chromosomes, A zygote having three sex chromosomes (XXY) chromosomes is formed. The resulting young one is an abnormal sterile male showing the following features: small testicles, mental retardation, longer arms, feeble breasts called gynaecomastia, high pitched voice and sparce body hairs.

Genome mapping (Human Genome Project):

The most significant advances in genetics have come form the publication of complete sequence of chromosomes and entire genome in 1990s.The first eukaryotic chromosome to be compleletly sequenced was chromosome 3rd of yeast published in 1992 .By February 2001.about 96% of euchromatic region of human genome was sequenced.

Human Genome Project is the most ambitious and exciting scientific undertaking by human being. This is an undertaking by many countries (administered jointly by the National Institute of Health and Department of Energy USA) to acquire complete knowledge of the organization, structure and function of human genome. It Is aimed at finding out all the genes in each of the human chromosome (and ultimately of other organism to determine their function, and

hopefully to understand how they together form the complete organism. The human genome project began on October 1,1990.This is regarded as the most ambitious project. The strategy of genome project may be grouped into the following three stages:

1. Mapping:- The first major goal of the project is to prepare high resolution orsaturated genetic and physical maps of human genome. Molecular markers have been used to produce maps of all human chromosomes in which markers are located only a few Cm apart. By August 2000, over 9300 markers had been maped to particular chromosomes. Therefore any new DNA sequence that(i.e., an additional marker)can be easily linked with these markers.

2. Sequencing:- the DNA fragment used for sequencing obtained by Short gun approach in which DNA fragment generated from a given source for example whole genomic DNA,a YAC or a cosmid clone are cloned and sequenced at random. As a result,a DNA fragment is ordinarily sequenced more than once, and the various fragments sequenced belong to random locations in the DNA source. Therefore integrating sequence data into correct order to obtain the sequence of the entire DNA molecule is a huge task even with the enormous computer capacities available at the movement.

   Another approach to sequencing is to create the series of contigs before sequencing. A contig consists of a series of recombinant clones that contain over lapping DNA inserts covering a specific region of a chromosome or even a chromosome. The member clones of a contig are sequenced individually and aligned properly to yield the sequence of the concerned chromosome/chromosome region. The approach facilitates proper alignment of sequenced pieces but creation of cotigs itself is time consuming.

   Both the approaches have been successfully used to sequence the human genome. The draft sequence of human genome was published in June 2000. As on April 2003 about 99% of the Euchromation part of human genome had been sequenced with 99.9% accuracy.

3. Functional analysis:- The ultimate objective of the genome project is to decipher the function pf each of the 30000 or so genes estimated to be present in the human genome. This is most challenging task and may take many decades. There are three general approaches for the functional analysis.

a. Analysis of cDNA clones from specific tissues e.g brain, each cDNA clone is sequenced only for a short region which provides an STS (expressed sequence tag EST) for the concerned gene as well as enough base sequence data to decide If the gene is new or already known.This way it should be possible to determine the tissue specific and ubiquitous (functional in all tissues) genes and also to map these genes

b.The sequence data may be analyzed using a computer to identify the genes present in the genome.

Finally (c) the gene function has to be determined by studying the effects of mutation, extensive mutant libraries are being created for this purpose.

Interesting features of human genome project:

1. There are 3.1647 billion base pairs.
2. The total number of genes is about 30,000 six times the genes contained in *E. coli.*
3. The function of over 50% of the discovered genes is unknown.
4. Within the human population are millions of single base differences called single nucleotide polymoprphism (SNPs). Each human differs from other by about 1pb in every 1000bp.
5. The length of different human genes varies widely. The average size is 3000 bp the longest gene of human body is that of Duchenne Muscular Dystrophy on X chromosome. It is 24000 kilo base pair long. The smallest gene is that of Testing Determining Factor (TDF) a holandric gene present on Y chromosome. It is only 14 base pair long.
6. About 99.9% nucleotide bases are exactly similar in all human beings.
7. Large amount of human genome is constituted of repeated sequences. Chromosome 1 bears maximum genes 2968 with chromosome Y having lowest 231.

HGP has been called a mega project due to:

1. Huge cost estimation about 9 billion dollars.
2. Base pairs identified and sequenced ($3x10^9$ bp).
3. Involvement of large number of scientists, technicians and supporting staff.
4. Storage of data generated which requires some 3300 books each with 1000 pages and each pages having 1000 typed letters. However high speed computational device for storage retrieval and analysis of data made it easier to do the same.

Prospectus and Implications of H.G.P

The Prospectus and implications of H.G.P are quite bright and we see many great prospectus attached with the project. We look forward to mapping of human genes, all sequences ,transposons and junk DNA . In future we may be able to treat the diseases like Alzheimers, Neurological disorders , Cardio vascular ailments ,Endocrine diseases. Since there are 1200 genes effected with such disorder /diseases .we may also be able to understand the interaction between various genes , proteins as well as forming tissues organs, tumors or switch over to different development stages.

Note: For detailed study of the techniques involved in *GenomeMapping* following books can be studied:

1.Biotechnology by B D Singh Published by Kalyani PublishersNew Delhi

2.Genetics by P. S. Verma Published by S Chand New Delhi

DNA Finger Printing

Definition: Technique of using DNA fragments, resulting from restriction endonuclease enzyme cleavage to identify particular individual is called DNA finger printing.

Introduction: The DNA finger printing technique was developed by Alee Jfferyery(1985,86) at Leicester university, united kingdom. Every person has specific pattern of DNA sequence which shows a combination of DNA sequence of both mother and father. Study of DNA finger prints helps in establishment of identity of a person, identification of criminals in case of murder or rape, and parental test in case of disputed parentage. This technique helps in identification even when the stains on victims clothes etc are even several years old.

Principal: Genetically every individual is unique since 0.1% of genome or $3x10^6$ differences occur in the base sequence of human beings. The difference occur not only in genes but also in repetitive DNA. It is also called satellite DNA because in density gradient centrifugation it forms small peaks while bulk DNA produces a major peak. On the basis of composition(A:T rich C:G rich) length and number of repetitive units satellite DNA is of several types like microsatellite and macrosatellite.

DNA of each individual has some non cistronic hyper variable repeat minisatellite sequence. They have core units of 11-60base pairs and are flanked by conserved restriction sites. They are called as VNTR. The VNTRs differ in families, are similar at certain sites and different at other sites. The reason being that a child inherits 50% of the chromosome from mother and the remaining 50% from father VNTR'S face deletion, inversion and other types of mutation.

VNTRs are located in the region of satellite DNA and is therefore the source of VNTR or RFLP.

The number of VNTR'S in a particular area of two homologous chromosomes or DNA molecule are likely to be different. As a result each individual comes to have a distinct combination of VNTRs or RFLP being unique to that person.

VNTR LOCI AND ALLELES

The specific site at which a VNTR sequence is present constitutes a VNTR locus. The different alleles of this locus consists of different numbers of the repeating unit of this VNTR sequence the number.The most polymorphic human VNTR locus is *MSI* locus; the number of tandem repeat at this locus ranges from 200 to 2000, the repeat unit being GTGGAYAGG where Y represents a pyrimidine viz T or C. The different alleles of VNTR locus are detected either as an RFLP or through PCR. Microsatellite are now used as PCR based Markers. For this the sequence of unique DNA located on both sides of repeat are determined and used to construct two PCR primers for flanking unique reasons . These primers are used for PCR amplification of the mini or macro satellite repeat; the amplification product is expected to be of different lengths in different individuals and would be detected as distinct bands following gel electrophoresis.

Preparation of the DNA sample:

Common sources of DNA include blood, semen, solid tissues, blood stains, semen strains, hair roots,buccal cells of saliva etc. Contamination and DNA degradation due to DNase should be avoided. Cells may be lysed with sodium dodecyl sulphate (SDS) and proteins digested with non specific protease, e,g proteinase K.Repeated extraction with phenol and chloroform precipitate cellular debris leaving the DNA in the aqueous phase.dna can be precipitated by the addition of ethanol .In case of mixed specimens,suitable separation procedures should be used to separate the constituent cells. DNA degradation is estimated by electrophoresis in agarose gel, staining with ethidium bromide and observation under UV light.High molecular weight DNA appears as a single large band,whereas degraded DNA forms a large smear.

DNA Profiling:

The DNA is analyzed on the basis of either RFLP(probe hybridization) or PCR. The RFLP analyzes are of following two types (1) Multi locus polymorphism (MLP) and (2) Single locus polymorphism (SLP) analyses. The PCR analyses are also of two types as follows (i) STR analysis and (ii) minisatellite variant repeat (MVR) mapping.

Multilocus Probe(MLP)analysis: In this method the DNA is digested with the selected restriction enzyme, subjected to agarose gel electrophoresis, the fragments are denatured by alkali treatment, DNA is transferred onto a Nylon membrane, and fixed to the membrane by exposure to a measured amount of short wave UV light. The commonly analyzed minisatellite regions

generate fragments of 1 to 20 kb.The resolution of the system is not sufficient to distinguish fragments that differ by a few repeats as a result, it is very difficult to define all the alleles that may exist at a VNTR locus. The hybridization is carried out under condition of low strigency, i,e., higher salt concentration and lower temperature. This allows the probe to hybridize not only with DNA fragments that are strictly complementary to the probe,but also with those fragments that have similar related sequences. Thus many different fragments are detected and a' bar code' type of band pattern is produced. The bands that hybridize with the probe are detected by autoradiography or chemiluminescence (due to alkaline phosphate attached to the probe).It should be noted that probe is synthetic DNA fragment and is radioactive.It helps in identification of VNTRs.

PCR Analysis of Short Tandem Repeats (STRs)

Use of PCR amplification for STR sequence analysis is faster, much more convenient and highly reliable. Such STR may have as many as 10 different alleles in the human population. The two primers used for PCR anneal to the unique DNA sequences located just outside the STR sequence. The PCR products are subjected to agarose gel electrophoresis and amplification products of different STR alleles appear as distinct bands on the gel. Each individual is likely to have two alleles at an STR locus since there are two homologous for each chromosome. It is necessary to analyse 9 or 10 loci in order to arrive at unambiguous conclusion. The PCR method is (i) very sensitive and it can generate results from very minute amount of DNA obtained from even such specimens as hairs and saliva stains on cigarette butts. (ii) The results are obtained rather quickly. (iii) PCR analysis could be done even when DNA is fragmented into short lengths, e.g., DNA from bones that have been buried for many years.(iv)a single multiplex PCR reaction enables analysis of a series of several STR loci.

Interpretation of Result: In the case of MLP method the bands from DNA recovered from the scene of crime are compared with those from the DNA of the suspect previous experiments have shown that the chance of two unrelated individuals having a band in common is 0.25. Therefore the probability of two individuals sharingthe complete MLP profile will be $0.25^{n,}$ where n is the total number of clearly visible and matching bands in the profile. In the given figure the profile from accused matches completely with that obtained from the semen recovered from victim. The profile has 17 distinct matching bands, therefore the probability that the accused is not the actual criminal will be 0.25^{17} (one in ~16.4 billions).

VNTR: It is natural small sequence of DNA. It is non radioactive. It helps in identification of genes.

PROBE: It is synthetic DNA fragment. It is radioactive and helps in identification of VNTRs

Application of DNA profiling

In case of human beings some of the important applications of DNA profiling are listed below:

(i) It is extremely valuable in clear identification of victims of crimes or accidents.
(ii) DNA profiling can be used to infer if two or more individuals are members of same family, this is called kinship analysis. The major day to day application of this analysis is to test if a given male is the father of given child.
(iii) It can be used for identification of sex of an individual by using a pair of primers that amplify a sequence that is specific to the Y chromosome.
(iv) Certain ethnic groups have specific alleles that provide that group resistance or proneness to various diseases. It is used in gene therapy.

Origin of life (Chemical Evolution of life)

It is generally agreed by astronomers, geologists and biologiststhat earth is some 4.5-5.0 x 10^9 years old. Many biologists believe that original state of the earth bore little resemblance to its present day form and had the following probable appearances.: it was hot (about 4000-8000^oC) and as it is cooled carbon and the less volatile metals condensed and formed the earth's core: the surface was probably barren and rugged as volcanic activity, continous earth movements and contraction on cooling, folded and fractured the surface.

In 1920's a new interest in the origin of life arose from independent speculation of two biologists **A.I Oparin and J.B.S. Haldane** , both these scientists got the ideas from the new bio-chemistry that was founded by sir F.G Hopkins. They were of the opinion that the evolution is purely chemical- the gradual transmutation of inorganic compounds into organic ones.

After 1920's the subject of the life attracted ever increasing interest. Pirie coined the term **biopoiesis** for the study of the origin of life. Oparin first of all gave the scientific account of the origin of life in his book entitled "**The Origin Of Life**"which was published in 1936. The main postulates of his hypothesis are mentioned as:

1. a) **Origin of earth:-**

The earth is presumedto have originated about 5-6 billion years ago. There are two hypothesis for its origin 1) **Planatesimal hypothesis** believes that the earth is originated as a part broken off from the molten mess of sun.

2) Nebular hypothesis. According to this hypothesis the earth is originatedby general condensation of interstellar dust from which entire solar system is supposed to be formed. At that time temperature was extremely high which served as basis of primary origin of organic compounds on earth**.**

b)Presence of elements on earth:-

In the beginning the earth was fiery spinning ball ofhotgases and vapours of elements. Gradually, through hundreds of millions of years, the gases condensed into a molten core and different elements got stratified according to their density. The heavier elements (e.g., nickel, iron) passing to the core, intermediate to middle (e.g., silicon, aluminum) while the lighter ones remained on the surface and the atmosphere. The surface being very hot, the lighter elements occurred only in their atomic state. They included hydrogen, carbon, nitrogen and oxygen.

2. **Formation of early molecules:-**

With slight decrease in the surface temperature of theearththe lighter elements interacted to form water H_2o methane (CH_4)

Ammonia (NH_3), carbon monoxide (CO), carbon dioxide (CO_2) and hydrogen cyanide HCN. Metal carbides , nitrides and oxides also formed on the surface of earth. There was no free oxygen so theprimitive atmosphere was reducing. These compounds were called **protoplasmic compounds**. Atmosphere did not contain ozone layer. Therefore ultraviolet radiation reached the surface of earthfreely. The later became solidified developing a number of depressions and elevations.

Meanwhile the atmospheric water vapours condensed and finally came to the surface as rain. Water collected in the depression, dissolved the minerals and finally formed large sized water bodies and oceans.

Formation of simple organic compounds:-

As the earth surface cooled to the 50-60^o c, molecules and minerals present in the water bodies combined and recombined in various types through the process of condensation, polymerization and oxido- reduction to form simple organic compounds like alcohols, aldehydes, glycerol, fatty acids, purines, pyrimidines, simple sugars (e.g. ribose, deoxyribose, glucose etc) and amino acids. These organic compounds accumulated in the water bodies because their degradation was very slow in the absence of any consumer or enzyme catalysis or absence of oxygen. Such transformation is not possible in the present oxidizing atmosphere because oxygen or microconsumers will decompose or destroy the living particle that may arise by mere chance.

The energy for these photochemical reactions was provided by one of the following factors:

1. Volcanic eruptions
2. Solar radiation (UV-rays)
3. Electrical energy produced during lightening and
4. Decay of radio-active elements.

Haldane proposed that these simple organic compounds gradually accumulated in these water bodies and finally a "hot thin soup" or free "biotic soup" or both were formed. This set the stage for the chemical reactions.

Formation of complex organic compounds:-

Simple organic compounds showed chance chemical reactions and polymerization to finally form complex organic compounds like polysaccharide, fats, nucleotides, nucleic acid, polypeptides etc. Main energy sources for chemical reactions and the formation of polymers were: electrical discharge lighting, solar energy ATP and pyrophosphates.Evaporation of water led to concentration of monomers and favoured polymerization.These polymers were more stable so these dominated in the water bodies. High concentration of the polymers shifted the chemical equilibrium towards the formation of stable polymers from unstable monomers.

Experimental proof:-

Stanley Miller and his teacher **Harold Urey** in 1953 devised an apparatus that simulated the conditions of the surface of the pre-biological earth and analyzed the molecular forms that arouse. They took **ammonia**, **methane** and **hydrogen** (in the ratio **of 2:2:1**) and **water** in a sterilized apparatus having a spark chamber with two electrodes (to provide electric energy) of 75000 volts, simulation of lighting) a flask for arrangement of boiling (by heating to 800^{o}c, simulation of evaporation) a tube with condenser for condensation (simulation of rain) and a trap for collection of aqueous solution. The materials and conditions resembled those present on early earth. The experiment was continues for eighteen days after which the contents of the apparatus were analyzed. A number of simple organic compounds were present- Some 15 amino acids (e.g. glycine alanine, aspartic acid, simple peptide chain, organic acids (acetic, propionic, lactic acid succinic) purine,adenine and ribose sugar. A control experiment was also set up but it lacked the source of energy (electrode) no significant amount of organic molecules was produced. Miller experiment was repeated by many subsequent workers with different source of energy (e.g. UV radiation) with slightly different starting material. Amino acids and other organic compounds were formed.

Conditions for origin of life:

For the origin of life from pre biotic molecules, three conditions must be fulfilled:

1. Presence of replicators or self-producing molecules.
2. Mutations in replicators

3. Perpetual supply of free energy and partial separation of replicators from general environment. Mutations could have been abundant due to high temperature and U.V radiation.

Main factor responsible for mutations in the replicators (prebiotic molecules) was probably thermal motions induced by high temperature. While the partial isolation has been attained within their aggregates. **Oparin** and **Sydney Fox** proposed that complex oeganic compounds synthesized abiogenetically on the primitive earth later tended to accumulate and formed large colloidal cell like aggregates called protobionts. Such first non-cellular forms of life probably originated 3 billion years back. Three types of protobionts were formed.

1. **Coacervates**: Aggregates of protein and polysaccharide with covering of water shell. Exhibited simple form of metabolism with no reproduction, no lipid layer.

2. **Microspheres**: Small spheroidal biochemical aggregates whose covering membrane was a lipid bilayer if mixture contained lipids, these could grow constrict and divide. However they had limited diversity.

3. **Vesicles**: The fusion of coacervates and micro spheres formed complex protobionts called vesicles (Daemer 1993).

Formation of Protocells:A lipoprotein covering enclosed the protobionts, proteins also got associated with them. So chromophores developed which absorbed light energy and transfered the same to the interior. An electric potential also developed across the membrane. The first information molecules replicators as well as enzymes were RNAs. Early biological world was RNA world where RNA functioned as both genetic and catalytic material. Replication of RNA was accompanied by division of eobionts. It is probable that

Viruses developed simultaneously with the evolution of protocells. Later on DNA evolved as genetic material. Protocells were preliving system which had machinery to perform several reactions, grow and divide. Viruses are considered to be protocells .

The Earliest Cells:(First living beings) They evolved about3900-4000 million years back in soupy sea where temperature had gone below 50 degree C. Atmosphere continued to be reducing due to absence of oxygen. Protocells collected more organic substance, formed cytoplasm or cellular machinery and became first living beings. The first living beings were single celled prokaryotes. They had naked DNA, protein forming machinery, mode of liberation of energy and its utilization. The first prokaryotes were anaerobes and chemoheterotrophs. They absorbed organic molecules from outside for body building and energy.

Autotrophism:-

1. **Development of Chemoautotrophs**: Drop in temperature stopped synthesis of organic molecules in the water bodies. Organic content of primordial soup decreased due to continuous withdrawal by chemoheterototrophs. Some of the early prokaryotes got converted into chemical chemoautotrophs. They developed the ability to synthesise organic materials from inorganic raw materials with the help of energy obtained from reduced inorganic substances of the medium. Some present-day chemoautotrophs are iron bacteria, nitrifying bacteria ,sulphur bacteria.
2. **Development of Photoautotrophs:-** Pigments evolved which could trap solar energy. The absorbed energy could be used in various reactions. Certain prokaryotes developed bacteriochlorophyll and later chlorophyll. The pigment could trap solar energy which could be used in synthesis of organic
3. Material from inorganic substances. The process is called **photosynthesis**. The first photoautotrophs were anaerobic and performed anoxygenic photosynthesis.Hydrogen was obtained from source other than water. All present-day photoautotrophic bacteria are anoxygenic e.g., *ChlorobiumRhodospseudomonas*. Aerobic photoautotrophs developed around 3300-3500 million years ago in the form of cyanobacteria or blur-green algae. They performed oxygenic photosynthesis using water as hydrogen donor and liberating oxygen. Fossils of these cyanobacteria or blue green algae have been found in rocks as old as 2.9 billion years old, e.g., *Archaespheroides barbertonensis*. In India 3.2 billion years old fossils of photosynthesis blue-green algae have been found from Kashia region of Odisha. Oxygen accumulated in the atmosphere. The latter became oxidising. Methane and ammonia disappeared because they reacted with oxygen to form $CO_2$and N_2 respectively. High energy radiation in the upper layer of atmosphere changed some of the oxygen onto ozone ,$3O_2$changed to$2O_3$. Ozone formed a shield that protects the living beings from UV radiations.
4. **Development of Eucaryotes**:- Eucaryotes (with distinct nuclei) evolved around 1600 million years back. They came into existence due to (i) Evolution from prokaryotes through mutations (Raffand Mahler, 1972). (ii) Symbiotic association of different types of prokaryotes (Marguilis, 1970).In this way life originated and gradually progressed on this planet earth.

Darwinism (Theory of Natural Selection):1809-1882

Introduction: Charles Darwin (1809-1882) an English naturalist was the most dominant figure among the Biologists of the 19th century . He made an extensive study of nature for over 20 years especially in (1831-1836) when he went on a voyage on the famous ship "H.M.S Beagle" and explored south America , the Galapagos islands and other islands. He collected the observation on animal distribution and the relationship between living and extinct animals. He found that existing living forms share similarities to varying degrees not only among themselves but also with the life forms that existed millions of years ago. Some of which have become extinct .He stated that every population has built in variation in their characters .From the analyses of his data of collection and from Malthus's Essay on population ,he got the idea of struggle of existence within all the population due to continued reproductive pressure and limited resources and that all organisms including humans are modified descendents of previously existing forms of life. In 1858 CE Darwin was highly influenced by a short essay entitled "On THE Tendency of Varieties to Depart Indefinitely from the Original type" written by another naturalist Alferd Russel Wallace (1812-1913) who studied biodiversity on Malayan archipelago and came to similar conclusion.

Darwin and Wallace's views about evolution were presented in the meeting of Linnean society of London by Leyell and Hooker on July 1,1858 . Darwin and Wallace work was jointly published in "Proceedings of Linnean Society of London" in 1859. So it is also called Darwin Wallace Theory. Darwin explained his theory of evolution in a book entitle'On the Origin of Species by means of Natural selection. It was published on 24th Nov 1859. In this theory Darwin proposed the concept of natural selection as the mechanism of evolution.

Features:

1. Overproduction: Organisms have a very high reproductive potential and capacity to multiply in geometric ratio, for example at 2.000% growth human population doubles every 35 years. An oyster forms 60-80 million offspring in one generation. In just 5 generation the volume of oysters can equal to 8 times the volume of earth. In 10 years a single pair of English sparrow would produce 275 billion individuals. After 5 years a single paramecium would produce descendants equal to 10000 times the volume of earth. Likewise other organisms to have immense power to multiply.

2. Limitation of food and space: The resources of earth are limited.Therefore, population of different species cannot increase beyond a certain limit.
3. Struggle for existence: A struggle occurs amongst organisms to obtain the available resources. It is of following types:

I. Intraspecific/Intranecine struggle: This is most acute type of struggle which occurs amongst individuals of same species for similar basic necessities like food, shelter, breeding, place, light, water etc. Cannibalism is an example of it.

ii. Interspecific/Internecine struggle: The struggle occurs amongst individuals of different species for similar requirements like food, shelter etc but it is less acute than intraspecific struggle due to different adaptation. Hunter/predator prey interaction is an example of this case.

iii. Environmental struggle: The struggle is between organisms and restricting environmental factors like carrying capacity, heavy rain, floods, lightening etc. Dinosaurs disappeared due to either changing environmental condition or by being struck by a meteorite.

iv. Variation: These are small morphological, physiological and behaviouristic differences amongst the individuals.Variations can be continuous (small changes, fluctuating around a mean or normal produced due to quantitative inheritance) also called fluctuations ,or recombinations formed due to reshuffling of genes),discontinuous(well marked inheritable variations not connected to the normal by any intermediate forms, produced due to action of a few major genes in qualitative inheritance or their mutations). Darwin believed that continuous and useful variation constitute the raw material of evolution.

v. Natural selection (survival of fittest): In the struggle for existence, only those individuals survive which possess the most useful variations. This

has been called natural selection by Darwin or survival of the fittest by Spencer.

vi. Inheritance of useful variation/Differential reproduction: Useful variations present in the surviving individuals are passed on to the next generation. Next generation repeats the process of development of variations and natural selection. Organisms therefore undergo continuous selection.

vii. Formation of new species: Favorable variations accumulate over the generations to ultimately form a completely new species.

CRITICISM

i) Darwin did not explain the mechanism of origin of variation.
ii) He did not know the mode of transmission of variants to the next generation.

In 1868 he put forward a theory of inheritance called theory of pangenesis. The theory proposed that every organ produced minute hereditary particles called gemmules or pangenesis (e,g brain gemmule, liver gemmule, heart gemmule, leg gemmules). They are carried by blood to the reproductive cells. The same was however disapproved by theory of germ plasm (Weismann,1892) which states that changes in somatic cells do not affect germ cells.

Continuous variations cannot go beyond the limits of species. Mutations are actually the source of evolution.

Darwinism does not explain the origin of variations, new characters (e.g wing) and arrival of the fittest.It is unable explain the persistence of over specialization (e.g:tusks of elephants,antlers of deer).

There are certain organisms which have remained unchanged (e,g selaginella) for the past several million years.

Evidences:

1. Evident Facts: High rate of reproduction,limitation of resources, abundance of variations and struggle for existence are quite evident.
2. Entomophily: Many pollinating insects have proboscis length exactly matching the position of nectar in the flower. This can develop gradually through natural selection.
3. Mimicry: It is the resemblance of an organism with another organisms (unpalatable) or a natural object as to conceal itself for protection, or some other advantages like catching

of prey e,g praying mantis, stick insect, leaf insect. The mimic must have evolved along with the model due to accumulation of useful variations.

4. Extinct forms: Extinction of past plants and animals can be explained only by development of better organisms through Natural Selection.
5. Artifical selection: It is selective breeding of plants and animals so as to obtain varieties with desired traits. Through artificial selection,wild cabbage has given rise to several vegetables like kale, kohlrabi,cabbage (broccoli).

All the varieties of dogs have developed from wild dog through artificial selection e,g Alsation, Terries, Bull dog, Wolfhound, Grey hound. A number of varieties have developedfrom rock pigeon e,g Pouter,Jacobin, Fantail. High milk yielding and breeding varieties of buffalo have developed by monitoring of animals producing more milk and breeding them with bulls of high milk yielding lineage.

6. Adaptations: Variations present in the population help the individuals in adapting themselves to changed environmental conditions. Adaptations produce new ecotypes from which new forms can develop.

Modern Synthetic Theory of Organic Evolution:

Since about 1935 onwards, when equipped with better understanding of related fields the geneticists, paleontologists' and statisticians have come together to formulate the "Synthetic Theory of Organic Evolution' which is considered almost perfect in the present times.

Julain Huxely (1940) used the word synthesis for the first time when he published his book "Evolution- the Modern synthesis. Although modern thinking on the subject had started with the publication of 'Genetics and Origin of species' by Dobzhansky (1937). Different works of biologists like Mayr (1934), Simpson (1953) R.A Fisher, U.B.C Haldane and S. Wright provided substantial basis to the theory.

G.L Stebbins in his book has compared Genetic mutation with petrol in an automobile vehicle , Genetic Recombination with the engine, Natural Selection with the driver, chromosomal change with transmission and accelerator and the reproductive isolation with speed limits and directive signals on the high way.

The synthetic theory of evolution can be illustrated under following points:

1. Biotic potential: - It has been defined as an innate capacity of population to increases under optional conditions with suitable age and Sex ratios present. Under ideal condition the potential of most animals is great. Moreover all the offsprings produced by the organism do not survive due limited food and space

2. **Variation**:- Darwin recognized two kinds of variations. a) Non hereditary and b)Hereditary. The non hereditary variations appear during the life of an animal and are passed on to the offspring. Hereditary variations are important for evolution as they are passed on to the off springs. Genetically controlled variations are produced by any of the three methods: a) mutation b) chromosomal change c) recombination. Besides some other phenomenon are also known such as Polygeny, polymorphism and reproduction which accelerate the frequency of variations. Since more individuals are produced that can survive and since variation of all grades do exist, it is only logical that an individual possessing some useful variation for survival will survive. Thus it cannot be asserted that all genes of an organism are useful or that all of the characters of organism have survival value.

Mutations:- These are sudden, unpredictable , stable and inheritable changes which occur in the organism due to permanent changes in their chromosomes and genes. Briefly mutations can be studied as under:

1. **Genomatic mutation**:- The mutation caused by the change in the number of chromosomes as seen in

a. **Polyploidy** and b. **aneuploidy.**

a. The increase in the number of chromosome sets e.g. 3n (Triploidy), 4n (tetraploidy), 5n(pentaploidy) 6n,(hexaploidy). Polyploidy provides greater genetic material for mutation and variability

b. **Aneuploidy** may be hyploidy or hyperpolidy. Hypoploidy maybe monosomy (loss of one chromosome) or nullisomy (lose of two chromosomes). Hyperploidy may be trisomy (gain of one chromosome) or tetrasomy (gain of two chromosomes). Thus in Aneuploidy there is mutation in which a numerical change occurs in the chromosome number of the genome.

2. **Chromosome Aberration**: These changes are in the morphology of the chromosome. It may be deletion of a segment, duplication (doubling of a segment),(inversion (reversal in the order of genes) and translocation (passage of a segment of a chromosome to a non homologous chromosome.

3. **Gene Mutation**:- Changes in the structure and expression due to addition, deletion, inversion or substitution of nucleotides. Genes undergo mutation. The frequency of mutation varies from gene to gene. Rate of gene mutation is increased by the presence of radiation and some chemicals called **mutagens**. Thus new alleles are added to the gene pool.

4. **Gene Recombination:-** Thousands of new combinations of genes are produced due to crossing over, chance arrangement of bi-valents at the equator during metaphase-I

and change fusion of gametes during fertilization. Thus **dual parentage**, **independent assortment of chromosomes,crossing over** and **random fusion of gametes,** play a fundamental role in gene recombination. Further recombination within a gene can produce new alleles, addition of new allele and combination of alleles function as the agents of evolution.

Genetic Drift:- This refer to the fact that variations in gene frequencies can occur by chance rather than by natural selection. It is observed in small and isolated population. Chance factor leads to elimination of certain alleles and preponderance of others. The surviving population has small gene pool and limited variability. In a new habitat the small band of colonizers is**called** as founders. They havefewer alleles. Inbreeding increases. It decreases heterozygosity and increases homozygosity. Homozygosity may be of dominant or recessive alleles. The other alleles of the genes will be eliminated. So under the influence of new environment and with mutations some alleles are selected producing different alleles. It is called founder effect as there is formation of atotally different gene pool. Rapid change occurs in phenotype forming new species. Gene pool is less variable than the original population, adaptability is reduced. This may result in extinction of a species or reduced species.

Among organisms having short life span (Viz; insects) population, fluctuate drastically and two large population of aspecies at different times are thus connected by an intermediate very low population. This type of low population of species has been referred by Stebbins as a "Bottle Neck". Such bottle neck assumes great importance because only the reproductively active survivors can pass on genetic material. Drift during the time of a bottle neck may result in the wide distribution in a large population of one or more non adaptive phenotypes. It is a supplement of the Swell Wright effect.

Gene low (Gene migration or gene exchange):-

Gene migration is addition or loss of alleles from a population due to entry or exit of a section of population. Gene migration leads to gene flow. Gene flow is spread of particular alleles within a population and between populations due to breeding and subsequent intercrossing. This gene migration changes gene frequencies of phenotypes of the individual. Another mechanism of gene exchange is occasional hybridisation between members of two different varieties, subspecies or even closely relayed species. The hybrid can vector genes from one species to another.

Natural selection:- In Darwinian terms, natural selection is survival in the struggle for existence and reproductive success of the fittest of surviving individuals. In modern terminologynatural selection is differential reproduction and differential contribution of various genotypes to the next generation. It leads to change in allele frequency that

promotes adaptation.The traits that promote non adaptive effects are kept under check. It operates through differential reproduction and reproductive success.

Differential reproduction states that those members which are best adapted to the environment reproduce at a higher rate and produce more springs than those which are less adapted. So these contribute proportionately greater percentage of genes to the gene pool of next generation while less adapted individuals produce fever off springs.

If the differential reproduction continues for a number of generations, then the genes of those individuals which produce more off springs will become predominant in the gene pool of the population.

Owing to sexual activity, there is free flow of genes so that the genetic variability which appears in certain individuals gradually spreads from one deme to another deme, from deme to population and then on neighboring sister population and finally on most of the members of a species. So natural selection causes progressive change in the gene frequencies,i.e.the frequency of some genes increases while the frequency of some other genes decreases.So more offspring's will be produced by the individuals:

i) Whose sum of the positive selection pressure due to useful genetic variability is more than the sum of negative selection pressure due to harmful genetic variability.
ii) Which have better chances of sexual selection due to development of some bright coloured spots on their body e.g. in many male birds and fish.
iii) Those who are able to overcome the physical and biological environmental factors to successfully reach the sexual maturity.

So natural selection of Neo- Darwinism acts as a creative force and operates through comparative reproductive success. Accumulation of a number of such variations leads to the origin of a new species.

Population genetics:- Evolution always takes place in a population. A population is a group of organism of the same species, which interbreed with one another in a particular geographical area.

1) **Genetic equilibrium**: G.H Hardy, an English mathematician and W. Weinberg a German physicist in 1908, independently answered the question,"What happens within a population when random mating takes place in successive generation".It is known as Hardy-Weinberg's law. The law is the foundation of population genetics and ofmodern evolutionary theory.

The law states, " If alternate forms of genes (alleles) are present in a population in a given proportion and if random mating and equal survival of offspring's exist, then the original

proportion will be retained in all subsequent generations unless it is upset by some other factor, such as mutation or selection pressures.

The genetic equilibrium has been expressed mathematically as:

$P+q=100\%$

were p= frequency of one allele in a population(T).

q= frequency of second allele (t).

Substituting F1 generation (Mendel) in terms of part q the phenotypic equation will be:

$P^2 + 2pq + q^2 = 100\%$ or 1

(TT) (2Tt) (tt)

If frequencies of p and q are equal, then

.25+.50+.25=1 (.5x.5+2x.5x.5+.5x.5=1)

1=1

If frequencies of p is 60% and that of q 40%, then

(.6x.6)+2(.6x.4)+.4x.4=1

.36+.48+.16=1

1=1

Salient features of Hardy Weinberg equation (law)

The relative frequency of alleles in the population remains constant from generation to generation in a population of sexually reproducing organism when:

1. The population is large enough so that accident of sampling may be ignored.
2. Mating takes place at random.
3. Mutation does not take place or ifit does, the rate is same in both direction and
4. All the members of the population survive and have equal reproductive rates.

Selection pressure: - Most of the mutations are harmful. Though some of them are favored by selection pressure which can be explained while studying a classic case in the peppered moth (*Biston betularia*) studied by R.A Fischer, E.b Ford and K. Well. Until 1845 only white colored moths were known in England. It had a great selective advantage in pre- industrial

England as it matched the background colours .But in 1845 a single black moth appeared in the industrial centre of England. Upto 1895 their population increased more than 99%. While the population of white moths is represented by few individuals. The change from white to dark colour is due to Sooty and coal dust covered area of England.

Many other examples of selective pressure can be given such as resistance to insecticides in Houseflies, mosquitoes, bed bugs etc.

Metabolic disorder	Approximate Frequency of Homozygous recessive Genotype (q^2)	Frequency of heterozygous genotype(2pq)
Albinism (lack of pigmentation in body)	1 in 10000 (in Europe)	1 in 50
Alkaptonuria (urine turns black Upon explosure to air	1 in 1000000	1 in 503
Amaurotic family Idiocy	1 in 40000	1 in 100
Diabetes mellitus (failure to secrete Insulin)	1 in 200	1 in 7.7
Phenylketonuria (may lead to mental Retardation if not Diagnosed)	1 in 10000 (in Europe)	1 in 50

Speciation:-

It is the phenomenon of formation of new species from the pre existing ones. Speciationcan be allopatric or sympatric ,multiplicative, phyletic or fusion, gradual or abrupt.

Allopatric Speciation:- It is speciation which occurs due to separation of a segment of population form the main population due to distance or geographical barrier cutting across

the species range e.g., creeping glaciers, development of mountain, ocean or land bridge in sea (like isthmus of panama). Migration of a few individuals to a new habitat away from original range also causes allopatric speciation. The separated segment of the population undergoes genetic drift, accumulates mutations and forms a gene pool quite different from the gene pool of the parent population. With the passage of time the separated population becomes reproductively isolated and forms a new species. Allopatric speciation is usually gradual. The mode of evolution is called **adaptive radiation or divergent evolution**. Drawin's finches of Galapagos islands formed 14 different species (out of them 1 in cocos islands) due to allopatric speciation. Similarly, Australian marsupials formedseveral types of new species.

Peripatric speciation:- it is speciation that occurs on the periphery of a large population due to separation of small groups bearing unique genotype or gene frequencies.

Sympatric speciation:-It is speciation that occurs in a sub- population in the midst of its parent population. There is no geographical separation. Sympatric speciation can occur either due to a **vital mutation** or **polyploidy** that causes instant or abrupt speciation. In autopolyploidy the number of chromosomes increases due to failure of meiosis or replication of chromosomes without mitosis. Allolploidy is another means. However polyploidy is not successful in case of animals. Here mutations are helpful in sympatric speciation. It may give rise to sibling species example *Drosophiliapseudoobscura* and *D. persimilis* .

Multiplicative speciation (Cladogenesis):- It is the formation of two or more species from a single species, e.g., allopatric speciation, sympatric speciation. Multiplicative speciation may be gradual or abrupt.

Fusion speciation:- It is an allogenous transformation. Isolation mechanism may break down due to a mutation. The two species will interbreed and merge to form a single species.

Phyletic speciation:- It is autogenous transformation of a species with a passage of time due to piling up of variations. The palaeonotology provides many evidences of such speciation

Gradual:- It is slow transformation of an isolated population or populations into new species due to gradual accumulation of variations. In small isolated pollution, **genetic drift** operates whereby even non adaptive traits remain in the population. In large populations accumulation of different variations in different areas first produces ecotypes than races, varieties, sub species and ultimately different species. This is an example of **adaptive radiation**.

Evolution of Man:-

Man is the crowning achievement of the evolutionary history. Inquiring into his ancestory has attracted the attention of biologists throughout the world. The fossil record of man's ancestory are very incomplete.

Phylogeny:- Modern man is a member the order primata, class mammalia, alon with prosominas, monkeys and apes. As a primate his characteristics are: ine pair mammary glands, nails instead of claws, and eyes directed enteriorly proportionately great development of brain. The characteristics of this order show adaptation to life in s a forest environment and it is these requirements for an aboreal (tree- dwelling) existence wgicgh pre adapted human ancestors for their evolutionary development. This enabled them to exploit the new ecologicalNiches which appeared as the luscious forests of the miocene period gave way to drier grassland savannahs of pliocene period.

Within the order primates ate three groups of animals called anthropoids. They include the new word monkeys (marmosets and spider monkeys) and old world monkeys (baboons and proboscis monkey) and hominoids (apes and humans). Human and their ancestors are more clearly related to apes than any other anthropouid, and apes in turn in closer in phylogeny to old world monkeys and new world monkeys.

A close phylogenetic relationship of apses with man is revealed by the characteristics given below:

1. Absence of tail.
2. Head is larger, the neck and limbs are larger.
3. The chest is broad due to flat sternum.
4. Lumber region is short
5. Prominent browridges above the eyes.
6. Molar teeth with 5 cups instead of 4.
7. Large brain and cranial cavity.
8. Capable of sound production.
9. Highly development facial musculature f0r expression (like surprise, pleasure etc.).
10. Menstruations in females.

On the basis of such resemblance between apes and man. It has been presumed that the apes and man are cousins .These resemblances occur between Orangutan and Gibbons. The Gorilla and Chimpanzee are regarded as the less distinct cousins due to sem opposable thumbs of apes.

Origin of man:-

Place of origin: The fossils of pre- human and ancestral human forms are obtained from widely diverged areas of Africa, Asia & Europe. This indicates that the main centre for origin of man was probably in Asia and Africa.

Time of origin:

The time of desent is not later than early Pliocene nor early than Miocene when terrestrial ape-man became what we would call human.

Impelling causes:

The Pliocene epoch was characterized by continental elevation and subsequently increased aridity of climate, especially to the northward of the Himalayas. With this increased aridity and tempering of tropical heat came the dwindling of the forests areas. The dwindling of the forest would have an effect upon the tree dwellers. They got down from the trees. Once upon the ground, they rapidly acquired such adaptation as were necessary to ensure survival. These changes frame out the individual which are called humans.

Significance of the descent from trees:

As a result of the descent from the trees, certain definite factors were called into play these are 1) Assumption of erect posture, 2) Liberation of the hands from their ancient locomotor function to become organs of mind, 3) Loss of the easily available food of the tropical forests necessitating the search for the plant and animal and man became hunter, 4) Need of clothing with increasing inclemency of the weather, especially during the long winters, 5) Freedom from climatic restriction, man was no longer limited to one definite habitat and the result was dispersal, 6) The development of communal life.

Evolutionary trends:- The human evolutionary changes which are recorded as follows.

1. More erect pressure due to development of lumbar curve.
2. Shortening of the forearms and perfection of thumb opposability into the organs of manipulation.
3. Reduction in the size of incisors and canines because of omnivorous diet.
4. Development of chin prominence.
5. Loss of jaw power.
6. Increase in the size and complexicity of brain, especially the frontal lobes.
7. Reduction in the size of eyebrow ridges and loss of simian shelf.
8. Broadening of iliac bones and pelic girdle.
9. Development of articulate speech
10. Increase in the cranial capacity.
11. Bipedal locomotion.
12. Loss of opposability of great toe (hallax) in hind limbs.

Fossil men:-Well authenticated fossils are as follows:

1. South African ape-man or *Australopithecus africans*. It was discovered in 1925 by Raymand Dart. These creatures were of small stature, about 1.20 m tall. They walked upright. Brain case was small.Large Jaws and teeth. Cranialcapacity was from 450 to 600c.c.It is regarded as ape-man. Ape man like characters are grasping hands, stereoscopic binocular vision .Its man like characters are upright posture and teeth similar to man, brain was also larger than that of apes. It represents the line of human ancestory at the beginning of Pleistocene or the end of the Pliocence.

2. *Homo habilis* :- Its fossils were discovered by Leaky and Napier in Tanzania in the year 1964. It lived in open grassy land, moved erect and was omnivorous, but had larger brain with 660 C.C. Cranial capacity. Length of *Homo habilis* was 1.2 to 1.5 m, weight 40-50kg.
3. *Homo heidelbergensis*: - It was discovered from Heidelberg in Germany 1n 1907 in the form of fossil jaw.

4. *Java man:-(Homo erectus erectus*) Java ape man lived about 0.6 million years back. Discovered from Trinil in Java. It had height of 160-170 cm, walked upright, face protruded forward. Chin small, brows thick, jaws large, nose flat, skull broad with rounded back,cranial capacity 775-900c.c., carnine teeth large, lips thick and protruded. Used tools of bones and stones, lived in caves, and knew use of fire for hunting defense and cooking.

5. *Peking man :-(Homo erectus pekinensis)* (1924 was year of discovery.It has been discovered from cave in choukoutien near Beijing. It had a height of 150 cm. weakly buil,t omnivorous with cranial capacity 915 to 1225 c.c. Cannabalism may have been practiced.Peking man used fire. Its tools were sharper and chisel shaped, made of bones, stones and quartz.

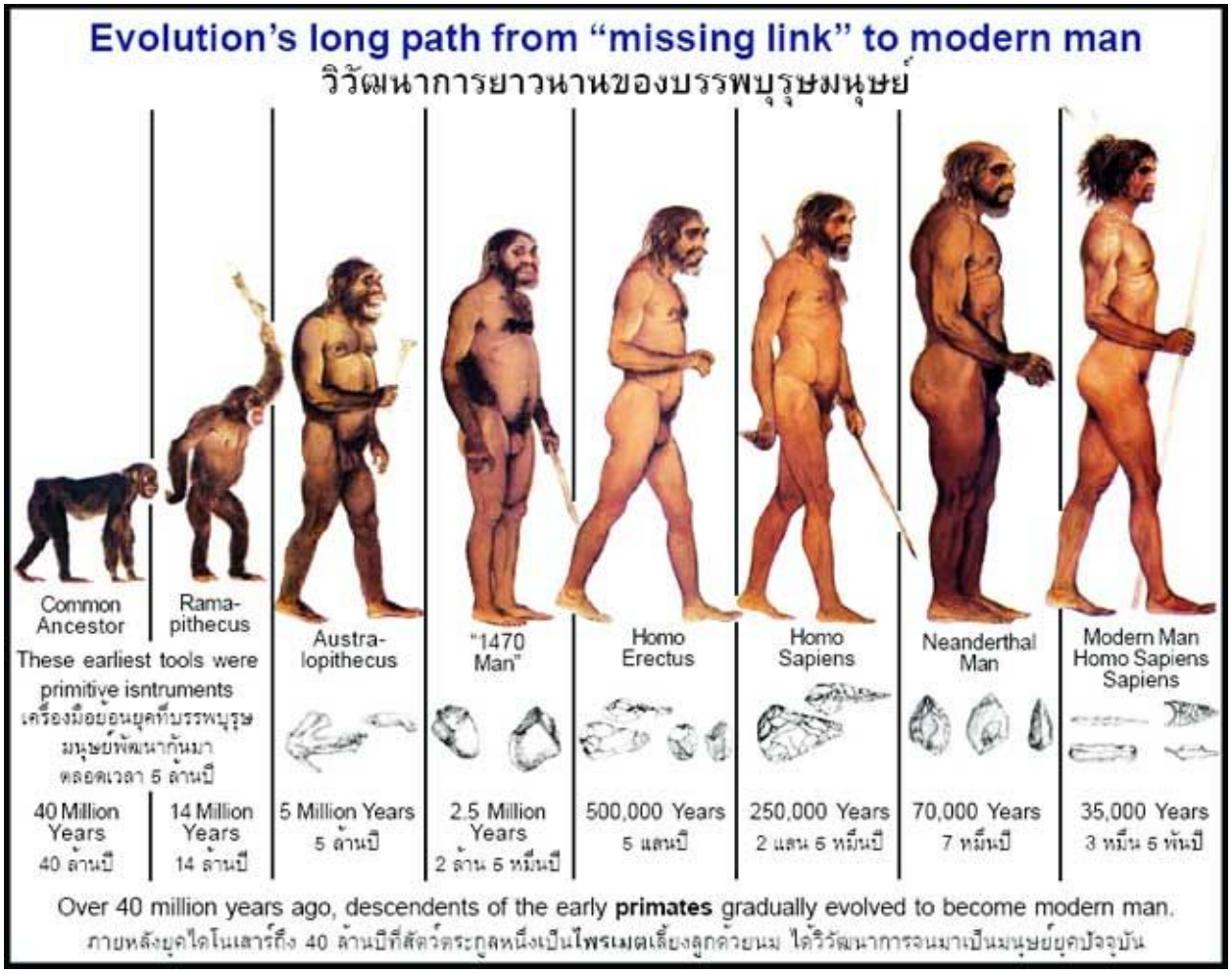
6. Neanderthal man:- *Homo neanderthalensis*/*Homo sapiensneanderthalensis.*It was first discovered from Neander valley of Germany by Fuhlrott (1856) lived 30000 to 100000 years ago. It had a height of 150cm but shoulders, chest cranial cavity (1200-1600 c.c.) were large. It had sloping broad fore head, brow ridges, long nose, smaller chin, large jaws and thick boned skull which was depressed from above but protruded behind. Neanderthal man used tools, animal hides, hut like dwelling as well as caves. Some paintings in the caves have also been reported. Neanderthal man started burying their dead. The skull boxes were thick. The speech centers had developed in Neanderthal man hence they were capable to communicate with each other by some sort of language.

7. Cro-Magnon man (*Homo sapiens fosssalis*) lived 20000-50000 years back . It was discovered by MaC Gregor in 1868 C.E. from Cro-Magnon rock of France. It had height of 180cm, cranial capacity of 1650cm^3, broad fore head, arched brows ridges, moderate chin present with strong jaws, face ortho gnathous with elevated narrow nose. He was cave deweller, omnivorous hunter with domesticated dog, used stone spears and arrow head, did some excellent cave paintings used ivory ornaments and animal skin garments.

8. Modern man:(*Homo sapiens sapiens)*:- From Cro-Magnon to the modern man, cultural evolution has been the main feature of human development. It evolved during ice age 25000-75000 years back but spread to various parts of the world about 10000-11000 years ago. There is thinning of skull bones, slight reduction in cranial capacity (1400-1450cm^3) four flexors in vertebral column and shight raising of skull cap. Modern man has undergone cultural evolution------

Paleolithic (age of tools of stones and bones, cane paintings in later period, 18000 years), Mesolithic (age of animal husbandry, origin of agriculture, development of languages, reading and writing) Neolithic (stone age, development of agriculture, manufacture of pottery and clothes 8000 years. Bronze age 6000 years, iron age 4000 years etc.

Modern man is intellectually well advanced and has acquired great strides in gaining knowledge and sharing it.



Human ancestory dates:

First mammal 210 -240 million years before

First primate 80 million years before

First hominids 24 million years ..before

Heidelberg man, Solo man, Rhodesian man and Atlantic man- believed to be various of homo erectus other than java man and Peking man.

Piltdown man- hypotheyical , developed on the basis of artifact, hoax consisting of fragments of skull at Peltdown, England.

Cradle of human evolution: South Africa

Mult-regional hypothesis: - Modern humans evolved independently in Asia, Africa and Europe. Some biologists say that modern humans evolved only in Africa and then traveled to Asia Europe and other places to replace the indigenous populations.

Chapter 3rd Biology and Human Welfare

INTRODUCTION:-A good health does not mean the mere absence of diseases rather it is the physical,mental,social and behavioral well being of a person.

Importance of good health

1.It increases the efficiency of person.

2.It increases the productivity and economic prosperity.

3.Healthy persons possess a good and pleasing personality.

Basic concept of immunology

The resistance of body against the disease causing organisms is called immunity and the system of body which in concerned with immunity is called immune system. The branch of biology which deals with the study of immunity is called immunology. Edward Genner is considered as the father of immunology for his contribution of discovery of first vaccine against small pox.

Immunity is of two types.

(a) Innate immunity and.(ii) Acquired immunity

Innate immunity: - Also called native or inborn immunity. It is the resistance against pathogens which an individual possess by virtue of its genetic and constitutional make-up. It is non – specific immunity. The innate immunity comprises all those defense elements with which an individual is born and which are always present in a living body. It consists of following components.

(1) Anatomical barriers: - These barriers prevent the entry of micro- organisms into the body thus act as the physical barrier .It is due to skin, nasal hair, mucus membranes and cilia. The anatomical barriers form the first line of body defense against the pathogen.

(2) Physiological barriers: - These barriers operate at chemical and functional levels and include.

(i) Lysozyme of saliva, tear, sweat and mucus is antibacterial.

(ii) Oil and sweat produced by sebaceous and sudoriferous glands of skin have bactericidal and fungicidal properties.

(iii) HCL of stomach kills microorganisms.

(iv) Rise in body temperature (Fever) in response to pyrogens inhibits the growth of pathogens.

(v) Cerumen produced in ear is bactericidal and insect repellent

(vi) Bile is also antiseptic and inhibits the growth of microorganism.

(3) Cellular barriers:- They are of two types: phagocytic cells and natural killer cells.

(a) Phagocyte barrier: - It involves the phagocytosis of pathogens by neutrophils and tissue macrophages.

(b) Natural killer cells: - These cells are active against any foreign agent and self altered cells. These cells attack target cells and create pores on their membranes. Water enters in to them and cause their bursting.

4. Inflammatory barriers:- An infection or tissue injury often cause redness, edema, pain and production of heat. Such expressions are generally localized and is called inflammatory response. This response is due to release of certain chemicals such as histamine, serotonin and prostaglandins by the damaged mast cells. Vasodilation occurs the serum proteins (antibacterials) and phagocytic cells move towards affected area and destroy the invading pathogens.

5.Complement system:- It is a system of 30 different proteins which have a cascade like effect resulting in lysis of bacteria. It is of two types.

a. Alternative pathway (Properdin system):- It is activated , once it gets exposed to any foreign material.

b.Classical Pathway:- It is activated by the formation of antigen- antibody complex. Thus it operates in acquired immunity.

6.Interferons:- They are glycoproteins released by viral infected cells. The interferons make the surrounding cells resistant to viral infection by inhibiting multiplication of viral particles.

All these systems form the second line of body defense against the pathogens.

"Acquired immunity":- The immunity that an organism acquires during its life is called acquired or adaptive immunity. It is specific and has the following features:

a. **Specificity:-** It is specific for each type of pathogen.
b. **Diversity:-** Can develop against all the diverse type of pathogen.
c. Has the power of Discrimination between self and non self.
d. **Memory:-** It keeps memory; and that is why the second reponse of this system against a particular pathogen is quicker and more strong.

Acquired immunity is of two types:

a. **Active immunity and (b) Passive immunity**
a. **Active immunity:-** this involves the active functioning of the person own immune system leading to the synthesis of antibodies and/or the production of cytotoxic T-cells. The response is delayed but long lasting. Active immunity may be natural or artificial.

i. **Natural Active Immunity:-** The immunity which occurs due to natural sub- clinical exposure of an organism towards a pathogen is called natural active immunity.
ii. **Artificial Active immunity:-** The immunity which is induced in the body by vaccines is called artificial active immunity.

b. **Passive immunity:-** In passive immunity, the readymade immune products like antibodies are introduced into the recipient. It is also of two types:-

i. **Natural passive immunity:-** This is the resistance passively transferred from the mother to fetus through placenta and breast milk. These antibodies prevent the newborn from some diseases.
ii. **Artificial passive immunity:-** Artificial passive immunity is the resistance passively transferred to a recipient by administration of anti-bodies. The antibodies are generated in the serum of some animals (like sheep, horse etc) and later on the serum containing antibodies is collected from the animals and injected into the individual to which the immunity is provided e.g. Anti-tetanus toxoid (ATT) and Anti-diphthena toxoid (ADT)

Immune response:

The specific reactivity induced in a host by an antigenic stimulus is known as the immune response. Immune response is of two types:

i. Cell mediated Immunity (CMI) and
ii. Humoral or Antibody mediated immunity (AMI)

i. Cell Mediated immunity:- This kind of immunity is due to T-Lymphocytes. The T-lymphocytes are of four types

a. Helper T- cells (b) Cytotoxic T-cells . (c)Suppress T-cells and (d) Memory T-cells.

The immune cell which is first stimulated is helper T-cell. It activates the cytotoxic T-cell and B-lymphocyte. The suppressor T-cell suppresses the response and memory T-cell keeps the memory against the invading pathogen.

The T-lymphocytes which causes the eradication of pathogen are cytotoxic T-cells. These cells produce some toxic substance which damage the pathogens. They also produce lymphokinins, which attract the macrophages and other kinds of W.B.C^{s} towards the site of infection where they damage the infecting agent.

The cell mediated immunity also play profound role in the rejection of grafts.

ii. Humoral Immunity:- Humoral means body fluid. It is called humoral immunity because the effective agents (i.e. antibodies) of this kind of immunity are present in body fluids. This kind of immunity is provided by B-lymphocytes. The activated B-lymphocytes gets converted into two kinds of cells.

i. Memory cells- Keep the memory

ii. Plasma cells- They produce antibodies against the specific antigen. About 2000 antibodies are produced per second by a plasma cell.

ANTIBODIES

Antibodies are immunoglobulins(Igs)produced by plasma cells in response to antigens(foreign bodies)

TYPES:-There are 5 types of antibodies viz IgA,IgD,IgE,IgG and IgM.

[Ig=immunoglobulin]

A=alpha,D=delta,E=epsilon,G=gamma and M=mu.

Among the antibodies ,IgG is most common (80% of all) and extensively studied antibody and also serves as a model of basic structural unit of all antibodies.

STRUCTURE OF ANTIBODY;-An antibody consists of following parts

1.**Polypeptide chains:**-It is composed of 4 polypeptide chains-two heavy and two light chains represented as H2L2.Usually the polypeptides form a Y shaped configuration in which the stem of Y is formed of heavy chains only and the arms of Y are formed of both heavy and light chains.Two heavy chains in tail region are linked by disulphide bonds.A disulphide bond also links the heavy chains with light chains at the base of the arms of Y.

IgA antibody:-Present in tear,saliva,mucus,colostrums,blood and lymph.It makes 10-15 % of all antibodies and is effective against inhaled and ingested pathogens.It can't cross placenta.

IgD antibody:-It occurs in blood,lymph and on surface of B cells.It makes 0.2% of all antibodies.It can't cross placenta.It activates B cells.

IgE antibody:-It occurs in blood,lymph and on surface of basophils and mast cells.It constitutes 0.1% of all antibodies and are involved in allergic reactions.It can't cross placenta.

IgG antibody:-It occurs in blood,lymph and in intestine.It is the most abundant antibody and constitutes about 80% of total.It is responsible for activation of complement system.It crosses placenta.

IgM antibody:-It occurs in blood,lymph and on surface of B cells.It makes 5-10% of all antibodies and are involved in activation of complement system.It can cross placenta.It is the largest antibody and is a pentamer having 10 binding sites.

ANTIGENS:-Any foreign substance ,toxin or pathogen which induce the immune system to produce cells and antibodies against it is called an antigen.

Haptens:-They are called incomplete antigens.They are substances with smaller molecular mass and can induce immune response if they first combine with an antigenic substances.

Epitopes:-(Gk epi-upon,topos-place)Ths sites on antigens which are recognized by B & T cells as well as by antibodies are called epitopes or antigenic determinants.

Paratopes:-(Gk para-beside,topos-place)The regions on antibodies,

B& T cells which function as receptors for epitopes are called paratopes.

A perticular antibody binds with a particular antigen and form antigen- antibody complex. The antibody makes the antigen ineffective by Agglutination, opsonization and neutralization

Agglutination:- When a particular antigen binds with its antibody clumping or agglutination of the farmer takes place. The agglutinized antigen is later on destroyed by complement system.

Opsonization:- here the antibodies coat the surface of microbes and make them more susceptible to phagocytosis.

Neutralization:- The toxic substances produced by pathogens are neutralized by anti-bodies.

Precipitation:- Some anti-bodies combine with antigens and form precipitation which are also easily ingested by phagocytic cells.

EVALUATION

Q.1) why are the antigens called antibody generating chemicals?

2. Which two types of lymphocytes are involved in immunity ?

3. What are the characteristics of acquired immunity ?

4. What are plasma cells?

5. What are interferons?

6.Differentiate between active and passive immunity?

7. What is epitope? Name the most abundant immunoglobulin in man?

"Vaccines".

"Vaccines:- (Latin vacca-cow). Vaccine is a liquid containing dead, weakened or attenuated form of a pathogen or their surface antigen which can be injected or taken orally to provide immunity towards that pathogen.

Vaccination:- It is a process of inoculation of harmless antigenic materials like attenuated pathogen or its surface antigen into a health person for providing active acquired immunity against the disease. A single vaccination sometimes may not give adequate immunity, therefore 2 to 5 booster doses of vaccine are administered at specific intervals.

Types of Vaccines

1. **First Generation Vaccine:-** There are the ones obtained by conventional techniques involving killing, weakening or attenuation of the pathogen by some chemical or physical treatment. The vaccines are seldom uniform quality. They may have side effects e.g. Oral polio vaccine, BCG Vaccine etc.
2. **Second generation vaccine:-** These vaccines are made of pure surface antigens of the pathogens and are produced through recombinant DNA technology e.g Hepatitis B Vaccine.

These vaccines are highly effective as they bring about anti-body development without the presence of Pathogen.

3. **Third Generation Vaccines:-** They are purest and with highest potency Vaccines which are synthetic in nature. e.g The first synthetic vaccine was produced against Polio on 21 Feb 2015.
4. **DNA Vaccine:-** The last revolution in vaccines is DNA Vaccine. The gene controlling the formation of immunogenetic protein is isolated. It is cloned and then integrated with a vector for introduction into an individual to be immunize.

DISEASE

Disease:- (dis-against , ease-comfort)

Any condition which interferes with the normal functioning of the body and impairs the health is called disease. It involves morphological**,** physiologicalorpsychologicaldisturbancesin **some** body parts. This shows that disease is opposite to health.

Some common diseases of Man are:

Typhoid:-

Cause:- It is caused by a gram negative bacterium Salmonella typhi commonly found in intestine of man initially but later spreads to other organs of body like liver and spleen. It is the 5^{th} most common communicable disease of India and attacks about 2.5 million Indians in the age group of 1-15 years every year.

Epidemiology:- Human infection is mainly direct and oral Bacteria are spread through intestinal discharge of typhoid carries.

Incubation period About 1-3 weeks.

Symptoms:- Common symptoms are headache, classic typhoid fever (spikes afternoon and increase with each day, persistent high fever in 2^{nd} week may be 103^0Fto 104^0F) and then gradually declines during the 3^{rd} and 4^{th} week) lesions of intestinal mucosa, ulceration of intestine, rose colored rashes on chest (during 2^{nd} week) Relapse is very common in typhoid.

Diagnosis:- Widal-test comes positive during the 2^{nd} week.

Prophylaxis:- Proper disposal of human faeces, screening of water and food, TAB- Vaccine provides immunity for about 3 years, Typhoral-oral vaccine.

Therapy:- Chloramphenicol. Ampicillin , Cefixm and Chloromycetin are effective to treat typhoid.

Amoebiasis

Amoebiasis:- Also called as Amoebic Dysentry or Enteritis.

Cuuse:- it is caused by a protozoan called Entamoeba histolytica found in large intestine and lower part of small intestine. It may also spread to liver, lungs and brain. It effects about 10% of world population.

Epidemiology:- Human infection is direct and oral, and is caused by ingestion of teranucleated cyst of E.histolytica with contaminated food and water.

Symptoms:- the pathogen secretes a cytolysin enzyme which damages intestinal mucosa leading to ulceration, acute diarrhea and blood and mucus in the stool. Patient also feels abdominal pain , nausea and nervousness.

Diagnosis:- Bloody stool and presence of tetrancleated cyst in the faeces.

Prophylaxis:- 1. Proper sanitary conditions.

2. Proper coverage of food and water.

3. used of boiled water

4. proper washing of fruits and vegetables.

Therapy:- Antibodies like terramycine, erythromycin and metronidazole (most effective) are used to treat this disease.

Malaria

Malaria:- Malaria is one of the most common disease of mankind, found in tropical and subtropical countries of Africa and Asia, where millions are infected.

Due to WHO and NMEP (National malaria Eradication programme) of India , the malaria was effectively reduced but partly owing to socio- economic factors and partly because of unexpected proliferation of DDT-resistant mosquitoes and drug resistant parasites, the attempts to eradicate the infection have failed and the malaria is again on increase.

Cause:- Malaria is caused by a toxic substance haemozoin formed from haemoglobin of RBC's when RBCs are destroyed by developing stages (Merozoites) of the malarial parasite, plasmodium.

Epidemiology:- Human infection is indirect and inoculative in which the infective sporzoites are injected into the blood of man along with a drop of saliva, when an infected female Anopheles mosquito bites a man.

Types of Malaria:- Four species of plasmodium cause the following types of malaria.

Plasmodium species	Type of Malaria	Period of Attack
1. P. Vivax	Benign tertian malaria	After 48 hours.
2. P. Ovale	Mild tertian malaria	After 48 hours
3. P. malaria	Quartian malaria/sub-clinical malaria	After 72 hours
4. P.falciparum.	Melignant tertian malaria (most serious)	After 48 hours.

Symptoms:- Malaria attack is preceded by headache, nausea and muscular pain. Total period of malarial attack is of 6-10 hours and can be divided into 3 stages.

a. **Cold stage:-** Characterized by chilling and shivering.
b. **Hot stage:-** Characterized by High fever (106^{o}F) faster respiration and heart beat.
c. **Sweating stage** and temperature goes down to normal after the malaria attack, the patient feels week, exhausted and anemic. The malaria may secondarily cause enlargement of spleen and liver.

Prophylaxis:-

1. To prevent the body from the bite of mosquitoes.
2. Use of insecticides like DDT and BHC
3. Sleeping under mosquitonets filling of small sized ditches with soil, sprinkling kerosene oil on large sized water body or introducing larvicidal fishes like Gambusia, trouts etc.

Therapy:- A number of anti malarial drugs are available e.g. quinine, chloroquin, paludrine, atabrine and daraprim (most effective). Daraprim kills the parasitic stages present in both liver cells and R.B.C's . Latest antimalarial drug in mefloquin.

FILARIASIS:

Cause:- It is caused by a nematode wuchenaria bancrofti and W. malayi found in lymph vessels and lymph nodes of man especially of legs while their larval stages called microfilaria are found in the saliva of mosquitoes like Aedes and culex which acts as its secondary hosts. So life cycle of this parasite is digenetic.

Epidemiology:- Human infection is indirect and inoculative in which the larva called microfilaria of worm is injected into man by culex or Aedes mosquitoes, when they bite.

Symptoms:- Fever, swelling of certain body parts like legs, scrotal sacs, breasts etc. due to blockage of lymph vessels. The swelled legs look like the legs of elephant, and for this reason the disease is also called elephantiasis .It may also cause deformities of genital organs.

Prophylaxis:- As in malaria.

Therapy:- Hetrazan and carbamazine are very effective.

ASCARIASIS

Cause:- It is caused by a nematode called Ascaris lumbricoides. It is an intestinal parasite and is more common in children. Ascaris is monogentic

Epidemiology:- Human infection is direct and oral. The Rhabditiform larva are ingested with contaminated food (fruits and vegetables) and water. Passive vectors are flies.

Symptoms:- Ascariasis is characterized by abdominal pain, indigestion, weakness, anaemia, nausea, vomiting, enteritis, appendicitis, blockage of intestine etc. The larva of parasite can enter into bloodstream and spread to other organs of the body and can cause pneumonia, hepatitis, gastritis and nervous problems like comma and convulsions.

Diagnosis:- Ascariasis is diagnosed by stool test.

Prophylaxis:- 1. Proper disposal of human faeces.

2. proper coverage of eatables (protection against flies)

3. Proper washing of vegetables and hands before meals.

4. Use of boiled water.

Therapy:- Albendazole 400 is most effective.

RINGWORM: (DERMATOPHYTOSIS)

Cause:- It is the most infectious fungal disease. It is caused by fungi with genera like microsporium, trichophyton and epidermophyton

Epdimiology:- Human infection occurs either from soil or through contact with infected person. The infection also spreads through the **use of towels, clothes ,combs etc of the infected persons.**

Symptoms:- Dry and scaly lesions on skin, nails, scalp etc of body accompanied with severe itching.

Prophylaxis:- 1. Isolation of patient.

2. Infected persons articles like towels, clothes, combs etc. should not be used.

Therapy:- Fluconzole is very effective

COMMON COLD (RHINITIS):

Cause:- It is one of the most infectious human disease. It is caused by some 100 types of rhinoviruses and small bacterium Dialister pneumosintes.

Epidemiology:- Human infection is air borne or through droplet infection or formite borne (through contaminated objects like hanky, pens, books, cups, computer parts, towels etc.

Incubation period:- Few hours to few days.

Symptoms:- It may affects nasal epithelium and upper part of respiratory tract but not the lungs . It is characterized by nasal-congestion and discharge, sore threat, hoarseness, coughing, headache, low grade fever, tiredness etc. the attack lasts for about 3-7 days.

Prophylaxis:-

1. Isolation of patients.
2. Sterilization of the articles and clothes used by the patient.

Therapy:- Antibiotics and antihistamine drugs are recommended.

HEPATITIS-B (SERUM HEPATITIS)

Cause:- It is caused by double stranded DNA virus called hepatitis-B virus (HBV).

Epidemiology:- Spreads through blood. Body fluids and sexual contact. It is 100 times more infectious than HIV.

Incubation period:- About 20-35 days.

Symptoms:- Fatigue, nausea, abdominal pain, arthritis, damage to liver cells, jaundice and finally liver cirrhosis.

Diagnosis:- Can be diagnosed by Australian Antigen test which is now also called hepatitis-B surface antigen test.

Prophylaxis:- Proper sanitation, proper coverage of food and water, use of chlorinated and boiled water.

Therapy:- At early stage, the disease can be treated with antibiotic therapy. If the disease is detected late, it is than almost incurable.

Hepatitis B- vaccine is also available , Three doses of vaccine are generally given during 0,1, and 6 months of age which give life long immunity.

Contagious diseases:- Communicable diseases which can spread by physical contact and through droplets of sneeze and cough.e.g common cold,covid 19,dermatophytosis.

Non-contagious diseases:- Communicable diseases which spread through air,water,food and vectors(carriers)e.g Typhoid,Malaria.

EVALUATION

Q.N.1) Define vaccine? Which vaccine is given is given to prevent tuberculosis?

2. What are third generation vaccines? Why the 1st generation vaccines are called conventional vaccines and what is their drawback?

3. What are the symptoms of ascariasis?

4. Give the causative agent of ring worm?

5. Expand NMEP ? Name the vector of malaria?

HIV And AIDS

AIDS is a severe viral disease caused by Human immuno virus (HIV). It is a serious health hazard and has threatened the entire mankind. The acronym 'AIDS" stands for Acquired Immuno Deficiency Syndrome. In India more than 5 million people are infected by HIV.Globally 37.9 million people were living with HIV at the end of 2018.

Discovery:- AIDS is believed to be transmitted to human beings from monkeys in 1960 in Africa. In human beings AIDS was first noticed in U.S.A among homosexuals in 1981. AIDS virus was isolated and identified by prop Luc Montagnier in France in 1983, and at the same time by Robert Gallo of U.S.A.

In India. AIDS was first detected in prostitutes of Chennai in 1986.

Causative agent:- It is caused by retero virus called human immuno deficiency virus (HIV), The virus was formerly known as human cell leukemia virus III. (HCLV)-iii) and lymphoadenopathy virus (LAV).

Epidemiology:- The disease is transmitted from infected to health person through following ways:-

1. Through sexual intercourse.
2. Through blood transfusion and organ transplantation.
3. Through contaminated needles, syringes (Mainly in drug addicts).
4. Through unsterilized surgical equipments.
5. From infected pregnant women to their children, mostly at the time of parturition and through breast milk.

Mode of action;- The HIV is a retero virus containing RNA as genetic material. The virus attacks the CD_4 T cells or helper T –cells and cause their mass killing. The helper T-cells are essential for the activation of B and T lymphocytes. Therefore the ultimate effect of this virus infection is the weakening of immune system of the body. As a result the person is suffering from a number if infectious diseases.

Incubation period:- The average incubation period of AIDS is 25-36 months. However sometimes it can be 6 to 10 years.

Symptoms:- Common symptoms of AIDS are

1. Unexplained weight loss.
2. Prolonged fever.
3. Chronic diarrhea for more than one month.
4. Persistent coughing.
5. General Itchy dermatitis.
6. Swelling of lymph glands.
7. Excessive sweating during night.

Diagnosis:- AIDS can be diagnosed by ELISA test, western blot test, Dot Blot, Latex and particle agglutination test.

Therapy:- There is no complete treatment of AIDS and mortality rate is 100% . However some drugs can prolong the life of the infected persons like Zidovudine, azidothymidine and interleukin. Both at national and international level the scientists are trying hard to develop an effective vaccine against the disease.

Prophylaxis (preventive measures):-

Different organizations like NACO (National Aids control organization) are doing their best to educate people about AIDS. Every year December 1 is recalled as world AIDS days, so that people will become aware about this disease. AIDS can be prevented by:

1. Educating the people about the AIDS.
2. Blood test must be done in blood transfusion, organ transplantation and in patients undergoing haemodialysis..
3. Use of disposable needles and syringes should be encouraged.
4. To promote monogamy and avoid polygamy.
5. Avoid visiting of prostitutes.
6. Sterilization of surgical equipments.
7. To follow ABC formula i.e. Abstinence, Being faithful and use of condoms.
8. NACO has approved the scheme to provide free Antiretroviral therapy (ART) to HIV infected persons from December 2004.

Cancer

Cancer:- The abnormal and uncontrolled growth due to uncontrolled division of cells is known as cancer, tumor or neoplastic growth and the cells which undergo uncontrolled divisioning are called cancerous cells, neoplastic cells or tumor cells. Cancer causes about 4 million deaths annually.

About 200 different types of cancer are known. Breast cancer is most common cancer in women and lung cancer in man.

Tumors are classified as:

1. **Benign Tumors:-** Abnormal and persistent cell division that remains localized at the spot of origin results in benign tumors. Such tumors can be successfully removed surgically. However if present in vital organs like brain, heart etc. They can create complications.
2. **Malignant tumors:-** Such cancers are very dangerous as the malignant cancer cells are invasive in nature i.e. these cancer cells have the capability to get detached from the main site of origin and travel by blood and lymph to different regions of the body where they form fresh colonies of cancer cells. It is called metastasis.

Types of cancer: Cancers are classified on the basis of the tissue from where they arose. The common types of cancer are:

a. **Carcinomas:-** It is the cancer of epithelial cells e.g. cancer of cervix , breast, skin, brain, lungs, stomach etc. It constitutes 80% of all cancers.
b. **Sarcoma:-** It is the cancer of connective tissue e.g. cancer of bones , cartilages, tendons etc. cancer of bones called ositeoma.
c. **Lipoma:-** It is the cancer of adipose tissue.
d. **Lymphoma:-** It is the cancer of lymphatic tissue.
e. **Leukemia:-** It is the cancer of blood. There is abnormal rise in the number of WBCs(2,00000-10,00000 per cubic mm of blood).
f. **Melanoma:-** Cancer of melanocytes.

Causes of Cancer:-Study of cancer is called oncology.The agents which can cause cancer are called carcinogens,which belong to three categories:-

1.**OncogenicTransformations**:-They change genetic material from non-oncogenic to oncogenic state.e.g chemicals & radiations.

2.**Tumourpromoters**:-They promote proliferation cells which have undergone oncogenic transformation,e.g.some growth factors and hormones.

Another classification of carcinogens is as :-

1. **Physical carcionogenes:-** The exposure to high ionizing radiations like UV rays, X rays, $\propto$ rays, β rays and Y- rays increase incidence of cancer. Kashmiri's use Kangri to keep

themselves warm, but it is known that the more use of Kangri can cause abdominal and thigh skin cancer, due to constant heat exposure.

2. **Chemical carcinogens:-** There are large No. of chemicals which are known to cause cancer, like caffeine, polycyclic hydrocarbons, heavy metallic ions, pesticides, asbestos, nickel, certain dyes, artificial sweeteners etc. Sex hormones and steroids in excess prove carcinogenic. Chewing of beetles and tobacco cause mouth cancer, cigarette, cigar and hukka, smoking cause lip,mouth, throat and lung cancer. An animal protein rich diet is known to cause cancer of large intestines.
3. **Biological agents:-** Some evidences shows that Epstein-Barr viruses (EB viruses), Herpes simplex type-2 viruses , Wart viruses and Helicobacter pyrolli (bacterium) are associated with human cancers in many cases. Such viruses are called Oncoviruses as they cause Oncogenesis.

Symptoms and Diagonisis:- The appearance of following symptoms help in the diagnosis of cancer. Cancer can be treated if detected in early stage. Therefore one should consult a doctor if any one of the following symptoms are found;

1. Persistent hoarseness in voice, persistent coughing or persistent difficulty in swallowing indicates chances of throat cancer.
2. Any wound not healing for long period and with continue bleeding.
3. Excessive bleeding during menses.
4. Persistent changes in the movement of bowl and bladder.
5. Persistent indigestion and abdominal pain and constipation.
6. Unexplained loss of weight and loss of appetite.
7. Unexplained low grade fever.
8. Any hard area of lump in the body.

These signals are not always due to cancer but signals for early diagnosis.

Cancer can be detected by Endoscopy, Radiological techniques (viz X- rays, CT Scan, MRI) etc.

Treatment of cancer:- Following therapies are available for the treatment of cancer.

1. **Surgery:-** It involves the removal of entire cancerous part at the earliest stage.

2. **Radiotherapy:-**Exposure of cancerous part to radiations with calcium and phosphorus isotopes is useful (Radiotherapy).
3. **Chemotherapy:-** Certain chemicals like mercaptopurine, 6-aminopterin, vincristin and vinblastin are used to treat cancer.
4. **Hormonal therapy:-** Breast cancer is known to be treated with testosterone hormone.
5. Immuno targeting is the latest miraculous hope for the cancer treatment. In this process cancerous cells may be destroyed by immuno targeting injection preparations which is a combination of anticancerous protein bodies plus radioactive substances.
6. Recently experiments are being made on P^{35} gene to activate its function as it is anticancerous.
7. Some vitamins like vit C and Vit B_{17} has anticancer property.

Characteristics of cancer cells:

1. Cancer cells are immortal and can grow indefinitely.
2. They don't show contact inhibition.
3. They lack intercellular adhesion.
4. They are invasive in nature and show metastasis.
5. Cancer cells do not depend on anchorage.
6. Cancer cells can grow in a cultural medium containing much less serum than required for normal cells.
7. In cancer cells, anaerobic respiration is more.

EVALUATION

Q. No.1) Why is AIDS called secondary immune deficiency?

2. Expand AIDS,HIV, NACO,ART,HART,ARC,ELISA,RIA?

3. How is AIDS transmitted from infected to healthy person?

4. Define oncology? What are proto-oncogenes?

5. What are carcinogens? In which cancer type, tumor is not formed?

6.Define SARCOMA,LEUKEMIA,ONCOVIRUSES,METASTASIS And BIOPSY?

7. What are the characteristics of cancer cells ?

ADOLESCENCE –DRUG AND ALCOHOL ABUSE:

Adolescence is the period of rapid physical, mental and reproductive growth which starts before the onset of puberty and continues upto complete sexual maturity. It is the period between 8-18 years for girls and 7-19 for boys. During this period, there occures changes in functioning of neuroendocrine system and in the behaviour of the person.

Drug and Alcohol abuse is very common in adolescents due to curiosity, group pressure, apathy, Excitement and adventure, desire to do more physical and mental work, failure in examination and in love affairs.

Alcoholism:-

Alcoholism:- The continuous drinking of alcohol in the form of beer, whisky, rum, teddy etc is known as alcoholism. If taken in small amounts it acts as stimulant but when taken in large quantities, it switches off the brain and act as depressant. Immediately after drinking of alcohol, it is absorbed through walls of stomach and is transported to liver via blood.

The various effects of alcohol addiction are:

1. It destroys gastric epithelium and cause gastritis resulting in indigestion, loss of appetite and vomiting.
2. The organ which is affected the most by alcohol is liver. In liver some alcohol is changed into more toxic acetaldehyde which provides energy for conversion of alcohol into fats- results in fatty liver syndrome. Liver becomes hard and dry, degeneration of hepatocytes takes place and they are replaced by fibrous tissues. The condition is called cirrhosis. In cirrhosis the glycogen and protein synthetic activities of liver are greatly reduced. Alcoholism may also lead to hepatitis. Liver failure and liver cell carcinoma

3. Due to alcoholism fat accumulation occurs in the body some fats are deposited on walls of blood vessels and cause arteriosclerosis. Thus alcohol drinkers have high risk of cardiac failure.
4. It reduces the blood glucose level (hypoglycemia) and cause degeneration of body cells especially of nerve cells.
5. Alcohol cause inflammation of neurons and nerve fibres and slows down the passage of impulses through nerves.
6. It effects visual centre in brain and reduce field of vision.
7. It effects auditory and speech centers in brain, and so drinkers can't hear properly and their speech becomes incoherent.
8. Alcohol effects cerebellum and causes loss of equilibrium and balance. It also causes loss of judgment.
9. It reduces immunity.
10. It reduces spermatogenesis and oogenesis and cause sterility.
11. It can cause cancer of oral cavity, pharynx, Esophagus, stomach and liver.
12. Babies of alcoholic mothers are often unhealthy and underweight. This is called foetal alcohol syndrome.

Withdrawal symptoms of Alcoholism:- The common withdrawal symptoms of alcohol are mild tremors, nausea, vomiting, weakness, insomnia, anxiety, low heart beat, sweating, hypertension, seizures and visual and auditory hallucination.

An alcoholic is a sick person and requires the attention of the family members and the friends to get rid off alcohol.

DRUG ADDICTION:-

Drugs are normally used for treatment of diseases. However some people use drugs for the purpose other than disease treatment. The continuous use of drugs for longer period makes the person, physiologically and psychological dependent on them. This condition is called drug addiction world Health organization (WHO) in 1964 has introduced the term drug dependence in place of drug addiction.

Various types of drugs, their effects and disorders caused by them are given below.

1. **SEDATIVES:-** they are also called depressants or tranquilizers. These drugs depress activity of central nervous system (CNS) and produce feelings of calmness, relaxation, drowsiness and deep sleep.

The addiction of these drugs result in permanent damage to brain, headache, muscular twitching and coma. E.g. Barbiturates, Benzodiazepines viz Diazepam, Alprozolam, Nitrazepam etc.

Withdrawal symptoms:- Withdrawal of these drugs is characterized by anxiety, tremors, insomnia, vomiting, weakness, seizures, restlessness and epilepsy.

2. OPIATES (NARCOTICS):- The drugs derived from opium alongwith their synthetic relatives are called opiates. These drugs suppress activity of CNS, induce sleep and reduce pain. They are also called pain killers. These drugs are taken in the form of injections, or taken orally or are smoked.

e.g. opium, morphine, codein, heroin (also called smacks or brown sugar) of all these drugs heroin is highly addictive and therefore considered most dangerous opiate.

Effects:- The addiction of these drugs slows down respiratory activity, decrease glandular secretion., impair digestion, produce nausea, vomiting, sterility and total loss of interest in work .

Withdrawl symptoms:- They include foaming of mouth, running of nose, vomiting, muscular cramps, epilepsy etc.

3. **STIMULANTS:-**These drugs stimulate the activity of CNS makes a p-person more wakeful alert, and active and cause excitement. The princip0al stimulants include caffeine, Cocaine and amphetamines. . the caffeine and cocaine are derived from coffee and cocaa plant respectively. The amphetamines are synthetic drugs and are commonly called pep-pills, anti-sleep drugs or sleep uppers . these are mostly consumed by athletes, sportsman, and students (especially during exams in order to do more work)

` The addiction of these drugs cause indigestion, disturbance in renal function, restlessness, convulsions, Headache, cardiac failure, nausea,, vomiting and mental confusion. Withdrawal symptoms include nausea vomiting, body pain, lethargy and severe depression.

4. HALLUCINOGENS(PSYCHEDELIC DRUGS): These drugs change ones mood behavior, thoughts and perceptions in a manner similar to that seen in psychosis. They produce a dream like state and carry a person on psychedelic trips. They cause hallucination and often make users to see sounds and hear colors. They produce false imaginations or extreme feelings of either despair or euphoria by effecting cerebrum and sense organs. They also cause hyperglycemia and polyureia.

The hallucinogens include LSD (Lysergic acid diethylamide) mescaline. Psilocybin and products of hemp plant such as bhang, ganja and charas.

Withdrawl symptoms:- include irritability, restlessness nervousness insomnia decreased appetite.

The hallucinogens prove very harmful if taken along with alcohol.

Preventive measures against alcohol/ drug abuse:-

1. Avoid undue peer pressure.
2. Adolescents should be educated and properly counselled to accept failures and disappointments as a part of life.
3. During difficult periods the adolescents should sought guidance from their parents and teacher and help from their close and trusted friends.
4. Addicts can be rehabilitated by seeking professional and medical help from highly qualified psychologists, psychiatrists and de addiction and rehabilitation programmes.

EVALUATION

Q.No.1) What is the effect of alcohol on liver and vision?

2. List the withdrawalof alcohol?

3.Name four categories of drugs? What are narcotics?

4. Give two sources each of opium,cocaine and caffeine?

5.Name two hallucinogens? Why they are called psychedelic drugs?

POULTRY FARMING:-

The term poultry includes fowls, ducks, geese, turkeys but it is more often used for fowls. The practice of rearing fowls for egg and meat production is known as poultry farming.

Because of cross breeding the new varieties of fowls which are efficient in meat and egg production, the poultry framing has now become popular and large number of people are earning their livelihood from it.

The factors favorable for the growth of poultry farming are small initial investment, quick return, requirement of small area, use of various kinds of food stuff, and increasing demand for eggs and meat.

For successful management of poultry farming it is required that they are provided with proper shelter and balanced diet. These should be protected from enemies. For obtaining maximum yield, the poultry should be kept in dry, clean , properly ventilated and well lighted sheds. Their shelter must be reasonably cool in summer and warm in winter. They should also be vaccinated against the common disease like cholera,ranikhet disease etc.

The majority of the present day chickens used as egg layers and for meat are the cross breed flocks.

Broilers are commonly used poultry for meat. For egg production the common varieties of (layers are IBL- 80 , ILS- 82 and B -77 lay 200 eggs per annum

NH - 260 lay 260 eggs in a year).

DAIRY FARMING

Dairy farming:- The branch of animal husbandry which deals with the improvement in milk production from dairy animals like cows and buffaloes and their proper rearing is known as dairy farming Dr. V. Kurien the founder chairman of National dairy development board (NDDB) at "Gujarat started operation blood which was the world largest dairy development programme. This operation was started in 1970. He is called the architect of India's modern dairy industry and the father of white revolution by which India became the largest prouducer of milk in the world.

Some high yielding breeds of cow and buffaloes are: High yielding breeds of cow:-

1. Holestein – friestan – introduced from Holland
2. Jersy - from England.
3. Ayrshire - Scotland.
4. Brown swiss - Switzerland.
5. Red dane -Denmark.

B. High yielding breeds of buffaloes:-

1. Murrah - Haryana and Punjab:

2.Mehsana _ Gujarat

3.Surti – Gurjat:

4.Jaffrabadi, Bhadawari, and Nilli ravi :Punjab and Haryana

For efficient and productive dairy farming the following things should be taken into consideration:-

1. **Feeding:-** the food given to animals is called feed. In order to maintain good health and increased yield cattle should be given a balanced feed. Feed constitutes two main components i.e., roughage and concentrates.

a. **Roughage:-** contains large amount of fibers but has low nutrients and includes hay, fodder, silage and legumes. It also includes common fodder and grass.

b. The Concentrate is a mixture of cereals like maize oat, barley, jowher, broken grams, cotton seeds, gram bran and oil seed cakes, moistened in water. They are rich in proteins and other nutrients, highly palatable and easily digestible.

Both over feeding and under-feeding should be avoided as both adversely affect yield of milk in cattle.

Dairy farm management practices:- Dairy farm management involves all those process and programs which helps in the increase of yield and improve the quality of milk. It includes:

1. **A goods animal shelter:-** It should have the following characteristics:-

i. it should protect the animals from extreme hotness , coldness, rain and enemy animals.

ii**.** it should have proper sunlight during the day

iii. It should be arrangement for clean drinking water and feeding troughs.

iv. It should be spacious enough.

v. It should have clean, dry, and well ventilated.

vi. It should have slight sloping floor for the hygienic disposal of animal excreta.

vii. Regular brushing of animals to remove dirt and loose hairs.

viii. Regular inspection of dairy farm by a veterinary doctor to identify any health problem and its earliest rectification.

2**. Controlled cross breeding:-** In this type of breeding, native cows are crossed with exotic bulls of superior quality or are artificially inseminated. Hybrid cows yield more milk. E.g. jersy-Sindhi, Browm Swiss- Sahiwal, Ayrshire- Sahiwal, Karan- Swiss etc. Similarly Murrah is an improved high milk yielding breed of buffalo.

There are more than 6000 artificial insemination centers in India. Most important of these is located at veterinary Research institute of India (IVRI) Izatnagar (U.P)

INSECTS AND HUMAN WELFARE (SILK, HONEY, LAC):

Sericuture:- the industries of obtaining raw silk from the silk worm by artificial rearing is called sericulture.

In Indian a number of wild and semi-domesticated silk moths have been cultivated for centuries to obtain usable silk. Mysore is the largest centre of raw silk industry in India followed by jammu and Kashmir.

Indian species of Silk Moth:

1. **Bombyx mori:-** It feeds on mulberry leaves and is commonly called as mulberry silkworm. It produces white or light yellow silk of good quality. Also called Chines silkworm
2. **The tussor silkworm (Anthera mylitta):-** Its catter pillers feed on the leaves of fig, Oak, sal and ber etc. they produce brownish silk.
3. **The muga silkworm (Anthera assma or A. assamensis):-** Its catterpillers feed on cinnamon and Machilus leaves.

The silkworm larva has a pair of silk glands, which are united in their anterior part and open together into the spinnert. Spinnert is the modified part of labium. Anterior section of silk gland secretes silk-substance-the fibroin while the middle section secretes sericin around the fibroin.

During spinning, the catterpiller larva of silk worm stop feeding and start to secrete silk around itself and result in the formation of cocoon. At the time of spinning, the temperature should be 23-24^{o}c.

The pupae inside the cocoon are to be killed, so that they do not crawl out by breaking the cocoon . The process of killing the pupae is called stifling. It is done by exposing the cocoons to heat.

Finally the silk threads are extracted from cocoons. It is called reeling. Prior to reeling the dried cocoons are boiled. The boiling makes cocoons suitable for reeling due to swelling and softening of sericin.

APICULTURE:

The process of rearing of honey bees in the artificial hives called apiaries, for the production of honey at commercial level is known as apiculture.

Species of honey bees:- Honey bees belong to phylum Arthropoda and class insect.

Common species of honey bees are:

a. **Indigenous species:**

i. Apis dorsata (rock bee or-giant bee)

ii. Apis Indica (Indian bee- most common species of India)

iii. Apis florae (little bee)

b. **Exotic species:-**

i. **Apis mellifera:-** It is commonly called Italian bee. It is preferred over the indigenous species, because of its docile nature, high yield of honey, prolific egg production, less swarming and with good defence mechanism.

Importance of Apiculture:

1. **Products of honey bees:-** It includes honey, bees wax , bee venom and royal jelly.

i. **Honey:-** It is produced by the workers from the collected nectar. It is formed of levulose, dextrose, maltose, enzymes and pigments, minerals, vitamins and water.

Honey has high food value and medicinal importance. It is used to treat typhoid, disorders of digestion, dysentery, vomiting and stomach and liver problems. It also acts as laxative and antiseptic. It promotes growth as it contains calcium and iron.

ii. **Bee wax:-** It is used in cosmetics, paints, ointments, polishes and microtomy.

iii. **Bee venom:-** it is used to cure certain diseases like gout and arthritis.

iv. **Royal jelly:-** It is used as a tonic to heart patients and growing children.

2. Honey bees help in cross-pollination.
3. Apiculture provides employment to number of people.
4. Apiculture is not labour intensive.

To get maximum yield, the bee hives should be placed near the bee- flora, so that they can easily get the nectar and produce honey.

Swarming:- It is the process of leaving off of the colony by the old queen with some works and drones to establish a new colony at a new place and to provide the existing hive for the progeny.

Composition of bee colony:- Honey bee are social and polymorphic insects. Bee colony consists of about 40,000 to 100,000 individuals of following types:-

i. **Queen:-** It is single in colony and the fertile female.

ii. **Drones:-** These are male members of colony and their sole function is to copulate with the queen.

iii. **Workers:-** These are largest in number but smallest in size. These are most active and perform variety of jobs like to produce honey, bee wax, clean hives and attend the queen and nursery etc.

LAC CULTURE:-

LAC is resinous secretion produced by lac insect as protective covering around its body. Lac insect belong to phylum arthopoda, class insect and genera laccifera or Tachardia. Laccifera lacca is the common Indian lac insect. It lives on the trees of fig family namely Kikar, ber, babul, peepal, Kusum and gular.

Lac insect feeds upon the sap of its host plant like any other sap sucking insect. It is found in India and Philippine Islands.

The adult male and female insects live on the tree twings enclosed in thick capsules or chambers separately. The lac insect have a sluggish and almost sedentary life. Therefore these have become degenerated , without wings and distinct legs. The females secrete more lac than the males.]

Secretion of Lac and Lac cultivation:

In order to obtain lac, lac insects are cultivated and the technique of lac production is known as lac culture. The secretion forms a shining layer over their bodies in the beginning but hardens and become opaque later on. The secretion is produced by the cutaneous glands, and is deposited around their body. The male comes out from the resinous coating and enter into female chambers and do copulation. The females lay eggs (about 200-300 eggs). The eggs hatch into red coloured larva. These crawl out from the females incubation chamber. The mass emergence of larva is called the swarming. The females remain in small cavities in the resinous mass from which they never come out.

Extraction of Lac:- The largest yield of lac are obtained by harvesting the infested twigs when females are still living. The harvesting is done twice a year in June and November. The encrusted twigs are pruned and lac scrapped from them.

Economin importance of Lac:- Lac is used in the preparation of sealing wax, paints, Varnish, in the manufacture of photographic materials, electrical goods. Lac is also used in the preparation

of bracelets, buttons, toys and in filling hollow gold ornaments. However the use of lac is gradually being replaced by plastic. Further a red dye is obtained from the body of female lac insect which is used by women to colour the soles of their feet and skin.

Lac insects are also used for curing lung and stomach problems.

Cultivation of Lac in India:- India has monopoly in the production of lac. It is about 75% of the world's total output. Approximately 40 lakh ponds of lac is produced annually. Bihar, M.P and West Bengal are the major lac producing States in India. Thailand and Philippine are the major competitor of India as they share 25% of the total export.

EVALUATION

Q.No.1) what is artificial breeding?

2.Expand NDDB and who is called the father of white revolution?

3. Name two high milk yielding each of cross breeds of cows and exotic breeds of cows?

4. Give two advantages of exotic breeds over the indigenous breeds of fowls?

5. Name the most suitable species of honey bee for apiculture?

6. Name the products obtained from honey bees?

7. What is the medicinal importance of honey and bee venom?

8. Give the scientific name of lac insect?

9. What is the economic importance of lac?

Chapter 4th Biotechnology

Biotechnology is the fusion of biology and technology
Term coined by Karl Erkry
Father of biotechnology is Paul berg

Biotechnology is an integration of biochemistry, microbiology and engineering science to achieve technological product of cells, tissues, and parts thereof for the welfare of humans.

Or

It is an integration of natural science and organisms, cells, parts thereof and molecular analogues for products and services. It is according to European federation of technology (EFB).
The two core principles of biotechnology are:

1. *Genetic engineering:- It is altration of genetic material (DNA & RNA) to introduce these into host cell and thus change the phenotype of host cell.*

2. *Chemical engineering:- Maintenance of sterile conditions (microbial free) and enable the growth of only desired cell parts thereof to achieve technological products on large scale. e.g antibiotics, vaccine, enzymes etc.*

Biotechnology

Old/Traditional	*Modern/New*
Products are produced	*Products are produced*
On smaller scale	*On large scale*

It is due to natural capability Recombinant DNA of micro-organism Technology is involved e.g. Curd, Vinegar etc Anti biotics, vaccine etc

The first recombinant DNA was constructed by Stanley Cohen and Herbet Boyer in 1972.

They cut a piece of DNA from plasmid with the help of molecular scissor/restriction end nuclease containing antibiotic resistant gene. Then linked it with native plasmid of salmonella typhimirium with the help of DNA ligase to form rDNA.

Then this rDNA was introduced into E Coli /close resemblance with salmonella typhimurium) where it multiplied with the help of DNA polymerase. This called gene cloning of antibiotics resistant gene in E coli.

Tools of recombinant DNA technology:

The three major tools of recombinant DNA technology are:

1. *Enzymes.*
2. *Vectors.*
3. *Competent host cell.*

1. *Enzymes:- They are of following types*

a) *Lysing enzymes: - these enzymes open the cell to isolate genetic material.*
e.g lysozyme:- dissolve bacterial cell wall.
Chitinase: - dissolve fungal cell wall.
Cellulose: - dissolve plant cell wall.
Proteases and lipases: - dissolve membranes.

b) *Cleaving enzymes: - these enzymes cut the DNA.*
E.g. nuclease.

Nucleases:

Exo Nuclease They remove nucleotides From terminal ends

Endo Nuclease they cut within DNA at specific sites e.g restriction endo nuclease

- *Restriction endonuclease:- they are also called mole molecular scissors/ chemical knives/chemical scalpels.*
They were first discovered by Arber, Nathan and Hamilton smith and they got noble prize.
In 1963 two enzymes were found in bacteria. One called methylase which causes methylation of its own genome at restriction sites. Other called restriction endonuclease which cuts the foreign DNA (bacteriophages) and prevents cell from the infections.

First restriction endonuclease to be discovered was Hin d II(haemopjilous influenza Rd II)

1. *Fragmented DNA is found to move in an electric field in towards the anode in a medium containing agrose (natural polymer obtained from a used called gracillaria gellidrium)*

2. *DNA smaller fragments move faster and farther from centre.*

3. *DNA fragments are separated on the basis size through sieving effect provided by agarose gel.*

4. *DNA is not visualized under normal light but it is stained first and ethidium bromide and followed by exposure to UV rays.*

5. *Bright orange coloured bands are formed. Desired fragments is isolated from gel called elution.*

Vectors/ Vehicle DNA/Carrier DNA.

These are the DNA molecules which carry foreign DNA and introduce it into host cell for multiplication and expressions.

Nomen clature of restriction endonuclease

e.g *E* *Co* *R* *I*

genus *species* *strain* *order*

c) Alkaline phosphate:- they remove phosphate group from 5 end of DNA in order to prevent recircularisation.

d) Joining enzymes:- They join DNA fragments by huping in the formation of phosphodiester bond. E.g DNA ligase.

e) Synthesizing enzymes:-

a. DNA $\xrightarrow{\text{DNA polymerae}}$ *DNA*

b. RNA $\xrightarrow{\text{Reverse transcriplase}}$ *DNA*

- *Gel electrophoresis :- This technique is used to separate and isolate DNA fragments.*
  DNA is negatively charged.

  e.g
  - *Plasmids*
  - *Bacteriophages*
  - *Fosmids*
  - *Cosmids*
  - *Phagemids*
  - *BAC*
  - *YAC*
  - *Animal viral vectors*
  - *Plant Viral vectors*
  - *Transposons*
  - *Shuttle vectors etc.*

Properties of a good vector.

It should have origin of replication (Ori), selectable marker genes, recognition site and easy to handle.
Plasmid:- They are extra chromosomal, circular, double stranded, self replicating present in prokaryotic cells and some yeast cells.
First discovered by William Hays and jashw liederberg
Number of plasmids per bacterial cell is called copy number.
1-2 low copy no
15-100 multiple copy no
1000 high copy no
Naturally occurring plasmids are modified to act as good vectors.
e.g. PBR322, PUC19 (Plasmid university of California)

PBR322:- this plasmid was constructed by Boliver and Redregrvez
P-Plasimd
B-Boliver
R-Redregruez
322-Distinguish this plasmid from others which were constructed in same laboratory

Recognition Sites:- these sites are present within selectable marker gene

e.g Bam H1 & Sal I is present tet^r

These are sites were restriction endonuclease leave and foreign DNA is linked to from rDNA.

Recognition sites also help in identifying and selecting transformed cell with rDNA from transformed cell with non recombinants.

The above method is cumbersome scientists developed an alternative method called Insertional inactivation method. They linked B galstosidae gene with a plasmid which acts as selectable marker gene. This gene produces as enzyme called B galatosidase enzymes and also possess restriction sites. A recombinant can't produce this enzyme and also produces colourless colonies in chromogenic substrate while as non recombinant produces this enzyme and also produces blue colonies in chromogenic substrate.

Ori (Origin of replication)

It is the sequence where from DNA replication starts it is obtained from Ecoli (colE1)

It also controls copy numbers.

Selectable marker genes:

Antibiotic resistant genes are commonly used as selectable marker genes.

e.g. amp^r (ampicilline resistant gene)

tet^r (tetracyclion resistant gene / tenemycin)

Chloroamphenicol

They are helpful in identifying and eliminating non transforments from transformants.
Transformation is process through which foreign DNA is introduced into host bacterium and allowing the growing of only transforments

Cosmids:- It is formed by fusion of Cos-site of phage and plasmid.
It is more efficient than plasmid.
It carries 45kb foreign DNA.

Fos-Mid:- Its formed by fusion of F-plasmid and Cos-site of phage
It carries 40kb foreign DNA

Phage-Mid:- It is formed by union of bacteriophage with plasmid

BAC (Bacterial artificial chromosome):-

It posses selectable marker genes, recognition site, Ori and is based on plasmid of E-Coli.
It carries 300-350kb forign DNA and is used as a cloning vector in human genome project.

Bacteriophage:- Viruses which infect bacteria are called becteriophages.
e.g Phage, M_{13}

Phage:- it posses double stranded linear DNA with 12 unpaired bases at each end called Cos-sites.
It carries 23kb foreign DNA
12 unpaired bases are complemanting to each other.

M_{13}:- It posses single stranded circular DNA
It enters into E coli through Sex Pili where it form double stranded circular DNA called replicative form.

Competent Host Cell

DNA is hydrophilic membrances are hydrophobic.
A competent host cell may be bacterial cell. Animal cell and plant cell.
Bacterial cell is treated

YAC (Yeast Artificial chromosomes):-

It is essentially PBR322 with some sequences of Yeast chromosomes e.g. centromeric Seq. telomeric seq.
It carries 1Mb foreign DNA.
It is also used as cloning vector in HGP

Animal Viral Vector:- the first colnning vector was Sv_{40} in animals cells.
Other include Adenovirus are used as animal viral vectors.
Plant viral vectors:
e.g TMV
Note:- Agrobacterium tumifacens (natural genetic engineer) causes crowngall disease in Dicot plants

It posses a plasmid called Ti plasmid (tumour inducing)

Process of rDNA technology:-

1. *Isolation of genetic material*

Bacterial cell, fungal cell, plant cell and animal cell are treated with Lysozyme, chitinase, cellular and protease, lipase for iso dissolving their cell wall and cell membrance respectively.

Histone proteins and RNA are dissolved by protease and ribonuclease.

Genetic material is then treated with chilled ethanol for purification and precipilation DNA spoling.

2. *Cutting of DNA at specific site: It is done with the help of restriction endonuclease.*

Fragmented DNA is separated and desired gene is isolated in gel electrophrosis.

The desired gene is then linked with vector DNA with the help of DNA ligase to form DNA.

Amplification of gene of interaction by using PCR (polymidase chain reaction)

This technique was invented by Karry Mullis (1985)

It is In-vitro DNA replication

1 billion copies of DNA can be synthesized.

It is completed in 3 steps.

1. *Denaturation:- Reaction mixture (nucleoside tri phosphate, Mg^{2+}, Taq polymerase is heated b/w 90^{o}-98^{o}c which results in breaking of hydrogen bonds*

between two strands of DNA. Hence, two strands of DNA get separating.

2. *Anneling:- Two oligo nucleotide primers are used which hyberdise at 3 of template strand. It is done between 40°c-60°c.*

3. *Extension :- it is performed at 72°c De oxy ribo nucleotides are polymerized in 5°- 3° direction with help of Taq polymerase (Thermus aquaticus)*

Insertion of rDNA into competent host cell/ organism
First the host cell is made competent to receive rDNA then transformed cells are isolated from non transformed cells with the help of selectable marker genes.
Obtaining foreign gene product on large scale.
When a gene is expressed in hetero logous host it is called recombinant protein.
Optimum conditions are required for growth and expression; these conditions are provided by bio reactors (large vessels).
Fo100L-1000L foreign gene product is synthesized in bio reactors.
Bio reactors provide raw materials salts, vitamins, minerals and optimum PH, optimum temperature oxygen.

Bio reactors are of two types

Simple tank bioreactor *Spar shed tank bioreactors*

Stirring makes the availability of (availability of) raw material and O_2 throughout whole bio reactor.

Downstream process:- It is separation, purification and preservation of products before marketing.

Applications of bio technology:-

Applications of bio technology in medicine.
Genetically engineered insulin
Deficiency of insulin causes diabetes.
Insulin was first extracted from the pancreas of Slaughtered cattle and pig then it was injected into humans which were suffering from dubieties but it causes some allergies.
Insulin is a hormone which is recreated by B cells of pancreas.
Gene of insulin is present on chromosome 11
Insulin is secreated as Pro-insulin with 84 amino acid present in 3 chains
(Chain A=21, chain B=30 Chain C=33AA)

Pro insulin is converted into active insulin (chain A&B) by removing chain C. hence active insulin contain only 51 amino acids, in which A and Chain B which are linked by 2 disulphide bridges.

Eli Lilly an American company in 1983 synthesized two DNA sequences corresponding to chain A and Chain B then linked

with Plasmid of Ecoli for synthesis of polypeptide Chain A and Chain B.
These chains were extracted and a[2] disulphide bridge was created b/w them to form human insulin called humulin.

Gene Therapy:-

It is the replacement of faulty gene by normal functional gene.

Gene Therapy

Gerline G.T *Somatic G.T*

Gene therapy is given to germ Cells e.g Sperm, ovum and Zygote
Gene therapy is given to somatic cells e.g Lymphocytes.

The first gene therapy was given to 4 years old girl Ashanti Desilva in 1990. She was suffering from SCID (severe combined immune deficiency) due to deficiency of Adenosine deaminase enzyme which is essential for the proper understanding of immune system
Enzyme therapy and bone marrow in which ADA is given to patient by injection transplantation can cure this disease but both are not permanent cure.
Lymphocytes were extracted from blood of patient and cultured in a cultural medium ADA cDNA was introduced into these lymphaytes by using Retro Virus as a vector. These lymphocytes were back injected into the patient. This

is also not a permanent cure as the lymphocytes have a definite life spam. Patients used a periodic infusion of such genetically eng lymphocyte. Early embryonic gene therapy may be a permanent cure.

Molecular Diagnosis:-

For effective treatment, early diagnosis and understanding pathology molecular diagnosis plays an important role. It involves following 3 methods.

1. *PCR:- polymerase chain reaction. It is used to detect HIV in suspected AIDS patient. It is also used to detect mutations in genes in suspected cancer patients and to identify many other genetic disorder.*

2. *ELISA (Enzyme Linked Immuno Sorbent Assay) it is based on principle of antigen antibody interaction.*

Infection by a pathogen can be detected by the presence of a antigen or by detecting the antibodies synthesized against antigen.

Application in Agriculture.

GMO(genetically modified organism) plants, bacteria, fungi, animals whose genes have been altered by mamupulation. Some plants were formed as post resistant like Rice, Potato, Tomato, BT corn, BT cotton, Soya bean.

In BT cotton BT intra cellular proteins toxin gene was introduced which was present in Bacillus Thuriengenesis. This gene produces pro- toxin in bacillus thuringenisis.

One insect infect cotton plant this pro-toxin gets converted into toxin due in mid gut due to alkaline PH. It causes lysis of epithelical cuts and swelling of mind gut with the result insect

This gene encoding pro-toxin in B.T is called Cry gene. It is having following forms. Cry IAC , Cry II AB control Cotton bollworm

Cry IAB Corn Borer

RNA interference:-

Silencing of mRNA by complementary double stranded RNA is called Rna interference.

It is a cellular defence.

A nematode specific gene is introduced into tobacco plant by using agro bacterium as a vector.

Meloidegyne incognitia infects roots of tobacco plant and causes great reduction in the yield.

Now the genetically modified tobacco plant will synthesizes dsRNA which is broken down into small fragments by Dicer protein.

Once nematode infects tobacco plant sdRNA enters into its body where it combines with RISC (RNA induced silencing complex) which breaks specific mRNA of the nematode and hence, prevents protein synthesis.

Transgenic animals:- animals that have had their DNA manipulated to possess and express the extra gene are called transgenic animals.

Transgenic animals include Mice, Rat, Rabbit, Sheep, Pig, Cows and Fish.

95% transgenic animals are mice. They are very much beneficial for humans.

Impo:-

1. *To study how genes affect normal physiology and development of body (of complex x factor like) Insulin like growth factor. i.e study of complex factor involved in growth such as.*

2. *d.I antitrypsin is synthesized in transgenic sheep which is given against Emphysema (chronic respiratory disease).*

3. *Transgenic animals are used to produce biological products hence, they work as bio reactors.*

4. *A transgenic cow called Rosie was formed in 1997 which produces milk enriched in lactalbumin (204g/l) which is more balanced than normal milk.*

5. *They are used to test the safety of vaccines e.g Polio vaccine in mice.*

6. *They are used to test toxicity of drugs (toxicity/ safety testing). First the transgenic animals are make sensitive to particular drug.*

7. *Study of disease: transgenic model exist for many human disease such as cancer, eystic, fibrosis,*

DNA Fingerprinting

Also called DNA typing / DNA profiling.

Study of fingerprints , palm print, soal print is called dermatoglyphis.

This technology was developed by Sir Alec Jeffry in 1984 in Leicester university (UK).

In india , it was developed by Dr Kashyap and Dr Lalji in CCMB (centre of cell and molecular biology) Hyderabad.

In human genome approximately $3x10^{a}$bp are present.

99.9 % of human genome is similar only 0.1% is different which constitutes $3x10^{6}$bp

These differences are present at telomere, centuomere, heterochromtin and Y chromosome where DNA sequence are repeated many times called repetitive DNA.

Repetitive DNA separates from bulk of DNA as a mior peak called satellite DNA during density gradient centrifugation.

Depending upon number, base pair and repeats satellite DNA are of 2 types.

Mini satellite	*Micro satellite*
1. 30,000 locations	*2 lakh locations*
2. 11-60bp	*10 bp*
3. 1000 repeats	*10-100 repeats*

Mini satellites are also called VNTR (Variable number of tandom repeats) (size varies from 0.1 to 20 kb)

Satellite DNA show DNA polymorphism. It means when a variant on loci is present with a frequency more than 0.01% in human population.

These variations are due to mutations which does not have immediate impact but gets transmitted from generation to generation.

Repetitive DNA is non coding.

DNA polymorphism is the tool for DNA finger printing

Technique of DNA fingerprinting.

1. *Isolation of DNA from source cell e.g. WBC hair follid, spermatozoa etc.*
2. *Cutting of DNA by using restriction endonuclease into fragments.*
3. *DNA fragments are separated by Gel Electrophorisis. Those fragments also contain VNTR.*
4. *VNTR's are amplified by rising PCR.*
5. *Double stranded VNTR's are splitted into single stranded VNTR's by treating them with alkaline chemical.*
6. *Single stranded VNTR's are transferred on nitrocellulose membrance/ nylon paper.*
7. *Radioactive DNA probes are poured on nitrocellulose membrance. The probes which have complementary basis will hybridize with single stranded VNTR's called southern blotting technique. Others are washed out.*
8. *Hybridized VNTR's are exposed to X-ray film dark bands are produced called auto- radiography. These bands represent DNA fingerprints.*

Apps of DNA Fingerprinting:

1. *It helps in distinguishing one human being from another.*
2. *It helps in solving maternal / paternal disputes and also solve (soil) racial issues.*

Cloning:-

Clone:- Exact carbon copy of a single parent is called clone.
e.g. Monozygotic twins, plants reproducing through a sexual reproducing, microbes and dolly.
Cloning:- formation of identical organism clones is called cloning.
Cloning are of following types.

1. *Microbial cloning:- microbes are cloned in a cultural medium for the welfare of humans*
   e.g. 1 .E-coli- for synthesis of insulin.
   2.bacillus thirungenesis- for synthesis of Toxin.
   3.Rhizobium meliloti- help in nitrogen fixation as it posses nif gene.

2. *Cell cloning:- It's based on property of toti potency and pleuri potency.*
   Toti potency is proper of a cell to form a complete individual.
   e.g. plants, Zygote, stem cells.

   Pleuripotency is property in which one type of cell like heart, kidney cell, nerve cell is transferred into another type of cell.

3. *Plant cloning:- is done for production of pest resistant plants, herbicide tolerant crops and production of plants with beautiful flowers.*

4. *Animal cloning:- the first animal clone was produced by Ian Wilmut in Roslin institute in Scotland. He took some udder cells of Ewe and culture them in nutrient deprived medium. Cell division halts and genes become inactive. Then he extracted diploid nucleus from one udder cells, then introduced by electrical stimulation into the egg of other ewe where from haploid nucleus was already extracted. This diploid cell was then kept in the uterus of 3rd ewe (surrogate mother). It developed into a lamb called Dolly (100% identical with mother sheep)*

In Japan 8 identical calves were produced. A cow and a bull were allowed to mate to produce a diploid zygote. Zygote divides to produce 8-celled early embryo. This embryo was extracted and the cells were separated by enzyme each cell was kept in uterus of 8 cows and identical calves were produced.

In USA, endangered species (Asian gaur-Bos gaurus) was cloned. Dead skin cell was taken and diploid nucleus was extracted from it. This nucleus was then introduced into egg of cow from which haploid nucleus was already extracted. This diploid cell was

then kept in the uterus of mother cow. Gaur Calf was produced.

Human Genome Project:-

It was mega project launched in 1990 and completed in 2003. Hence it was 13 year project coordinated by US department if energy and national institute of health.

Maximum funding was given by UK and became major partner.

Japan, France, Germany, china and other are also involved in the project.

Human genome has approx $3x10^9$ bp and cost of sequencing 1 bp requires US dollars. Hence, total cost of sequencing whole genome is $9x10^9$ US dollars(9 billion).

If the sequence were to be stored in typed form in book will require 3300 books with 1000 pages and each page accomidate with 1000 letters.

HGP is closely associated with the aapid development of new era of biology called Bio-informatics.

Goals Of HGP:-

Identify all the approximately 20,000-25000 gene present in human genome.

Determine the sequence of 3 billion base pairs.

Store the information in database.

Transfer the information to other sector.

Address ethical legal and social issues (ELSI) that may arise from the project improve tools for data analysis.

Many non human model organisms such as Eaenorhabidites elegans (non par pathogenic nematode) , bacteria, yeast.
These sequences were then arranged based on some overlapping regions present in them.

Last chromosome to be sequenced was chromosome 1 in may 2006.

Salient features of HGP.

1. *Human genome contains 3164.7 million nucleotide bases.*
2. *Average gene consists of 3000 basis but largest dystrophin gene contain 2.4 million bases and smallest gene Sry contain 14 bases.*
3. *The largest chromosome is chromosome 1 containing 2968 genes while smallest chromosome is Y chromosome and 231 genes.*
4. *The function is unknown for over 50% of discovered genes.*
5. *Less than 2% of genome code for protein.*
6. *The total no of genes estimated are 30,000 which was previously estimated as 80,000 -1,40,000.*
7. *Repeated sequences makeup very large protein of human genome. These sequences are called Repitative DNA.*
8. *Scientists identified 1.4 million locations where only 1 nucliotide difference occurs, called single nucleotide Polymorphism (SNP).*

There are lakh varieties of Rice in India.
27 document varieties of Basmati.
30 recombinant therapeutics.

12 being marketed in india.

Crops engineered for gly phosate are resistant to herbicides. Southern hybridization, include electrophore, clotting. Autoradiography.