HIGHER SECONDARY SECOND YEAR

ZOOLOGY MODULE

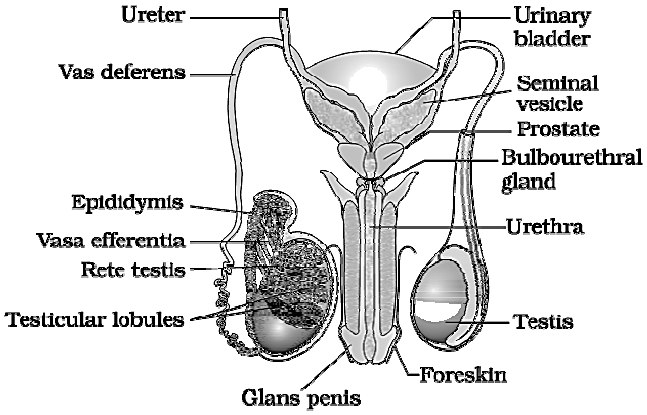
PREPARED BY
SURENDRAN.K
HSST ZOOLOGY
GHSS KUNHIMANGALAM
KANNUR
surendranaduthila@gmail.com

HUMAN REPRODUCTION

THE MALE REPRODUCTIVE SYSTEM.

Male reproductive system includes

I. A pair of testes.
II. Accessory ducts.
III. Accessory glands.
IV. External genitalia



I. Testes:

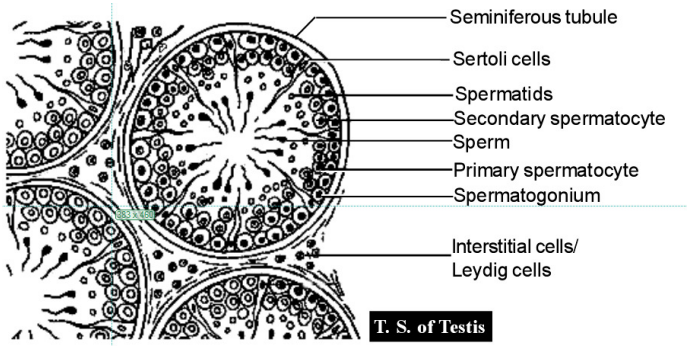
- Located outside the abdominal cavity within a pouch called scrotum. Scrotum provides low temperature required for spermatogenesis. Each testis has about 250 compartments called testicular lobules. Each lobule contains one to three seminiferous tubules. With in the testes there are three types of cells

a. Male germ cell (Sperm mother cells : undergoes meiosis and produce sperm.

b. Sertoli cells provide nutrition to the germ cell and the sperm.

c. In between the seminiferous tubule there is interstitial cell or Leydig cell.

Leydig cells produce testicular hormones called androgen (testosterone).



II Accessory ducts:

- Includes rete testis, vasa efferentia, epididymis and vas deferens. Seminiferous tubules open into vasa efferentia through rete testis . The vasa efferentia leaves the testis and open into epididymis. The epididymis leads to vas deferens that ascends to the abdomen through inguinal canal and loops over the urinary bladder. Vas deferens receives a duct from seminal vesicle and opens into the urethra as the ejaculatory duct. Urethra originates from the urinary bladder and extends through the penis to its external opening called urethral meatus.

rete testis→vasa efferentia→ epididymis →vas deferens→Ejaculatory duct→Common urinogenetal duct

III. Accessory glands:

- Paired seminal vesicle, A prostate gland, Paired bulbourethral gland.
- Secretion of these glands constitutes the seminal plasma. Seminal plasma rich in fructose, calcium, and certain enzyme. Secretion of bulbo-urethral glands helps in lubrication of penis.

IV. Penis is the external genitalia.

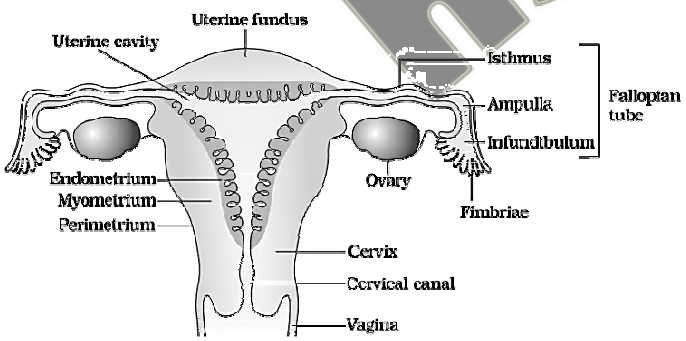
- It is made of special tissue that helps in erection of the penis to facilitate insemination. The enlarged end of penis is called glans penis. Glans penis is covered by a loose fold of skin called foreskin.

THE FEMALE REPRODUCTIVE SYSTEM

The female reproductive system includes:

I. A pair of ovaries
II. A pair of oviduct.
III. Uterus
IV. Cervix
V. Vagina (Oviducts, uterus and vagina constitute the female accessory ducts.)
VI. External genitalia.
VII. A pair of mammary gland.

- Ovaries:
- It is the primary female sex organs that produce the female gamete (ovum). It produces several steroid hormones. The ovaries located in the lower abdomen. They are connected to the pelvic wall and uterus by ligaments. Each ovary is covered by thin epithelium which encloses the ovarian stroma . The ovarian stroma has two zone. A peripheral cortex. An inner medulla.
- Oviduct:
- Oviducts, uterus and vagina constitute the female accessory ducts.
- Each fallopian tube is about 10-12 cm long and extends from the periphery of each ovary to the uterus. Close to the ovary the oviduct has a funnel shaped structure called infundibulum. The edges of the infundibulum possess finger-like projections called fimbriae, which helps in collection of the ovum after ovulation. The infundibulum leads to a wider part of the oviduct called ampulla. The last part of the oviduct is called isthmus which joined to uterus.
- Uterus:
- It is single and is called womb. It is inverted pear shaped. The uterus opens into vagina through a narrow cervix. The lumen of cervix is called cervical canal. Cervical canal along with vagina form the birth canal. The wall of the uterus has three layers of tissues



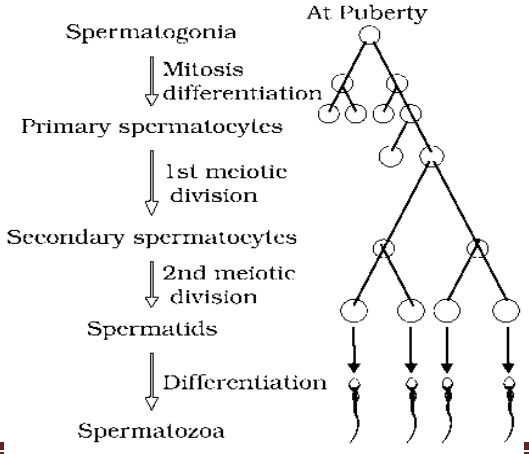
- Perimetrium: external thin membranous. Myometrium: middle thick layer of smooth muscles Endometrium: inner glandular layer. It undergoes cyclical changes during menstrual cycle. Myometrium: exhibits strong contraction during delivery of the baby.
- External genitalia:
- It includes following structures:
- Mons Pubis: cushion of fatty covered by skin and pubic hair.
- Labia majora: fleshy folds of tissue which extends down from the mons pubis and surrounds the vaginal opening.
- Labia minora: are paired folds of tissue under the labia majora.
- Hymen: the opening of vagina is often covered partially by a membrane called hymen.
- Clitoris: a tiny finger-like structure lies at the upper junction of two labia minora above the urethral opening.

- Mammary glands:
- Mammary gland consists of glandular tissue and variable amount of fat. Glandular tissue of each breast contains into 15-20 mammary lobes. Mammary lobes contain cluster of cells called alveoli. The cells of alveoli secrete milk, stored in the lumen of alveoli. The alveoli open into mammary tubules. The tubules of each lobe join to form a mammary duct. Several mammary ducts join to form a wider mammary ampulla. Mammary ampulla connected to lactiferous duct, through which milk is sucked out.

lumen of alveoli ---> mammary tubules --- > mammary duct---> mammary ampulla--- > lactiferous duct

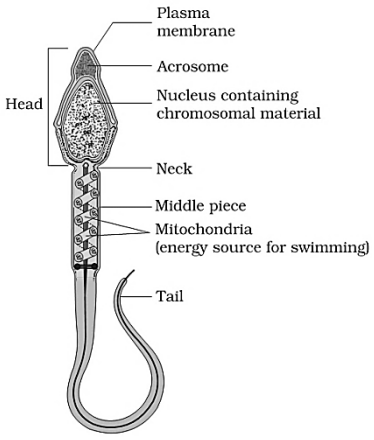
- **GAMETOGENESIS:** (formation of gametes, Formation of Sper4m and Ovum)

• Spermatogenesis:



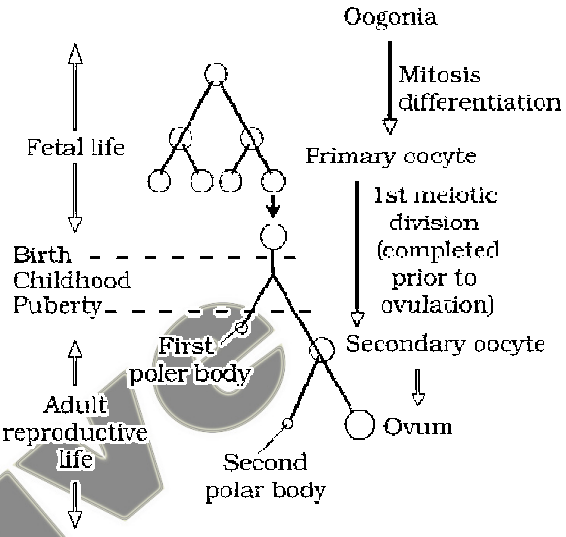
- Formation of sperm from the germ cell in the testes is spermatogenesis. The process begins at puberty only . Spermatogonia present in the lining of seminiferous tubules undergo mitotic division to increase their number. Each spermatogonium is diploid (2n) which contain 46 chromosomes. Some of them becomes Primary spermatocyte(2n). Primary spermatocyte undergoes meiosis-I to form two equal haploid secondary spermatocytes (n). Each secondary spermatocyte undergoes meiosis-II to form two equal, haploid spermatids. Each primary spermatocyte produces four spermatids. Spermatids transformed into spermatozoa (sperms) by the process called spermiogenesis. The sperm head embedded in the Sertoli cell.
- Release of sperm from the seminiferous tubule is called spermiation.
- **Hormonal control of spermatogenesis:.**
- Hypothalamus →Gonadotrophins releasing hormone (GnRH)→ stimulate anterior pituitary
- Pitutary ---- >Luteinizing hormone (LH) + Follicle stimulating Hormone (FSH)
- LH acts on Leydig cells and stimulates synthesis of androgens. Androgen stimulates spermatogenesis.
- FSH acts on Sertoli cells and stimulates spermatogenesis in other ways.

- **Structure of sperm:**
- A sperm has a head, neck, a middle piece and a tail.
- The sperm head contain an elongated haploid nucleus. Above the nucleus a cap like structure present called acrosome. The acro- some contains enzy- mes which help in fertilization of ovum.



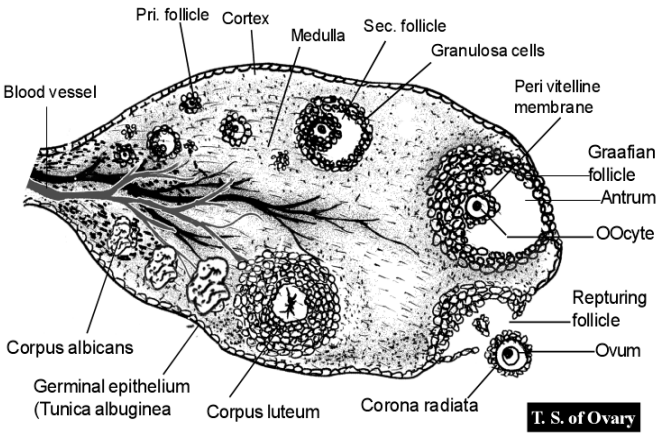
- The middle piece contains mitocho- ndria, which provide energy for movement of tail.
- Tail facilitate sperm motility.
- Human male ejaculates 200-300 million sperms during coitus. 60 percent must have normal shape and size and 40 percent of them must show vigorous motility.

Oogenesis:



- Formation of a mature female gamete or ovum is called oogenesis. Oogenesis starts during embryonic stage. Germinal epithelium of ovary divided mitotically to produce millions of ovum mother cell or oogonia. No oogonia formed or added after birth. Oogonia enters into meiosis-I and continuesuptodiakinesis of Prophase-I and get suspended, at this stage called primary Oocytes.

- Each primary oocyte surrounded by layers of granulose cells and then called primary follicle. At puberty only 60,000 to 80,000 primary oocytes are left in each ovary. After puberty primary follicles get surrounded by more layers of granulosa cells and a new theca to form secondary follicles. The secondary follicle transformed into tertiary follicle, characterized by a fluid filled cavity called antrum. The theca layers organized into an inner theca interna and outer theca externa.
- During the growth of primary follicle into tertiary follicle during puberty, the primary oocyte restarts its first meiotic division and completes it within tertiary follicle resulting two unequal haploid cells. Large haploid cell is called secondary oocyte. A tiny cell called first polar body. The secondary oocyte



retains bulk of the nutrient rich cytoplasm of primary oocyte. The tertiary follicle having secondary oocyte further changes into Graafian follicle. The secondary oocyte surrounded by a new membrane, zonapellucida. The secondary oocyte

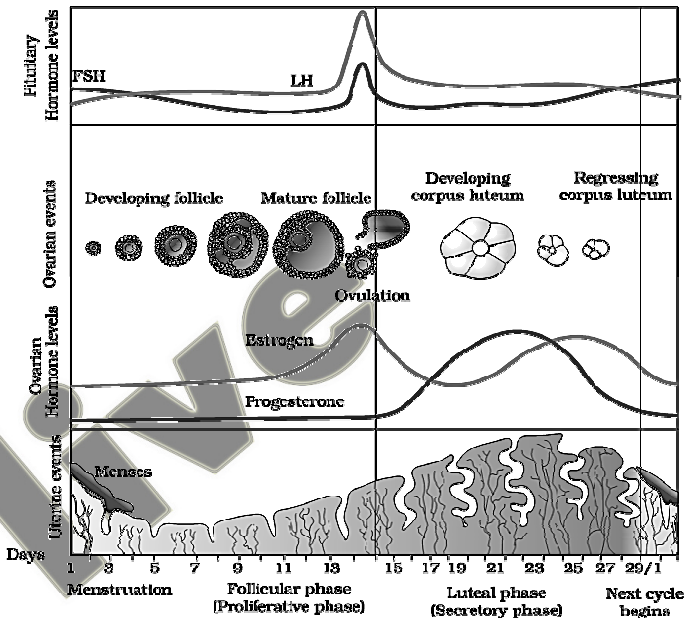
undergoes second meiotic division continued upto metaphase-II and get suspended until entry of sperm.

- At this stage Graafian follicle releases secondary oocyte from the ovary by the process called ovulation. The secondary oocyte complete meiosis-II only is if there is fertilization, and forms a haploid ovum and a second polar body (n).

• Menstrual cycle:

- Reproductive cycle of female primates is called menstrual cycle. The first menstruation begins at puberty is called Menarche. Menstrual cycle repeated at an average interval of 28⁄29 days. One ovum is released in the middle of each menstrual cycle. Menstrual cycle has following phases:

- **Menstrual phase:**1st phase of menstrual cycle. Menstrual flow occurs. Lasts for 3-5 days. Breakdown of endometrial lining and blood vessel causes bleeding through vagina. It occurs only when ovum released but no fertilization. Lack of menstruation is the indication of pregnancy.
- **Follicular phase:**Menstrual phase followed by follicular phase. Primary follicle becomes Graafian follicle. Regeneration and proliferation of uterine endometrium. LH and FSH level increases gradually in follicular phase. Level of estrogen increases as it is secreted from growing follicle. It lasts for 5-13 days.
- **Ovulatory phase:**FSH and LH attain peak level in this period (14th day). This is called LH surge, which induces rupture of Graafian follicle and release of ovum from the ovary called ovulation.



- **Luteal phase:** Remaining part of Graafian follicle transformed into corpus luteum. Coupusluteum produces large amount of progesterone. Progesterone maintains the uterine endometrium, and prepares it for implantation. Thickness of uterine endometrium increase in many folds, due to proliferation.
- If there is fertilization, corpus luteum grows further and pregnancy continued, menstrual cycle stopped. In the absence of fertilization corpus luteum degenerates. Disintegration of endometrium leading to menstruation.
- Menstrual cycle ceases around 50 years of age, called menopause.

FERTILIZATION AND IMPLANTATION:

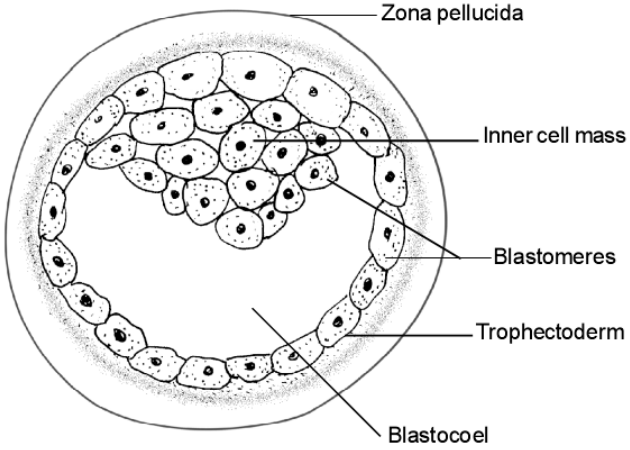
Fertilization involves following events

1) Insemination: During copulation (coitus) semen is released by the penis into the vagina is called insemination.
2) Movement of gamestes: The motile sperm swim rapidly, pass through cervix, uterus and finally reach

the junction of isthmus and ampulla (ammpullary-isthmic junction). The ovum released from the ovary also transported to ampullary isthmic junction where fertilization takes place. Fertilization only takes place if both sperm and ovum reach ampullary – isthmic junction simultaneously.

3) Penetration of sperm into egg :Acrosome of sperm secretes enzymes helps in penetration into the ovum.
4) Changes in the egg : When sperm head touches with egg it completes its second meiotic division and forms a one large ovum (ootid) and one small second polar body (n).
5) Prevention of Polyspermy: Once a sperm comes contact with the zonapellucida of ovum and induces the changes in the membrane that blocks the entry of additional sperms. This preventspolyspermyie. only one sperm fertilize with one ovum.
6) Syngamy: Haploid nucleus of sperm fused with the haploid nucleus of ovum to form a diploid zygote.

- **Sex determination:** Sex of a baby has been decided during fertilization and in the zygote. Sex is determined by the sex-chromosomes present in gametes. Human female contain two XX chromosomes. Human male contain XY chromosomes. All the female gametes produced with only 'X' chromosome. Sperms produced by male, 50% with 'X' and 50 % with 'Y' chromosome.



After fertilization zygote either carries XX or XY chromosomes. Zygote with XX chromosomes develop into female and with XY chromosome develops into male.

- **Early embryonic development:**
- **Cleavage:**Repeated mitotic division of the zygote without growth resulting a multicellular ball like embryo is called cleavage. Cleavage starts soon after fertilization. Daughter cells produced during cleavage are called blastomeres.

- The product of cleavage is called Morula, which is 8 to 16 celled. The morula continues to divide and grow and transformed into blastocyst. The blastomeres in blastocyst arranged into an outer layer called trophoblast and an inner mass of cells attached to trophoblast called inner cell mass. Trophoblast cells attached to the endometrium helps development of placenta. Inner cell mass gets differentiated into the embryo.
- After attachment the uterine cells divide rapidly and cover the blastocyst. Blastocyst
- completely embedded in the uterine endometrium. This is called implantation.

- **Pregnancy and embryonic development:**
- After implantation, finger like projections appears on the trophoblast called chorionic villi. Chorionic villi surrounded by uterine tissue and maternal blood. Temporary association between the fetal tissue (chorionic villi) and maternal tissue (uterine endometrium) is called placenta.

Function of placenta:

a) Transports substances to and from the embryo.
b) Facilitate transport of oxygen and nutrient from mother to embryo.
c) Removes CO_2 and waste material from the embryo.
d) Acts as endocrine gland and produces several hormones like Human chorionic gonadotrophins (hCG), Human placental lactogen (hPL), Estrogen, Progesterone
e) Relaxin produced from the ovary in the later stage of pregnancy. It helps in parturition

Embryonic development:

After implantation the inner cell mass of blastocyst differentiated into an outer layer called ectoderm and an inner layer called endoderm. Mesoderm differentiated in-between ectoderm and endoderm. The inner cell mass thus called stem cells, having potency to produce all types of cell, tissues and organs by differentiation.

- **Organogenesis:**
- Formation of different organs in the embryo is called organogenesis. Human pregnancy lasts for 9 months.
- After one month of pregnancy heart is formed in the embryo.
- By the end of 2nd month the foetus develops limbs and digits.
- By the end of 12 weeks (first trimester) most of organ system is formed (limbs and external genitalia are well developed).
- First movement of foetus and appearance of hairs observed in 5th month.
- By the end of 24th week (2nd trimesters) the body is covered with fine hairs, eye-lids separate, and eyelashes are formed.
- By the end of 9 months the foetus is fully developed and is ready for delivery.

- **PARTURATION AND LACTATION:**
- The period of pregnancy is called gestation period. (9 months). Ejection or expulsion or delivery of foetus is called parturition. Parturition is due to vigorous contraction of uterine Myometrium. The signal of parturition is originated from the fully developed foetus and the placenta which induces mild contraction of uterus called fetal ejection reflex. Fetal ejection reflex triggers the release of Oxytocin from pituitary. Oxytocin induces stronger contraction of uterine endometrium. Stimulatory reflex continues stronger contraction leads to expulsion. After delivery the placenta is also expelled out of the uterus.

Lactation:

- The mammary gland of the female more differentiated during pregnancy, Mammary gland starts producing milk towards the end of the pregnancy. Process of milk production in mammary gland is called lactation. Milk produced during initial days of lactation is called colostrum. Colostrum contains several antibodies which provide immunity to the new born baby.

Prepared by

SURENDRAN. K

HSST ZOOLOGY

GHSS KUNHIMANGALAM

KANNUR

surendranaduthila@gmail.com

REPRODUCTIVE HEALTH

- REPRODUCTIVE HEALTH:- It refers to as a total well being in physical, emotional, behavioral and social
- aspects of reproduction.
- The programme "family planning" initiated in 1951.
- Reproductive and child health care (RCH)
- Sexually transmitted diseases (STD).
- **Amniocentesis:** A fetal sex determination test based on the chromosomal pattern in the amniotic fluid surrounding the developing embryo.
- 'Saheli' an oral contraceptive for female, developed by CDRI.

POPULATION EXPLOSION AND BIRTH CONTROL:

Reasons for population explosion :

a) Increased health facilities,
b) better living conditions.
c) All round development in the various fields
d) Rapid decline in death rate, maternal mortalility rate (MMR) and infant mortality rate (IMR)

Out of 6 billion world population 1 billion are Indians. Indian population growth rate is around 1. 7 percent.

BIRTH CONTROL METHODS:

A. Natural methods: work on the principle of avoiding chances of ovum and sperms meeting.
   1. Periodic abstinence: Avoid or abstain from coitus form day 10 to 17 of the menstrual cycle when ovulation could be expected. Chance of fertilization is very high in this period. It is called fertile period.
   2. Withdrawal or coitus interruption:The male partner withdraws his penis from the vagina just before ejaculation, so as to avoid insemination into the vagina.
   3. Lactational amenorrhea:No menstruation during lactation period. Chance of fertilization is nil. It is effective upto six month.

B. Barrier methods:Prevents physical meeting of sperm and ovum. Such methods available both for male and female.
   1. Condoms: Barriers made of thin rubber/latex sheath. Used to cover the penis in male or vagina and cervix in the female. Used just before coitus so that semen not entered into the female reproductive tract. Male and female condoms are disposable. They also prevents AIDS and STDs.
   2. Diaphragm, cervical caps and vaults:Barriers made of rubber. Inserted into the female reproductive tract to cover the cervix. Prevents conception by blocking the entry of sperm through cervix. They are reusable.

C. Intra Uterine Devices:These devices are only used by female. Inserted by doctor or by expert nurses in the uterus through vagina.
   * Non-medicated IUDs e. g. Lippes loop.
   * Copper releasing IUDs
   (CuT, Cu7, Multiload 375)
   * Hormone releasing IUDs(Progestasert, LNG-20)
   IUDs Increase phagocytosis of sperm within the uterus. Cu ion released suppresses sperm motility and fertilizing capacity of sperm. Hormone releasing IUDs make the uterus unsuitable for implantation and the cervix hostile to the sperm.

D. Oral contraceptives: Used by females in the form of tablets hence popularly called pills. Pills contain progestogens or progestogen-estrogen combination. Pills have to be taken daily for a period of 21 days. Started within first five days of menstruation. Pills are very effective with lesser side effect.

- Saheli- a non steroidal preparation used as oral contraceptive pills.
- Principle of working:
  - Inhibit ovulation.
  - Inhibit implantation.
  - Prevent/retard entry of sperms.

E. Injections or implants:Progestogens alone or in combination with estrogen used as injections or implants under the skin by female. Mode of

action is similar as in pillsIt is very effective for long periods.

F. Surgical methods:

It is also called as sterilization method.

Permanent or terminal method to prevent pregnancy. Sterilization process in male is called '**vasectomy,** Sterilization process in female is called '**Tubectomy**' In vasectomy, a small part of the vas deferens is removed or tied up. In Tubectomy a small part of the fallopian tube is removed.

* Demerit: Reversibility is very poor.

- **MEDICAL TERMINATION OF PREGNANCY**: Intentional or voluntary termination of pregnancy before full term is called medical termination of pregnancy (MTP) or induced abortion. MTP has significant role in decreasing population as it accounts for 1/5th of the total number of conceived pregnancies.
- Merits : Help to get rid of unwanted pregnancies that occur due to casual unprotected intercourse, rapes, Failure of contraceptive used during coitus etc.
- Demerits:

*This method is safe within 1st trimester only

*Use of amniocentesis followed by MTP results in female foeticide which upset male female ratio

*MTP perfomed by un qualified quakes is lethal.

SEXUALLY TRANSMITTED DISEASES:

- Diseases or infections which are transmitted through sexual intercourse. Also known as Venereal diseases (VD) or reproductive tract infections (RTIs). Gonorrhea, Syphilis, Genital herpes, chlamydiasis, genital warts, trichomoniasis, hepatitis-B and HIV are some common STDs. Except hepatitis-B, genital herpes and HIV infections, others are curable.
- Symptoms:
- Itching, fluid discharge, slight pain, swelling in the genital region.
- In the later stage it may leads to Pelvic inflammatory diseases (PID), abortion, still births, ectopic pregnancy, infertility or even cancer in reproductive tract.
- Preventions:
- Avoid sex with unknown partners/ multiple partners.
- Always use condoms during coitus.
- In case of doubt, consult with a qualified doctor for early detection.
- Get timely treatment if diagnosed with disease.

INFERTILITY

- The couple unable to produce children inspite of unprotected sex for long years.
- The reason of infertility may be:- physical, congenital, diseases, drugs, immunological or even psychological.
- Infertility clinic can diagnose and correct the cause of infertility through some special technologies used to have children called assisted reproductive technologies. (ART)
- Assisted reproductive technologies:

(a) In vitro fertilization: Fertilization outside the body in the laboratory. Condition created in laboratory similar to the body.

(b) Embryo transfer: Popularly known as test tube baby programme. Ova from the wife/donor and sperm from the husband/donor are collected and induced to form zygotunder simulated conditions in the laboratory. The zygote or early embryos (with upto 8 blastomeres) could be transferred into the fallopian tube.

- ZIFT- Zygote intra fallopian transfer.
- IUT- Intra Uterine transfer (embryo with more than 8 blastomeres). Further development taken place within the female body.

(c) Gamete intra fallopian transfer- GIFT Transfer of ovum collected from the donor into the fallopian tube of another female who cannot produce it. Such female can provide suitable environment for fertilization and development.

(d) Intra cytoplasmic sperm injection (ICSI): The sperm is directly injected into the ovum. After in vitro fertilization either ZIFT or embryo transfer technique is followed.

(e) Artificial insemination (AI) Semen is collected either from the husband or donor is artificially introduced into vagina or into the uterus (IUI-intra uterine insemination) of the female.

Abbreviations:

IUCD: Intra Uterine Contraceptive Device
RCH: Reproductive and Child Health care
STD: Sexually Transmitted Disease
HIV: human Immuno deficiency virus.
AIDS: Acquired immuno deficiency syndrome
CDRI: Central Drug Research Institute
MMR: Maternal Mortality Rate
IMR: Infant mortality rate.
MTP: Medical Termination of Pregnancy
VD: Venereal Disease
RTI: Reproductive Tract Infection
PID: Pelvic Inflammatory Disease
ART: Assisted Reproductive Technologies
IVF: In Vitro Fertilisation
ZIFT: Zygote Intra Fallopian Transfer
AI: Artificial insemination
IUI: Interna uterine insemination.
ET: Embryo transfer.
IUT: intra uterine transfer.
ICSI: Intra Cytoplasmic Sperm Injection.

Prepared by

SURENDRAN. K

HSST ZOOLOGY
GHSS KUNHIMANGALAM
KANNUR

surendranaduthila@gmail.com

PRINCIPLES OF INHERITANCE AND VARIATION

Genetics: deals with the inheritance, as well as the variation of characters from parents to offsprings.

Inheritance: is the process by which characters are passed on from parent to progeny.

Variation: is the degree by which progeny differ from their parents.

MENDEL'S LAWS OF INHERITANCE:

Gregor Mendel. Conducted hybridization experiments on garden peas for seven years (1856 – 1863) and proposed laws of inheritance. Mendel conducted artificial pollination/cross pollination experiments using several true-breeding pea lines.

Characters of. Pea plants selected by Mendel

S.No	Characters	Contrasting Traits
1.	Stem height	Tall/dwarf
2.	Flower colour	Violet/white
3.	Flower position	Axial/terminal
4.	Pod shape	Inflated/constricted
5	Pod colour	Green/yellow
6.	Seed shape	Round/wrinkled
7.	Seed colour	Yellow/green

INHERITANCE OF ONE GENE:

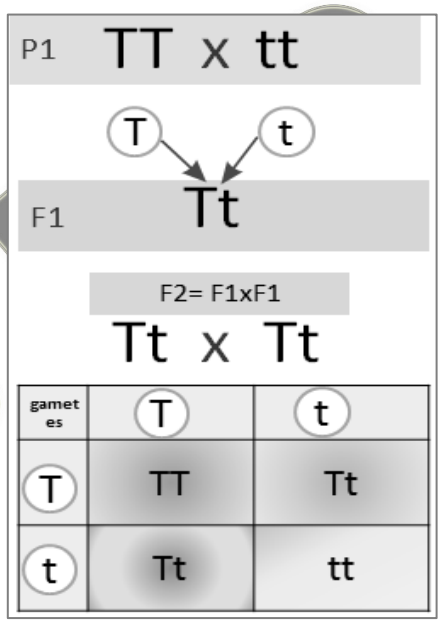
Mendel crossed tall and dwarf pea plants to study the inheritance of one genHe collected the seeds produced as a result of this cross and grew them to generate plants of the first hybrid generation. This generation is called filial progeny or the F1.

Mendel observed that all the F1 progeny plants ere tall, like one of its parents; none were dwarf.

He made similar observations for the other pairs of traits – he found that the F1 always resembled either one of the parents, and that the trait of the other parent was not seen in them.

Mendel then self – pollinated the tall F1 plants and to his surprise found that in the F2 generation some of the offsprings were dwarf; the character that was not seen in the F1 generation was now expressed. The proportion of plants that were dwarf was 1/4th of the F2 plants while 3/4th of the F2 plants were tall.

The tall and dwarf traits were identical to their parental type and did not show any blending, that is all the offsprings were either tall or dwarf, none were of in between height. Similar results were obtained with the other traits that he studied: only one of the parental traits was expressed in the F1 generation while at the F2 stage both the traits were expressed in the proportion of 3:1.



Mendel's proposition:

Mendel proposed that something was being stably passed down, unchanged, from parent to offspring through the gametes, over successive generations. He called these things as 'factors'. Now a day we call them as genes.

***Term gene was given by Johansenn.

Gene is therefore are the units of inheritance.

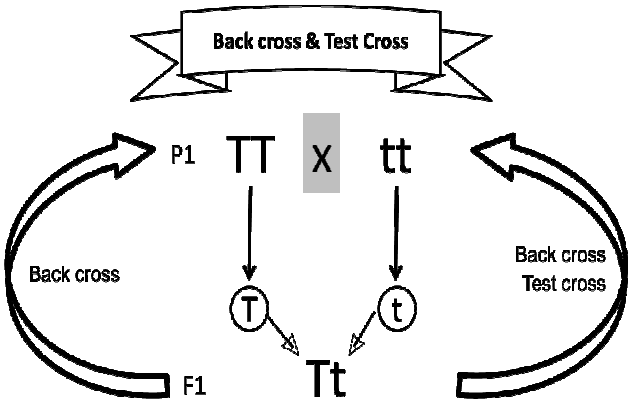
- Genes which codes of a pair of contrasting traits are known as alleles, i. e. they are alternate forms of the same gene.

Test cross:

When F1 hybrid is crossed back with the recessive parent, it is known as test cross.

It is used to know the genotype of the given plant/animal.

Test cross ratio is 1:1



Back cross

Crossing of F1 with either of parents is back cross

Test cross

Crossing of F1 with recessive parent is test cross. Monohybrid test cross ratio is always 1:1.

Law of Dominance:

Characters are controlled by discrete units called factors. Factors occur in pairs.

In a dissimilar pair of factors one member of the pair dominates (dominant) the other (recessive).

Law of Segregation:

During gamete formation; the factors or alleles of a pair segregate or separate from each other such that a gamete receives only one of the two factors.

Incomplete dominance:

When hybrid phenotype dose not resemble either of the two parents and was in between the two, the condition is called incomplete dominance.

Inheritance of flower color in the dog flower (snapdragon or Antirrhinum sp.) is a good example of incomplete dominance.

In incomplete dominance the phenotypic and genotypic ratio are same ie. 1:2:1.

Co – dominance:

F1 generation resembles both parents side by side is called (co-dominance).

Eg. AB blood group in man. Here the two dominant genes (gene A and gene B) expresses together.

Multiple Alleles:

Condition in which more than a pair of allele (genes) control a single character.

Example of ABO blood grouping in man

There are more than two i. e. three allele, control the same character (Blood group)

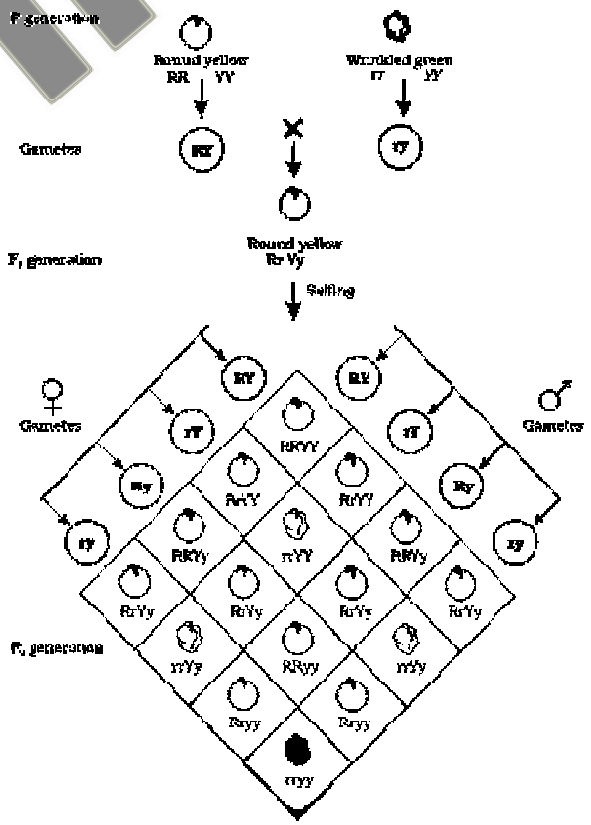
They are IA, IB and i. Each person possesses any two of the three I gene alleles.

I A and I B are completely dominant over i.

When I A, and I B present together they both express as in AB blood group

INHERITANCE OF TWO GENES:

Dihybrid Cross Ratio is 9:3:3:1



Law of independent Assortment:

When two characters (dihybrid) are combined in a hybrid, segregation of one pair of traits is independent of the other pair of traits.

Reasons for unrecognition of Mendel's concepts

1. Communication was not easy in those days and his work could not be widely publicized.
2. His concept of genes (or factors, in Mendel's word) as stable and discrete units that controlled the expression of traits and of the pair of alleles which did not' blend' with each other, was not accepted by his contemporaries as an explanation for the apparently continuous variation seen in nature.
3. Mendel's approach of using mathematics to explain biological phenomena was totally new and unacceptable to many of the biologists of his time.
4. He could not provide any physical proof for the existence of factors.

Rediscovery of Mendel's result:

In 1990 three scientists (deVries, Correns and von Tschermak) independently rediscovered Mendel's result on the inheritance of character.

CHROMOSOMAL THEORY OF INHERITANCE:

Proposed by Walter Sutton and Theodore Bovery in 1902.

1. Genes present in chromosomes are the vehicles of inheritance
2. Both chromosome and genes are present in pairs in diploid cells.
3. Homologous chromosomes separate during gamete formation (meiosis)
4. Fertilization restores the chromosome number to diploid condition.
5. Chromosomes segregate and assort independently.

***Experimental verification of chromosomal theory of inheritance by Thomas Hunt Morgan and his colleagues. Morgan worked with tiny fruit flies, Drosophila melanogaster.

Drosophila is an excellent genetic material -Reasons

- Suitable for genetic studies.
- Grown on simple synthetic medium in the laboratory.
- They complete their life cycle in about two weeks.
- A single mating could produce a large number of progeny flies.
- Clear differentiation of male and female flies
- Have many types of hereditary variations that can be seen with low power microscopes.

Morgans experiments

Morgan hybridized yellow bodied, white eyed females to brown-bodied, red eyed male and intercrossed their F1 progeny. He observed that the two genes did not segregate independently of each other and the F2 ratio deviated very significantly from 9:3:3:1 ratio (expected when the two genes are independent).

When two genes in a dihybrid cross were situated on the same chromosome, the proportion of parental gene combinations was much higher than the non-parental type. Morgan found that this due to the physical association or linkage of the two genes and coined the term linkage.

Linkage: physical association of genes on a chromosome.

Due to linkage genes fail to segregate, and thus the linked genes inherit together throughout generations.

Recombination: the generation of non-parental gene combinations.

Morgan found that even when genes were grouped on the same chromosome, some genes were very tightly linked (showed very low recombination) while others were loosely linked (showed higher recombination).

The genes white and yellow were very tightly linked and showed 1. 3 percent recombination.

The genes white eye and miniature wing showed 37. 2 percent recombination, hence loosely linked.

Alfred Sturtevant used the frequency of recombination between gene pairs on the same chromosome as a measure of the distance between genes and 'mapped' their position on the chromosome.

SEX DETERMINATION:

***Henking (1891) discovered by X-chromosome.

XX-XO type.

Eg. Sex-determination of grass hopper:

All egg bears one 'X' chromosome along with autosomes. Some sperms (50%) bear's one 'X' chromosome and 50% do not. Egg fertilized with sperm (with 'X' chromosome) became female (AA+XX).

Egg fertilized with sperm (without 'X' chromosome) became male (AA + X0)

XX-XY type

Eg. Sex determination in some insects and mammals

Bothe male and female has same number of chromosomes.

Female have autosomes and a pair of X chromosomes. (AA+ XX)

Male have autosomes and one large 'X' chromosome and one very small 'Y-chromosomes. (AA+XY)

This is called male heterogammety and female homogamety.

ZZ-ZW type

Eg. Sex determination in birds:

Female birds have two different sex chromosomes designated as Z and W.

Male birds have two similar sex chromosomes and called ZZ.

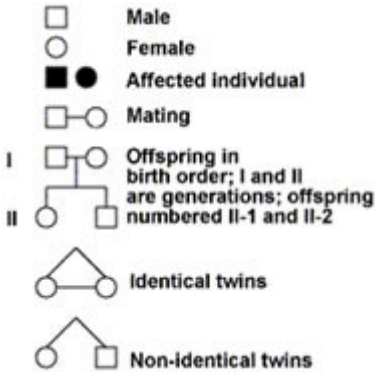
Such type of sex determination is called female heterogammety and male homogamety.

MUTATION

Mutations are sudden heritable genetic changes. It results in alteration of DNA sequences and consequently results in changes in the genotype and phenotype of an organism. Loss (deletion) or gain (insertion/duplication) of a segment of DNA results in alteration in chromosomes. Alteration in chromosomes results in abnormalities or aberration.

- Chromosomal aberrations are commonly observed in cancerous cells.
- Mutations also arise due to change in a single base pair of DNA. This is known as point mutation. E. g. sickle cell anemia.
- Deletion and insertions of base pairs of DNA causes frame shift mutations.

Pedigree Analysis:



Analysis of traits in several of generations of a family is called the pedigree analysis.

In the pedigree analysis the inheritance of a particular trait is represented in the family tree over generations.

Autosomal Dominant:

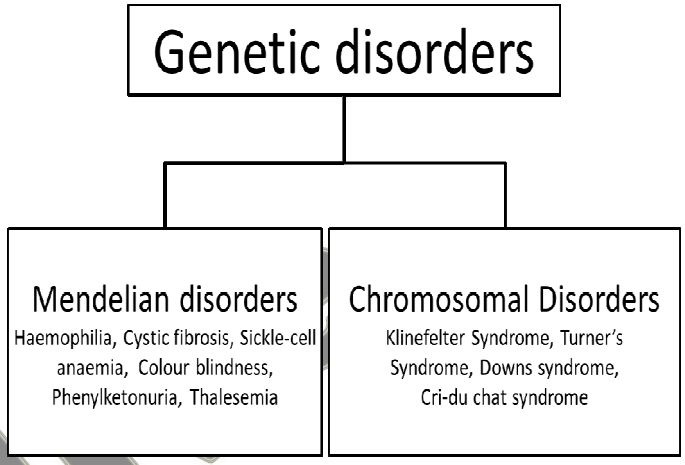
E g. polydactyly, tongue rolling ability etc

Autosomal recessive:

Eg. - Albinism, sickle cell anaemia

GENETIC DISORDERS

•Genetic disorders grouped into two categories



Mendelian disorders & Chromosomal disorder

Mendelian disorders are mainly determined by alteration or mutation in the single gene.

Transmission occurs in Mendelin patterns. Transmission can be predicted. Can be expressed in pedigree analysis.

E.g. Haemophilia, colorblindness, Cystic fibrosis, Sickle cell anemia, Phenylketonuria, Thalasemia etc.

Mendelian Disorders

Hemophilia:

In this disease a single protein (enzyme) that is needed for clotting of blood is not produced. Due to this in an affected individual a simple cut will result in non-stop bleeding.

•Sex linked recessive disease.

• The diseases transmitted from unaffected carrier female to some of the male progeny.

• Female becoming hemophilic is extremely rare because mother of such a female at least carrier and the father should be hemophilic.

• Affected transmits the disease only to the son not to the daughter.

• Daughter can receive the disease from both mother and father.

Sickle cell anaemia:

- Genetic disorder due to mutation in DNA (point Mutation) charactersied by sickling of RBC. Shape of the RBC changes from circular to sickle shape.
- The defect is caused due to substitution of Glutamic acid (Glu) by Valine (Val) at the sixth position of the beta globin chain of the haemoglobin molecule.
- Substitution of amino acid takes place (single base substitution) at the sixth codon of the beta globin gene from GAG to GUG.
- The mutant haemoglobin molecule undergoes polymerization under low oxygen tension causing the change in the shape of the RBC from biconcave disc to elongated sickle like structure.
- This is an autosome linked recessive trait.
- Transmitted from parents to the offspring when both the parents are carrier for the gene (heterozygous).
- This disease is controlled by single pair of allele, Hb^A, and Hb^S.
- There are three possible genotypes (HbAHbA, Hb^AHb^S, and Hb^SHb^S.
- Only homozygous individuals for HbS (HbSHbS) show the diseased phenotype.
- Heterozygous (Hb^AHb^S) individuals appear apparently unaffected but they are carrier of the disease.

Phenylketonuria:

- Autosomal recessive trait.
- Inborn error of metabolism.
- The affected individual lack one enzyme called phenyl alanine hydroxylase that converts the amino acid phenyl alanine to tyrosine. In the absence of the enzyme phenyl alanine accumulated and converted into phenylpyruvic acid and other derivatives. Accumulation of these in brain results in mental retardation. These derivatives excreted through kidney.

Chromosomal disorders:

Caused due to abnormal increase or decrease of one or more chromosome.

Failure of segregation of chromatids during ce7ll division cycle results in the gain or loss of chromosome(s), called Aneuploidy.

Down syndrome:

- Caused due to presence of an additional copy of the chromosome number 21 (trisomy of 21).
- This disorder was first described by Langdon Down (1866).
- Short stature with small round head.
- Furrowed tongue
- Partially opened mouth
- Palm is broad with characteristic palm crease.
- Physical, psychomotor and mental development is retarded.

Klinefelter's syndrome:

- Caused due to the presence of an additional copy of X-chromosome resulting into a karyotype of 47, (44+XXY).
- Overall masculine development.
- Also develop feminine character (development of breast i. e. Gynaecomastia)
- Individuals are sterile.

Turner's syndrome:

- Caused due to the absence of one of the X-chromosomes i. e. 45 (44 + X0).
- Such females are sterile as ovaries are rudimentary.
- Lack of other secondary sexual characters.

Prepared by

SURENDRAN. K

HSST ZOOLOGY

GHSS KUNHIMANGALAM

KANNUR

surendranaduthila@gmail.com

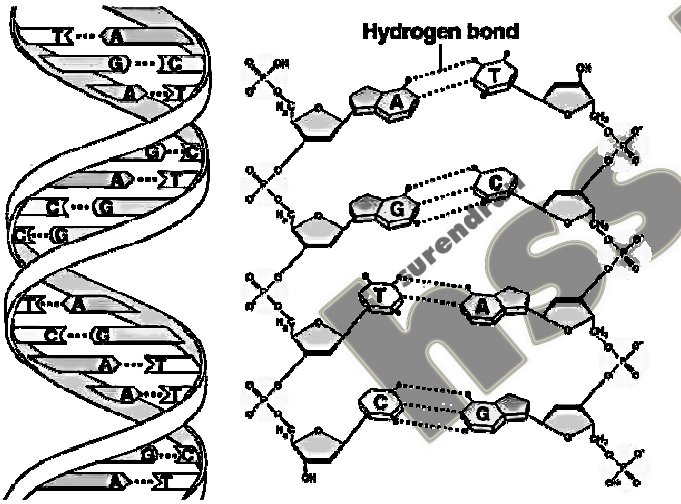
MOLECULAR BASIS OF INHERITANCE

Molecules of inheritance are nucleic acids-DNA & RNA

THE DNA

- DNA is a long polymer of deoxyribo nucleotides.
- The length of the DNA depends on, number of nucleotide pair present in it.
- Number of nucleotides present in an organism is haracteristics of that organism
  - Bacteriophage ø174 has 5386 nucleotides.
  - Bacteriophage lambda has 48502 base pairs.
  - Escherichia coli have 4.6 X 106 base pairs.
  - Human genome (haploid) is 3.3 X 10^9 bp. Diploid human cell has 6.6 x10^9 bp

Structure of polynucleotide chain:



- A nucleotide has three component:-
  - A nitrogen base
  - A pentose sugar (ribose in RNA and deoxy ribose in DNA)
  - A phosphoric acid.
- Nitrogen base are of two types :
  - Purines (Adenine and Guanine)
  - Pyrimidines (Cytosine, Uracil and Thymine)
- Adenine, Guanine and Cytosine is common in RNA and DNA.
- Uracil is present in RNA and Thymine is present in DNA in place of Uracil.
- Pentose sugar is ribose in RNA and Deoxyribose in DNA.
- A nitrogen base attached to the pentose sugar at C1 of pentose sugar by N-glycosidic linkage to form a nucleoside.
- According to the nature of pentose sugar, two types of nucleosides are formed ribonucleoside and deoxyribonucleotides.

	Ribo nucleosides	Deoxyribo nucleotides
Adenine+sugar	Adenosine	Deoxyadenosine
Guanine+sugar	Guanosine	Deoxyguanosine
Cytosine+sugar	Cytidine	Deoxycytidine
Uracil/Thymine+sugar	Uridine	Deoxythymidine.

- Phosphoric acid attached to the 5' OH of a nucleoside by Phosphodiester linkage a corresponding nucleotide is formed. (Ribonucleotide or deoxyribonucleotides depending on the sugar unit).
- Two nucleotides are joined by 3'-5' Phosphodiester linkage to form dinucleotide.
- More than two nucleotides joined to form polynucleotide chain.
- Polynucleotide chain has a free phosphate moiety at 5' end of sugar, is referred to as 5' end
- In the other end of the polymer with 3'-OH group called 3' end.
- The backbone of the polynucleotide chain is sugar and phosphate.
- Nitrogen bases linked to the sugar moiety project from the backbone.
- In RNA every nucleotide has an additional –OH group at 2' of ribose.
- In RNA Uracil is found in place of thymine.
- 5-methyl uracil is the other name of thymine.

Discovery of DNA:

- DNA is an acidic substance in the nucleus was first identified by Friedrich Meischer in 1869. He named it as 'Nuclein"
- 1953 double helix structure of DNA was given by James Watson and Francis Crick, based on X-ray defraction data produced Maurice Wilkins and Rosalind Franklin.
    - Chargaff observed that for a double stranded DNA, the ratio between Adenine and Thymine, and Guanine and Cytosine are constant and equal one.

Salient features of Double helix structure of DNA:

- Made of two polynucleotide chains.
- Sugar and phosphate forms the backbone and bases projected to inside.
- Two chains have anti-parallel polarity.
- Two strands are held together by hydrogen bond present in between bases.
- Adenine of one strand pairs with Thymine of another strand by two hydrogen bonds and vice versa. Guanine of one strand pairs with Cytosine of another strand by three hydrogen bonds and vice versa.
- A purine comes opposite to a pyrimidine. This generates approximately uniform distance between the two strands of the helix.
- The two chains are coiled in a right – handed fashion.
- The pitch of the helix is 3.4 nm or 34 A^0
- There are roughly 10 bp in turn.
- The distance between the bp in a helix is 0.34nm or 3.4 A^0.
- The plane of one base pair stacks over the other in double helix.
- H-bond confers stability of the helical structure of the DNA.

Central dogma: Genetic information passes unidirectionaly. Ie, DNA→ RNA→ Protein.

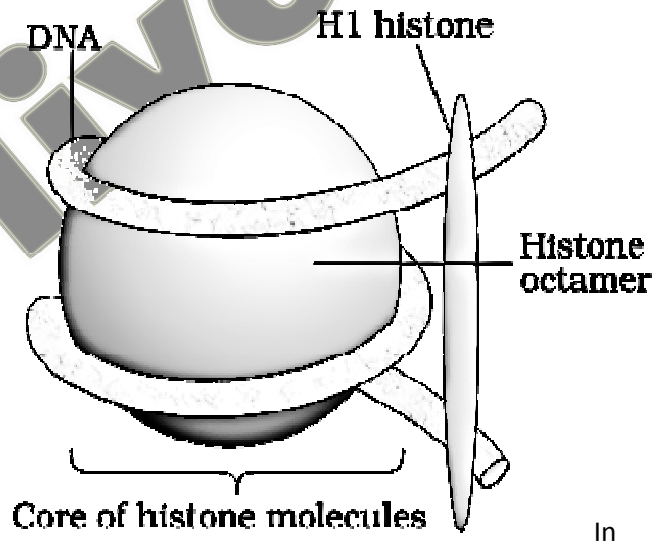
Packaging of DNA Helix:

- Distance between two conjugative base pairs is 0.34nm, the length of the DNA in a typical mammalian cell will be 6.6 $X10^9$ bp X 0.34 $X10^{-9}$ /bp, it comes about 2.2 meters.
- Size of a typical nucleus (10^{-6}m),
  how is such a long polymer packaged in a cell?

Packaging in prokaryotes:

- They do not have definite nucleus.
- The DNA is not scattered throughout the cell.
- DNA is held together with some proteins in a region is called 'nucleoid'.
- The DNA in nucleoid is organized in large loops held be proteins.

Packaging in Eukaryotes:

- 

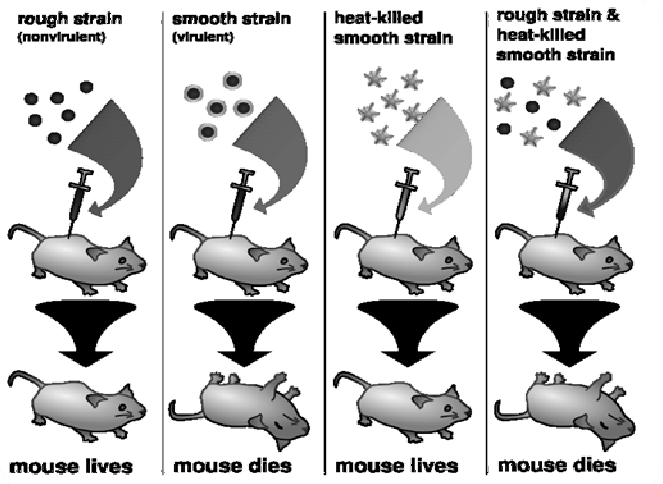
In eukaryotes the packaging is more complex.
- There is a set of positively charged, basic protein called Histones.
- Histones are positively charged due to rich in basic amino acids likeLysines and arginines.
- Histones are organized to form a unit of eight molecules calledhistone octamere.
- Negatively charged DNA wrapped around positively charged histone octamere to form a structure called nucleosome.
- A typical nucleosome contains 200 bp of DNA helix.
- Nucleosome constitutes the repeating unit of a structure in nucleus called chromatin, thread like stained bodies seen in the nucleus.

- The nucleosomes are seen as 'beads-on-string' structure when viewed under electron microscope.
- The chromatin is packaged to form chromatin fibers that are further coiled and condensed at metaphase stage to form chromosome.
- Packaging at higher level required additional set of proteins calledNon-histone Chromosomal (NHC) proteins.
- In a typical nucleus some loosely coiled regions of chromatin (light stained) is called euchromatin.
- The chromatin that more densely packed and stains dark are calledHeterochromatin.
- Euchromatin is transcriptionally active chromatin and heterochromatin is inactive.

THE SEARCH OF GENETIC MATERIAL:

Transforming principle:(Frederick Griffith)

- Given by Frederick Griffith in 1928.
- His experiment based on Streptococcus pneumoniae (caused pneumonia).
- There is change in physical form of bacteria.
- There are two colonies of bacteria:
  - Smooth shiny colonies called S strain.
  - Rough colonies called R strain.



- S-strain bacteria have a mucous (polysaccharide) coat.
- R-strain does not have mucous coat.
- S-strain is virulent and caused pneumonia in mice and died when infected.
- R-strain is non-virulent and dose caused pneumonia in mice when infected.
- Heat killed S-Strain is non-virulent and dose not causes pneumonia.
- The heat killed S-Strain mixed with live R-Strain injected into mice; the mice developed pneumonia and died.
- He recovered live S-Strain bacteria form the dead mice.

Inference from experiment:

- R – Strain bacteria had somehow been transformed by the heat killed S-Strain bacteria.
- Some 'transforming principle', transferred from heat killed S-Strain bacteria, had enabled the R-Strain to synthesize smooth polysaccharide coat and become virulent (S Strain).
- The transformation of R-Strain to S-Strain is due to transfer of Genetic material.
- However the biochemical nature of genetic material was not defined from his experiment.

Biochemical characterization of transforming principle:

- Biochemical nature of transforming principle was discovered by Oswald Avery, Colin Macleod and Maclyn McCarty.(1933-44)
- Prior to their work genetic material was thought to be protein.
- They worked to determine the biochemical nature of the 'transforming principle' of Griffith's experiment.
- They purified biomolecules (proteins, DNA and RNA) from the heat killed S cells to see which one could transform live R cells to S cells.
- Heat killed S-Strain + protease + Live R-Strain → transformation.
- Heat killed S-Strain + RNase + Live R-Strain → transformation.
- Heat killed S-Strain + DNase + Live R-Strain → transformation.

Conclusion of the experiments:

- Protein of heat killed S-Strain is not the genetic material

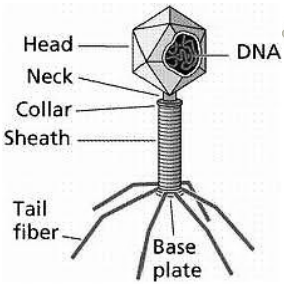
- RNA of heat killed S-Strain is not the genetic material.
- DNA of heat killed S-Strain is the genetic material, because DNA digested with DNase mixed with R-strain unable to transform R-Strain to S-Strain.

DNA-THE GENETIC MATERIAL

Hershey Chase Experiment

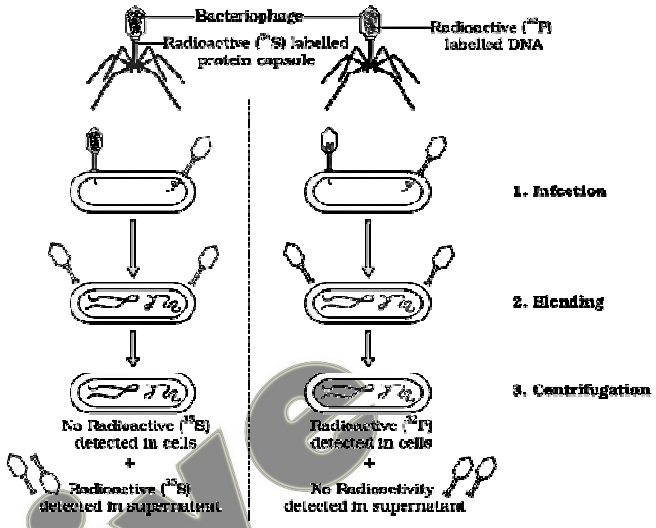
- 'DNA is the genetic material' is proved by Alfred Hershey and Martha Chase (1952).
- They worked on the virus that infects bacteria called bacteriophage.
- During normal infection the bacteriophage first attaches the bacteria cell wall and then inserts its genetic material into the bacterial cell.
- The viral genetic material became integral part of the bacterial genome and subsequently manufactures more virus particle using host machinery.
- Hershey and Chase worked to discover whether it was protein or DNA from the viruses that entered the bacteria.

Experiment : blenders experiment)



Bacteriophage

- They grew some bacteriophage viruses on a medium having radioactive phosphorus and some others on medium having radioactive sulfur.
- Viruses grown in radioactive Phosphorus have radioactive DNA but not radioactive protein because Phosphorus present in DNA not in protein.
- Viruses grown in radioactive sulfur have radioactive protein not radioactive DNA because sulfur present in protein but not in DNA.
- Infection: radioactive phages were allowed to attach to E.coli bacteria; the phages transfer the genetic material to the bacteria.
- Blending: the viral coats were separated from the bacteria surface by agitating them in a blender.
- Centrifugation: The virus particles were separated from the bacteria by spinning them in a centrifuge machine.



Observation:

- Bacteria infected with viruses that had radioactive DNA were radioactive and no radioactivity in the supernatant.
- Bacteria infected with viruses that had radioactive protein were not radioactive, but radioactivity found in the supernatant.

Conclusion of Experiment:

- DNA is the infecting agent that made the bacteria radioactive hence DNA is the genetic material not the protein.

PROPOERTIES OF GENETIC MATERIAL (DNA VS RNA):

Criteria for genetic material:

- It should be able to generate its replica (replication)
- It should be chemically and structurally stable.
- It should provide the scope for slow changes (mutation) that required for evolution.
- It should be able to express itself in 'Mendelian patterns. Protein dose not fulfill the criteria hence it is not the genetic material. RNA and DNA fulfill the criteria.

RNA is unstable:

- 2'-OH group present at every nucleotide (ribose sugar) in RNA is a reactive group and makes RNA liable and easily degradable.
- RNA is also now known as catalyst, hence reactive.
- RNA is unstable and mutates faster. Consequently the viruses having RNA genome and having shorter life span mutate and evolve faster.

DNA is more stable:

- DNA is highly stable, it cannot be destroyed by heat treatment. Two strands being complementary if separated by heating come together, when appropriate conditions are provided.
- Presence of Thymine in place of uracil confers additional stability to DNA
- DNA is chemically less reactive and structurally more stable when compared to RNA. RNA being unstable mutate at a faster rate
- **Therefore among the two nucleic acids the DNA is a better genetic material**.

RNA WORLD:

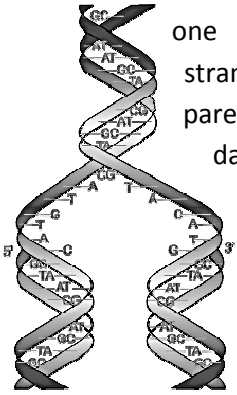
- RNA is the first genetic material.
- Essential life processes evolved around RNA.
- RNA used to act as a genetic material as well as catalyst.
- But RNA being catalyst was reactive and hence unstable.
- Hence DNA has evolved from RNA with chemical modifications that make it more stable.
- DNA being double stranded and having complementary strand further resists changes by evolving a process of repair.

DNA REPLICATION

Process of duplication of DNA by which DNA synthesise its daughter molecule

- "It has not escaped our notice that the specific pairing we have postulated immediately suggests a possible copying mechanism for the genetic material (Watson and Crick, 1953)
  1. Parental DNA Strands unwind
  2. Each unwound strand act as a template
  3. Complimentary nitrogen bases are added to the template strand
  4. Two daughter DNAs are thus formed

- New DNA molecule must have one parental strand and one new strand. ie, Half portion of the parental strand is conserved in each daughter strand. This scheme of replication is called **Semiconservative type** of replication.



Experimental Proof of semiconservative replication:

Mathew Meselson and Franklin Stahl (1958.)

- STEPS OF THE EXPERIMENTS:
- They grew E.coli in $_{15N}$H4Cl medium for many generations. (15N is heavy nitrogen not radioactive element)
- The result was that 15N was incorporated into newly synthesized DNA and other nitrogen containing compound as well.
- This heavy DNA molecule could be distinguished from normal DNA by centrifugation in a cesium chloride (CsCl) density gradient.
- Then they transferred the E.coli into a medium with normal 14NH4Cl and let them grow.(E.coli divides in 20 minutes)
- They took samples at definite time intervals as the cells multiplied, and extracted the DNA that remained as double-stranded helices.
- Various samples were separated independently on CsCl gradients to measure the densities of DNA.
- The DNA that was extracted from the culture one generation after the transfer from 15N to 14N medium had a hybridor intermediate density.
- DNA extracted from the culture after another generation (after 40 min.) was composed of equal amount of this hybrid DNA and of 'light 'DNA.

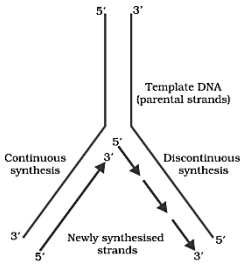
Experiment by Taylor and colleagues:

- Used radioactive thymidine to detect distribution of newly synthesized DNA in the chromosomes.
- They performed the experiment on Vicia faba (faba beans) in 1958.

- They proved the semiconservative nature of DNA replication in eukaryotes.

Replication Machinery and Enzymes:

- In all living cells such as E.coli replication requires a set of enzymes.
- E.coli completes the replication of its DNA in within 38 min.
- The average rate of polymerization has to be approx. 2000 bp per sec.
- The polymerization process must be accurate; any mistake during replication would result into mutation.
- Deoxyribonucleoside triphosphates (dATP, dGTP, dCTP, dTTP) serve dual purposes:
  a. Provide energy for polymerization
  b. Acts as substrates for polymerization.
- The replication process occurs within a small opening of the DNA helix called replication fork.
- The region where, replication fork formed is called origin of replication.
- The replication fork is formed by an enzyme called helicase.
- Two separated strand is called template strands.
- Main enzyme is DNA-dependent DNA polymerase, since it uses a DNA template to catalyze the polymerization of deoxyribonucleotides.
- DNA polymerase catalyses polymerization only in one direction i.e. 5'→3'.



•On one strand (template with 3'→5' polarity) the replication is continuous hence called leading strand.

•In another strand (template with 5'→3' polarity) the polymerization takes place in the form of short fragment called Okazaki fragment.

•The short fragments are joined by DNA ligase, hence called lagging strand.

- In eukaryotes replication takes place in S-phase of cell cycle.
- A failure of cytokinesis after replication results into polyploidy.

TRANSCRIPTION:

'The process of copying genetic information from one strand of the DNA into RNA is termed as transcription'.

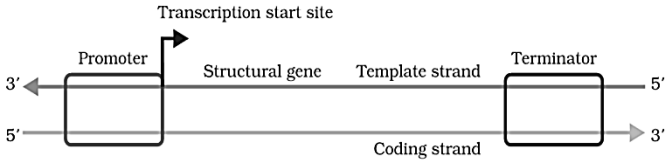
Replication	DNA forms DNA
	once set in, the total DNA of an organism gets duplicated
	Both the strands are copied
	Adenine pair with Thymine
Transcription	DNA forms RNA
	only a segment of DNA is copied
	only one of the strands is copied into RNA
	Adenine pair with uracil

Why both strands of DNA not copied during transcription:

- If both strand of DNA acts as template, they would translated into two RNA of different sequences and in turn if they code for proteins, the sequence of amino acids in the protein would be different. Hence one segment of DNA would be coding for two different proteins.
- The two RNA molecules if produced from simultaneously would be complementary to each other, hence will form double stranded RNA. This would prevent RNA translation into protein.

Transcription unit:

- A transcription unit in DNA has three regions:



- A promoter
- The structural gene
- A terminator.
- DNA dependent RNA polymerase catalyses the polymerization in only one direction that is 5'→3'.

Promoter:

- The promoter located towards 5' end (upstream) of the structural gene.
- It is a short sequence of DNA that provides binding site for RNA polymerase

- Presence of the promoter defines the template and coding strands.
- If the position of promoter is changed with terminator the definition of coding and template strand will be reversed.

Structural gene:

- The DNA strand having polarity 3'→5' is called template strand for transcription.
- The other strand of DNA having polarity 5'→3' is called coding strand.
- The sequences of nitrogen base in the RNA transcribed from the template strand are same as the coding strand of DNA except having Thymine in place of Uracil.
- All the reference point defining a transcription unit is made with the coding strand only, not the template strand.

Terminator:

- The terminator located towards 3' end (down stream) of coding strand.
- It terminates the process of transcription.
- It is also a short segment of DNA which recognizes the termination factor. (ρ-factor).

Transcription unit and the gene:

- Gene is defined as the functional unit of inheritance.
- Genes are located on the DNA.
- The DNA sequence coding for tRNA and rRNA molecule also define a gene.
- Cistron: a segment of DNA (structural gene) coding for a polypeptide.
- Monocistronic: most of eukaryotic structural gene codes for single polypeptide.
- Polycistronic: Most prokaryotic structural gene code for more than one polypeptides.
- In eukaryotes the monocistronic structural gens have interrupted coding sequences, the genes are said to be split gene
  - The coding sequences or expressed sequences are called Exons.
  - Exons are interrupted by Introns.
- Exons are said to be those sequences that appear in mature or processed mRNA.
- Introns never appear in mature of processed mRNA. They are spliced out.

Types of RNA:

- In prokaryotes there are three major types of RNAs: mRNA (messenger), tRNA (transfer), and rRNA (ribosomal).
- All three RNAs are required to synthesize protein in a cell.
- The mRNA provides the template and having genetic information in the form of genetic code.
- The tRNA brings the amino acids and read the genetic code of mRNA.
- The rRNA is the structural part of the ribosome and also as catalytic role during process of translation.

Process of transcription: prokaryotes.

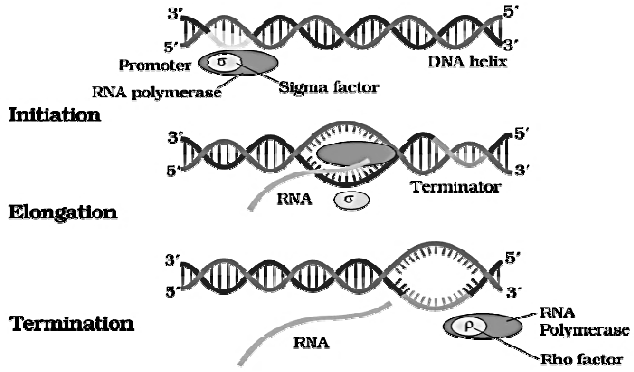
- There is a single DNA dependent RNA polymerase that catalyses transcription or synthesis of all three types of RNAs in prokaryotes.
- The process of transcription completed in three steps:

Initiation:

- RNA polymerase binds to the specific site of DNA called promoter.
- Promoter of the DNA is recognized by initiation factor or sigma (σ).
- RNA polymerase along with initiation factor binds to the promoter.

Elongation:

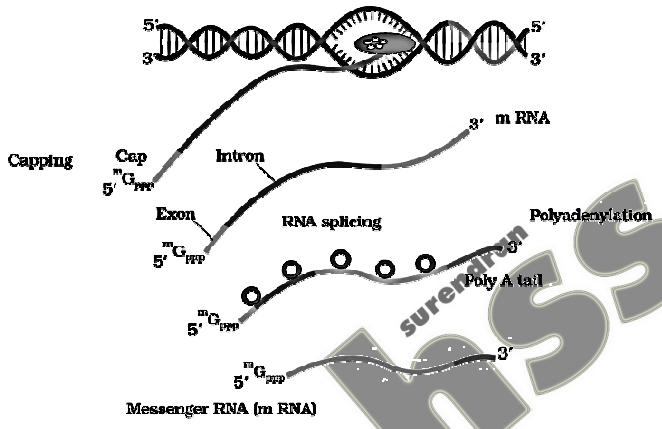
- RNA polymerase unzipped the DNA double helix and forms an open loop.
- It uses ribonucleoside triphosphates as substrate and polymerizes in a DNA template following the rule of complementarity.
- Only a short stretch of polymerized RNA remains binds with the enzyme.
- The process of polymerization continued till the enzyme reaches the terminator gene.



Termination:

- RNA polymerase recognizes the terminator gene by a termination-factor called rho (ρ) factor.
- The RNA polymerase separated from the DNA and also the transcribed RNA.

Additional complexities in eukaryotes:



- There are three different types of RNA polymerases in the nucleus:

o RNA polymerase I transcribes rRNA (28S, 18S, and 5.8S)

o RNA polymerase II transcribes heterogeneous nuclear RNA (hnRNA).

o RNA polymerase III transcribes tRNA, 5srRNA and snRNA.

- Post transcriptional processing: (occurs inside the nucleus)

(a) Splicing:

o The primary transcript (hn RNA) contain both exons and introns and required to be processed before translationally active (mRNA).

o The introns are removed and exons are joined in a defined order.

(b) Capping: an unusual nucleotide called methyl guanosine triphosphate is added to the 5' end of hnRNA.

(c) Tailing: Adenylate residues (200-300) are added at 3' end of hnRNA in a template independent manner.

The processed hnRNA is now called mRNA and transported out of the nucleus for translation.

GENETIC CODE:

- Genetic code direct the sequence of amino acids in proteins during translation.
- George Gamow proposed the code should be combination of bases, he suggested that in order to code for all the 20 amino acids, the code should be made up of three nucleotides.

Discovery:

- Har Govind Khorana synthesised RNA molecules with desired combinations of bases (homopolymer and copolymers).
- Marshall Nirenberg's cell – free system for protein synthesis finally helped the discovery of genetic code.
- Severo Ochoa enzyme (polynucleotide phosphorylase) was also helpful in polymerizing RNA with desired sequences in a template independent manner (enzymatic synthesis of RNA)

Salient features of genetic code:

- The codon is triplet. Three nitrogen base sequences constitute one codon.
- There are 64 codon, 61 codes for amino acids and 3 codons are stop codon.
- One codon codes for only one amino acid, hence it is unambiguous.
- Degeneracy: some amino acids are coded by more than one codon.
- Comma less: the codon is read in mRNA in a continuous fashion from in 5' → 3' direction. There is no punctuation.
- Universal: From bacteria to human UUU codes for phenyl alanine.
- Initiation codon: AUG is the first codon of all mRNA. And also it codes for methionine (met), hence has dual function.
- Non-overlapping: The genetic code reads linearly

- Anticodon: Each codon has a complementary anticodon on tRNA.
- UAA, GUA, and UAG do not code for amino acid and has no anticodon on the tRNA.

1st letter	Second Letter: U	Second Letter: C	Second Letter: A	Second Letter: G	3rd letter
U	UUU Phe, UUC Phe, UUA Leu, UUG Leu	UCU Ser, UCC Ser, UCA Ser, UCG Ser	UAU Tyr, UAC Tyr, UAA Stop, UAG Stop	UGU Cys, UGC Cys, UGA Stop, UGG Trp	U C A G
C	CUU Leu, CUC Leu, CUA Leu, CUG Leu	CCU Pro, CCC Pro, CCA Pro, CCG Pro	CAU His, CAC His, CAA Gln, CAG Gln	CGU Arg, CGC Arg, CGA Arg, CGG Arg	U C A G
A	AUU Ile, AUC Ile, AUA Ile, AUG Met	ACU Thr, ACC Thr, ACA Thr, ACG Thr	AAU Asn, AAC Asn, AAA Lys, AAG Lys	AGU Ser, AGC Ser, AGA Arg, AGG Arg	U C A G
G	GUU Val, GUC Val, GUA Val, GUG Val	GCU Ala, GCC Ala, GCA Ala, GCG Ala	GAU Asp, GAC Asp, GAA Glu, GAG Glu	GGU Gly, GGC Gly, GGA Gly, GGG Gly	U C A G

Mutation and Genetic code:

- Mutations alter the reading frame of m-RNA, and such mutations are called as frame shift mutations.
  - This will change entire physical and chemical properties if the protein to be synthesised.

tRNA-the Adaptor molecule:

- The tRNA is called sRNA (soluble RNA)
- It acts as an adapter molecule.
- tRNA has an anticodon loop that base complementary to the codon.
- It has an amino acid accepter end to which it binds with amino acid.
- Each tRNA bind with specific amino acid i.e 61 types of tRNA found.
- One specific tRNA with anticodon UAC called initiator tRNA.
- There is no tRNA for stop codons. (UAA, UGA, UAG)
- The secondary structure is like clover-leaf.
- The actual structure of tRNA is compact, looks like inverted 'L'.

TRANSLATION:

- It refers to polymerization of amino acids to form a polypeptide.
- The number and sequence of amino acids are defined by the sequence of bases in the mRNA.
- The amino acids are joined by peptide bond.
- Amino acids are activated in the presence of ATP and linked to their specific tRNA is called charging of tRNA or aminoacylation of tRNA.
- Ribosome is the cellular factory for protein synthesis.
- Ribosome consists of structural rRNA and 80 different proteins.
- In inactive state ribosome(70S) present in two subunits:-

o A large sub unit 50S.

o A small sub unit 30S.

Initiation:

- The process of translation or protein synthesis begins with attachment of mRNA with small subunit of ribosome.
- The ribosome binds to the mRNA at the start codon (AUG).
- AUG is recognized by the initiator tRNA.

Elongation:

- Larger subunit attached with the initiation complex.
- Larger subunit has two site 'A' site and 'P' site.
- Initiator tRNA accommodated in 'P' site of large subunit, the subsequent amino-acyl-tRNA enters into the 'A' site.
- The sub subsequent tRNA selected according to the codon of the mRNA.
- Codon of mRNA and anticodon of tRNA are complementary to each other.
- Formation of peptide bond between two amino acids of 'P' and 'A' site, catalyzed by ribozyme, (23S rRNA in bacteria)
- The moves from codon to codon along the mRNA calledtranslocation.

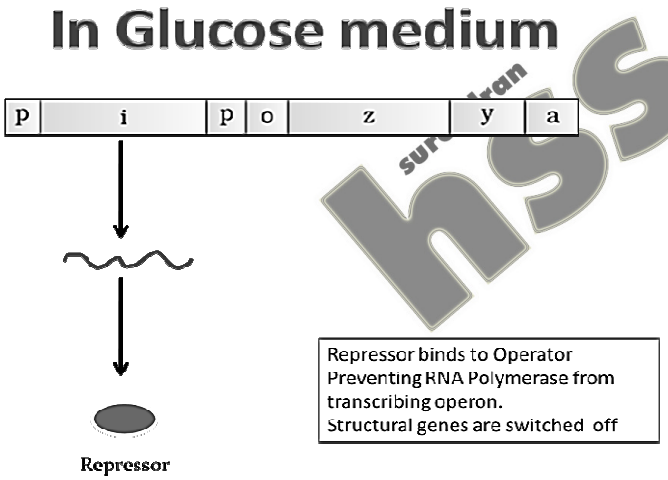
Termination:

- Elongation continues until a stop codon arrives at 'P' site.
- There is no tRNA for stop codon.
- A release factor binds to the stop codon.
- Further shifting of ribosome leads to separation of polypeptide.
- An mRNA also has some additional sequences that are not translated called untranslated regions (UTR).

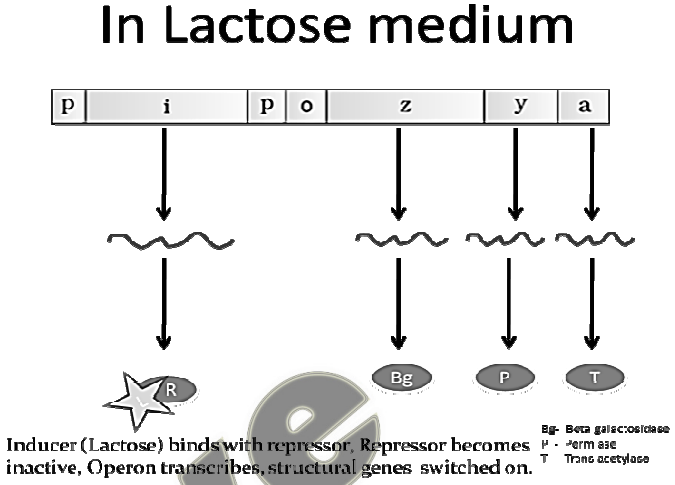
REGULATION OF GENE EXPRESSION:

Lac operon:

- Francois Jacob and Jacque Monod first to describe a transcriptionally regulated system of gene expression.
- A polycistronic structural gene is regulated by common promoter and regulatory genes. Such regulation system is common in bacteria and is called operon.
- Lac operon consists of:-
  - One regulator gene (i-gene)
  - Three structural genes (z,y,a)
  - Operator. (binding site of repressor protein)
  - Promoter.(binding site of the RNA polymerase)
- The i-gene codes for repressor of the lac operon.
- The three structural genes are (z, y and a)
  - 'z'-gene codes for beta-galactosidase, which hydrolyze lactose into Galactose and glucose.
  - 'y' –gene codes for permease, which increases the permeability of bacterial cell to lactose.
  - 'a'-gene codes for transacetylase.



- All three genes are required for the metabolism of lactose in bacteria.
- Inducer: lactose is the substrate for β- galactosidase and it regulates the switching on and off of the lac operon. Hence it is called inducer.
- In the absence of glucose, if lactose is added in the growth medium of the bacteria, the lactose is transported into the cell by permease.
- Very low level of expression of lac operon has to be present in the cell all the time; otherwise lactose cannot enter the cell.



Mechanism of regulation of lac operon:

- The repressor protein is synthesized from i-gene (all time constitutively)
- In the absence of the inducer i.e. lactose the active repressor binds to the operator and prevents RNA polymerase from transcribing the structural gene
- In the presence of the inducer such as lactose or allolactose, the repressor is inactivated by interaction with inducer.
- This allows RNA polymerase access to the promoter and transcription proceeds.
- The regulation of lac operon by repressor is referred to as negative regulation.

HUMAN GENOMIC PROJECT:

- Genetic make-up of an organism or an individual lies in the DNA sequences.
- Two individual differs in their DNA sequences at least in some places.
- Finding out the complete DNA sequence of human genome.
- Sequencing human genome was launched in 190.

Goals of HGP:

- Identify all the approximately 20.000 – 25000 genes in human DNA.
- Determine the sequence of all 3 billion chemical base pairs.
- Store this information in data bases.
- Improve tools for data analysis.
- Transfer related technologies to other sectors, such as industries.
- Address the ethical, legal, and social issues (ELSI) that may arise from the project.

Methodology:

- To identify all the genes that expressed as RNA referred asExpressed Sequence Tags (ETSs).
- Simply sequencing the whole set of genome that contained all the coding and non-coding sequence, and later assigning different regions in the sequence with functions called Sequence Annotation.
- The commonly used hosts for sequencing were bacteria and yeast and vectors were called as BAC (bacterial artificial chromosome) and YAC (yeast artificial chromosome).

Salient features of Human Genome:

1. The human genome contains 3164.7 million nucleotide bases.
2. The average gene consists of 3000 bases.
3. The largest known human gene being dystrophin at 2.4 million bases.
4. The total number of gene is estimated at 30.000.
5. 99.9 percent nucleotide base sequences are same in all peoples.
6. The function of 50% genes discovered is unknown.
7. Less than 2 percent of the genome codes for proteins.
8. Repeated sequences make up very large portion of human genome.
9. Chromosome I has most genes (2968) and the Y has the fewest (231).
10. It is identified about 1.4 million locations where single-base DNA differences (SNPs – single nucleotide polymorphism) occurs in humans.

DNA FINGER PRINTING:

- DNA finger printing is a very quick way to compare the DNA sequences of any two individual.
- DNA fingerprinting involves identifying differences in some specific regions in DNA called repetitive DNA, because in these sequences, a small stretch of DNA is repeated many times.
- During centrifugation the bulk DNA forms major peak and the other small peaks are called satellite DNA.
- Depending on base composition (A:T rich or G:C rich), length of segment, and number of repetitive units, the satellite DNA classified into many types, such as mini –satellite and micro – satellite.
- These sequences dose not code for any proteins.
- These sequences show high degree of polymorphism and form basis of DNA fingerprinting.
- Polymorphism in DNA sequence is the basis of genetic mapping of human genome as well as of DNA fingerprinting.
- Polymorphism (variation at genetic level) arises due to mutations.
- If an inheritable mutation is observed in a population at high frequency it is referred as DNA polymorphism.

The process:

- DNA fingerprinting was initially developed by Alec Jeffreys.
- He used satellite DNA as the basis of DNA fingerprinting that shows very high degree of polymorphism. It was called as Variable Number Tandem Repeats.(VNTR)
- Different steps of DNA fingerprinting are:-

o Isolation of DNA.
o Digestion of DNA by restriction endonucleases.
o Separation of DNA fragments by gel electrophoresis.
o Transferring (blotting) of separated DNA fragments to synthetic membranes, such as nitrocellulose or nylon.
o Double stranded DNA made single stranded.
o Hybridization using labeled VNTR probe.
o Detection of hybridized DNA fragments by autoradiography.

- The VNTR belongs to a class of satellite DNA referred to as mini-satellite.
- The size of VNTR varies from 0.1 to 20 kb.
- After hybridization with VNTR probe the autoradiogram gives many bands of different sizes. These bands give a characteristic pattern for an individual DNA. It differs from individual to individual.
- The DNA from a single cell is enough to perform DNA fingerprinting.

Applications:

- Test of paternity.
- Identify the criminals.
- Population diversity determination.
- Determination of genetic diversity.

Prepared by

SURENDRAN. K

HSST ZOOLOGY

GHSS KUNHIMANGALAM

KANNUR

surendranaduthila@gmail.com

EVOLUTION

ORIGIN OF LIFE:

- Stellar distances are measured in light years.
- The universe is very old – almost 20 billion years old.
- The **Big Bang** theory attempts to explain to us the origin of universe.

The Big Bang theory:

- A singular huge explosion of a dense cosmic mass unimaginable in physical term.
- The universe expanded and hence the temperature came down.
- Hydrogen and Helium formed sometime later.
- The gases condensed under gravitation and formed the galaxies of the present day universe.
- In the solar system of the Milky Way galaxy, earth was supposed to have been formed about 4. 5 billion years back.

Condition of early earth:

- Earth formed 4. 5 billion years back.
- There was no atmosphere on early earth.
- Water vapor, methane, carbon dioxide and ammonia released from molten mass covered the surface.
- The UV rays from the sun broke up water into Hydrogen and oxygen and lighter H_2 escaped.
- Oxygen combined with ammonia and methane to form water, CO_2 and others.
- The ozone layer was formed.
- As it cooled, the water vapor fell as rain, to fill all the depressions and form oceans.

Life appeared 500 Million years after the formation of earth.

Origin of life:

1 Conventional religious literature tells us about the **theory of special creation.**

- The theory of special creation has three connotations:-
  - All the living organisms (species types) that we see today were created as such.
  - The diversity was always the same since creation and will be same in future.
  - Earth is about 4000 years old.

2. Theory of extra terrestrial origin

- Early Greek thinkers thought units of life called **spores** were transferred to different planets including earth.
- Such spores were called 'Panspermia'

3. Theory of spontaneous origin

- Life came out of decaying and rotting matter like straw, mud etc. This was the theory of spontaneous generation.
- **Louis Pasteur experiment:**
- He demonstrated that life comes only from pre-existing life.
- He showed that in pre-sterilized flasks, life did not come from killed yeast while in another flask open to air, new living organism arose from 'killed yeast'.
- This disproved the theory of spontaneous generation.

4. **Oparin – Haldane theory of origin of life: (**chemical origin of life)

- Oparin of Russia and Haldane of England proposed that the first form of life could have come from pre- existing non-living organic molecule (e. g. RNA, protein etc.).
- Formation of life was preceded by chemical evolution i. e. formation of diverse organic molecule from inorganic constituents.

Urey and Miller experiment: Experimental proof to chemical origin of life

- **The conditions on earth were –**
  - High temperature.
  - Volcanic storms.
  - Reducing atmosphere containing CH_4, NH_3 etc.

- In **1953, S. L. Miller** an American Scientist created similar conditions in a laboratory
  - He created **electric discharge** in a closed flask to raise temperature upto 800oC as it was in primitive earth.
  - Used CH_4 H_2, NH_3 and water vapor inside the flask.
  - He observed the formation of **amino acids**.

- In similar experiments others observed, formation of sugars, nitrogen bases, pigment and fats.
- Analysis of meteorite content also revealed similar compounds indicating that similar processes are occurring elsewhere in space.

Theory of biogenesis:

- The first non-cellular forms of life could have originated 3 billion years back.
- They would have been giant molecules (RNA, proteins, Polysaccharides, etc).
- These capsules reproduced their molecules perhaps, named as **coaservates.**
- The first cellular form of life about 2000 millions years ago.
- The first cellular forms of life were probably unicellular.
- All life forms were in water environment only.
- This theory of **biogenesis** is most accepted.

EVOLUTION OF LIFE FORMS – A THEORY:

- Charles Darwin concluded that existing life forms share similarities to varying degrees not only among themselves but also with life forms that millions of years ago. His Observation made during a sea voyage in a sail ship called H. M. S. Beagle round the world.
- Many such life forms exist anymore. There had been extinctions of different life forms in the years gone by just as new forms of life arose at different periods of history of earth.
- There has been gradual evolution of life forms.
- Any population has built in variation in characteristics.
- Those characteristics which enable some to survive better in natural conditions (climate, food, physical factors, etc) would outbreed others that are less-endowed to survive under such natural condition.
- Survival of the fittest. The fitness, according to Darwin, to reproductive fitness.
- Those who are better fit in an environment, leave more progeny than others. These, therefore, will survive more andhence are selected by nature. He called it natural selection.
- **Alfred Wallace**, a naturalist who worked in **Malay Archipelago** had also come to similar conclusions around the same time.

WHAT ARE EVIDENCES FOR EVOLUTION?

- **Paleontological evidence:**
- Fossils are remained of hard parts of life-forms which lived long ago and found in rocks.
- Different-aged rock sediments contain fossils of different life-forms who probably died during the formation of the particular sediment.
- A study of fossils in different sedimentary layers indicates the geological period in which they existed.
  - ✓ *The study showed that life-forms varied over time.*
  - ✓ *Certain life forms are restricted to certain geological time-span.*
  - ✓ *New lives have arisen at different times in the history* of earth.
- All this called **Paleontological evidence.**

Comparative anatomy and morphological evidence:

Comparative anatomy and morphology shows similarities and differences among organisms of today and those that existed years ago.

Divergent evolution:

- Whale, bats, cheetah and human share similarities in the pattern of bones of forelimbs.
- These forelimbs perform different functions in these animals, they have similar anatomical structure – all of them same type of bones in their forelimbs.
- Here, the same structure developed along different directions due to adaptation to different needs.
- This is **divergent evolution** and these structures are **homologous.**
- Homology indicates common ancestry.
- Other examples
  - Vertebrate hearts and brains.
  - **Thorn of *Bougainvillea*** and **tendrils of *Cucurbita***

Convergent evolution:

- Wings of butterfly and of birds look alike.
- They are not anatomically similar structure though they perform **similar function.**
- Hence **analogous** structures are a result of **convergent evolution.**
- **Examples:**
  - Eye of octopus and eye of mammals.
  - Flippers of Penguins and Dolphins.
  - Sweat potato (root modification) and potato (stem modification).

Biochemical evidences:

- Similarities in proteins and genes performing a given function among diverse organisms give clues to common ancestry.

Evolution by natural selection:
Industrial melanism

- Based on observation of moth population in England made in 1850.
- Before industrialization set in, it was observed that there were more white-winged moths on trees than dark-winged or melanised moths.
- After industrialization i. e. 1920 there were more dark-winged moths in the same area i. e. the proportion was reversed
- This showed that in a mixed population, those that can better-adapt, survive and increase in population size. No variant is completely wiped out in natural selection.

Evolution by anthropogenic action:

- Excess use of herbicides, pesticides etc. , has resulted in selection of resistant varieties.
- Excess use of antibiotics result resistance development in microbes.
- These are the examples of evolution by **anthropogenic action**.
- **Evolution is a stochastic process based on chance events in nature and chance mutation in the organisms.**

ADAPTIVE RADIATION

- **Darwin's Finches:**
  (Divergent evolution)
- In Galapagos Islands Darwin observed small black birds later called Darwin's Finches.
- There were many varieties of finches in the same island.
- All the varieties, he came across, evolved on the island itself.
- Form the original seed-eating features, many other forms with altered beaks arose, enabling them to become insectivorous and vegetarian finches
- This process of evolution of different species in a given geographical area starting from a point and literally radiating to other areas of geography (habitats) is called adaptive radiation.
- **Australian marsupial:**
  (Convergent evolution)
- A number of marsupials each different from the other evolved from an ancestral stock. But all within the Australian island continent.
- When more than one adaptive radiation appeared to have occurred in an isolated geographical area (representing different habitats), it is called as **convergent evolution.**
- **Placental mammals** in Australia also exhibit adaptive radiation in evolving into varieties of such placental mammals each of which appears to be 'similar' to a corresponding **marsupial** (e.g. placental wolf and Tasmanian wolf-marsupial).

BIOLOGICAL EVOLUTION:

- The essence of Darwinian Theory is natural selection.
- The rate of appearance of new forms is linked to the life cycle or the life span.
- There must be a genetic basis for getting selected and to evolve.
- Some organisms are better adapted to survive.
- Adaptive ability is inherited.
- It has genetic basis.
- Fitness is the end result of the ability to adapt and get selected by nature.
- **Branching descent and natural selection are the two key concepts of Darwinian Theory of Evolution.**

- **Lamark's theory of evolution: (theory of inheritance of acquired characters)**
- French Naturalist Lamark had said that evolution driven by use and disuse of organs.
- He gave the example of Giraffes which had stretched their necks so as to reach at heights in an attempt to forage leaves on tall trees. This caused elongation of their necks.
- They passed on this acquired character of elongated neck to succeeding generations.
- Giraffes, slowly over the years, came to acquire long necks.

- **MECHANISM OF EVOLUTION:**
- In the first decade of twentieth century, **Hugo deVries** based on his work on **evening primrose** put forward the idea of **mutations.**
- Mutations are the sudden heritable large scale changes in an organism.
  - ***deVries theory of mutation Vs. Darwin's theory of natural selection?***

- It is the mutation which causes evolution and not the minor variations that Darwin talked about.
- Mutations are random and directionless while Darwinian variations are small and directional.
- Evolution for Darwin was gradual while deVries believed mutation caused speciation and hence called it **saltation** (single step large mutation).

HARDY – WEINBERG PRINCIPLE:

- In a given population frequency of occurrence of alleles of a gene is supposed to remain fixed and even remain the same through generations.
- Hardy-Weinberg principle stated it using algebraic equations.
- The principle states that **allele frequencies in a population are stable and is constant from generation to generation**.
- The gene pool (total genes and their alleles in a population) remains a constant. This is called **genetic equilibrium**:
- Sum total of all the allelic frequencies is 1.
- **$(p + q)^2 = p^2 + 2pq + q^2 = 1$.**
- When frequency measured, differs from expected values, the difference (direction) indicates the extent of evolutionary change.
- Disturbance in genetic equilibrium, or i. e. change of frequency of alleles in a population would then be interpreted as resulting in evolution.

- Five factors are known to affect Hardy-Weinberg equilibrium:
  - **Gene migration or gene flow.**
  - **Genetic drift.**
  - **Mutation.**
  - **Genetic recombination.**
  - **Natural selection.**

- **Gene migration:** When migrations of a section of population to another place occur, gene frequencies change in the original as well as in the new population. New genes /alleles are added to the new population and these are lost from the old population.
- **Gene flow**: Gene migration occurs many time is termed as gene flow.
- **Genetic drift**: change in gene frequency takes place by chance.
- **Founder effect:** sometimes the change in allelic frequency is so different in the new sample of population that they became a different species. The original drifted population becomes **founder species** and the effect is called **founder effect.**
- **Operation of natural selection on different trait:**
- Natural selection is of three tyes:
  - **Stabilizing selection**: in which more individuals acquire mean character value.
  - **Directional selection** i. e. more individuals acquire value other than the mean character value.
  - **Disruptive selection:** more individuals acquire peripheral character value at both ends of the distribution curve.

A BRIEF ACCOUNT OF EVOLUTION:

- ⊕ About 2000 million years ago (mya) the first **cellular forms** of life appeared on earth.
- ⊕ Some cellular form had the ability to release O_2.
- ⊕ Slowly single cell organisms **became multi-cellular life** forms.
- ⊕ By the time of 500 mya **invertebrates** were formed and active.
- ⊕ **Jawless fish** probably evolved around 350 mya.
- ⊕ Sea weeds and few plants existed probably around 320 mya.
- ⊕ **Coelacanth** a lobe finned fish discovered in South Africa in 1938 evolved into first amphibians that lived on both land and water. These were **ancestors of modern day frogs and salamanders.**
- ⊕ The amphibian evolved into **reptiles.**
- ⊕ Reptiles' lays eggs which don not dry up in sun unlike those of amphibians.
- ⊕ Giant ferns (pteridophytes) were present but they fell to form coal deposits slowly.
- ⊕ Some of the reptiles went back into water to evolve into fish like reptiles probably 200 mya (***Ichthyosaurs***)
- ⊕ The land reptiles were the **dinosaurs.**
- ⊕ The biggest dinosaurs are *Tyrannosaurus rex* was about 20 feet in height and had huge fearsome dagger like teeth.
- ⊕ About 65 mya the dinosaurs suddenly disappeared from the earth.
- ⊕ Some of them evolved into **birds.**

- ⊕ The **first mammals** were like shrews. Their fossils were small sized.
- ⊕ Mammals were viviparous and protected their unborn young inside the mother's body.
- ⊕ Due to continental drift, pouched mammals of Australia survived because of lack of competition from any other mammals.

ORIGIN AND EVOLUTION OF MAN:

- About 15 mya primates called ***Dryopithecus*** and ***Ramapithecus*** were existing.
- They were hairy and walked like gorillas and chimpanzees.
- *Ramapithecus* was more **man like** while *Dryopithecus* was more **ape-like.**
- Few fossils of man-like bones have been discovered in Ethiopia and Tanzania.
- Two mya ***Australopithecines*** probably lived in East African grasslands.
  - They hunted with stone weapons.
  - Essentially ate fruit.
- The first human-like being the hominid and was called ***Homo habilis***.
  - Brain capacity between 650 – 800 c.
  - They did not eat meat.
- Fossils discovered in Java in 1891 revealed the next stage i. e. ***Homo erectus*** about 1. 5 mya.
  - Had large brain around 900 cc.
  - Probably ate meat.
- **Neanderthal man:**
  - Brain size 1400 cc
  - Lived in east and central Asia between 1, 00,000-40,000 years back.
  - They used hides to protect their body.
  - Buried their dead.
- ***Homo sapiens:***
  - Arose in Africa and moved across continents and developed distinct races.
  - During ice age between 75,000-10,000 years ago modern Homo sapiens arose.
  - Pre historic cave art developed about 18,000 years ago.
  - Agriculture came around 10,000 years back and human settlement started.

Prepared by

SURENDRAN. K

HSST ZOOLOGY

GHSS KUNHIMANGALAM

KANNUR

surendranaduthila@gmail.com

HUMAN HEALTH AND DISEASE

- ✓ Improper functioning of one or more organs or systems of the body is called **disease.**
  Three tyes of diseases
- ✓ genetic disorders
- ✓ infections diseases
- ✓ life style diseases

- ✓ Diseases which can easily transmit from one person to other by any means are called **infectious** or **communicable diseases.**
- ✓ Diseases which can not be transmitted from one person to another are called **non-infectious** or **non-communicable diseases.**
- Disease causing organisms are said to be **pathogen.**

COMMON DISEASES IN HUMANS

TYPHOID:

- **Pathogen:** *Salmonella typhi* (bacterium)
- **Organs affected**: small intestine, migrate to other organs through blood.
- **Method of transmission**: contamination of food and water.
- **Symptoms:**

⊕ Sustained high fever (39^{o} to 40^{o}C)
⊕ Weakness, stomach pain, constipation, headache and loss of appetite.
⊕ Intestinal perforation and death may occur.

- **Test:** Typhoid fever could be confirmed by **Widal test.**

PNEUMONIA:

- **Pathogen:** *Streptococcus pneumoniae*and *Haemophilus influenzae.*
- **Organs affected:** Alveoli of lungs, alveoli get filled with fluid.
- **Method of transmission:** inhaling the droplets/aerosols released by infected person. Sharing glasses and other utensils.
- **Symptoms:**

⊕ Fever, chills, cough and headache.
⊕ In severe cases the lips and finger nails turn gray to bluish colour

- **COMMON COLD:**
- **Pathogen**: Rhino viruses.
- **Organs affected**: nose and respiratory passage
- **Method of transmission:**
- Direct inhalation of droplets from infected person.
- Through contaminated objects like pen, books, cups, computer key board.
- **Symptoms:**

⊕ Nasal congestion and discharge, sore throat, hoarseness, cough.

- **MALARIA:**
- **Pathogen:***Plasmodium. (P. vivax, P. malariae, P. ovale, P. falciparum)*
- **Malignant malaria** caused by **P. falciparum** is fatal.
- **Organs affected**: liver, RBC.
- **Method of transmission**: by biting of female anopheles mosquito (vector)
- **Symptoms:** high fever and chill, fever occurs on every alternate day, vomiting.

- **Life cycle of malaria parasite:**
- Life cycle of plasmodium starts with inoculation of **sporozoites** (infective stage) through the bite of infected female *Anopheles* mosquitoes.
- The parasite initially multiplied within the liver cells and then attack the red blood cells (RBCs) resulting in their rupture.
- There is release of a toxic substance called **hemozoin** from the ruptured RBCs which responsible for the **chill and high fever**.
- From the infected human the parasite enters into the body of Anopheles mosquito during biting and sucking blood.
- Further development takes place in the body of Anopheles mosquitoes.
- The female mosquito takes up **gametocytes** with the blood meal.
- Formation of gametes and fertilization takes place in the intestine of mosquito.
- The zygote develops further and forms thousands of sporozoites which migrated into the salivary gland of mosquito.
- When the mosquito bite another human sporozoites are injected.

- The malarial parasite requires two hosts – human and Anopheles, to complete their life cycle.

AMOEBIASIS (Amoebic dysentery)

- **Pathogen:***Entamoeba histolytica* a protozoan parasite.
- **Organs affected:** large intestine of man
- **Method of transmission:**
- House fly acts as mechanical carrier.
- Contamination water and food with faecal matter.
- **Symptoms:**

⊕ Constipation, abdominal pain and cramps.
⊕ Stools with excess mucous and blood clots.

ASCARIASIS:

- **Pathogen:***Ascaris lumbricoids* (nematode)
- **Organs affected:** intestine of man
- **Method of transmission:** Contaminated water, vegetables, fruits.
- **Symptoms:**

⊕ Internal bleeding, muscular pain, fever, anemia.
⊕ Blockage of the intestinal passage.

- **FILARIASIS** OR **ELEPHANTIASIS:**
- **Pathogen:** Wuchereria (*W. bancrofti* and *W. Malayi*) (nematode parasite)
- **Organs affected**: lymphatic vessels of the lower limbs, genital organs.
- **Methods of transmission**: biting of infected female culex mosquito.
- **Symptoms:**

⊕ Chronic inflammation of the organs where they live for many years.
⊕ Abnormal swelling of lower limb, scrotum, penis.

- Hence the disease named as **elephantiasis** or **Filariasis.**

RING WORMS:

- **Pathogen**: *Microsporum, Trichophyton* and *Epidermophyton* (fungi)
- **Organs affected**: Skin, nails, folds of skin, groin.
- **Method of transmission:**
- Acquired from the soil.
- Using towel, clothes or even comb of infected individuals.
- **Symptoms:**

⊕ Appearance of dry, scaly lesions in skin nails and scalp.
⊕ Lesion accompanied with intense itching.

- **Heat** and **moisture** help these fungi to grow.

PREVENTION AND CONTROL OF INFECTIOUS DISEASES:

- Maintenance of personal and public hygiene is very important for prevention and control of many infectious diseases.
- **Personal hygiene** includes:
  - Consumption of clean drinking water, food vegetable fruits.
  - Keeping the body cleans.

- **Public hygiene** includes:
  - Proper disposal of waste and excreta
  - Periodic cleaning and disinfection of water reservoirs, pools, cesspools.
  - Standard practices of hygiene in public catering.

- In case of **air-borne diseases**, close contact with the infected persons or their belongings should be avoided.
- **For vector borne diseases**
- Control or eliminate the vectors and their breeding places.
- Avoiding stagnation of water in and around residential areas.
- Regular cleaning of household coolers.
- Use of mosquito nets.
- Introducing fishes like ***Gambusia*** in pond that feeds on mosquito larvae.
- Spraying of insecticides in ditches, drainage area and swamps.
- Window and doors must be fitted with wire mesh.
- All these precautions are useful for vector borne disease like dengue and Chickungunya, malaria and filarial etc.

Immunization:

- By massive immunization we eradicated smallpox.
- Diseases like polio, diphtheria, pneumonia, and tetanus have been controlled in large extent.

IMMUNITY:

- The overall ability of the host to fight the disease causing organism by immune system is called **immunity.**
- There are two types of immunity:
  - Innate Immunity.
  - Acquired Immunity.

Innate (non-specific) immunity:

- Called **inborn immunity.**
- Always available to protect out body.
- This is called the **first line of defense.**
- Consists of various **barriers** that prevent entry of foreign agents into the body.
- Different types of barriers are as follows:

a. Physical barriers:

- Skin is the main barrier which prevents entry of micro-organism.
- Mucous coating of the epithelium lining of respiratory, gastrointestinal and urinogenital tracts helps in trapping microbes.

b. Physiological barriers:

- **Acidity** of the stomach kills most ingested microbes.
- **Lysozyme** in tears, saliva, and snot kills bacteria by digesting bacterial wall.
- **Pyrogen** released by WBC raise body temperature to prevents growth of microbes in out body.
- **Interferon** induces antiviral state in non-infected cells.

c. Cellular barriers (Phagocytic barrier)

- **Polymorpho-nuclear leukocytes** (PMNL-neutrophils), **macrophages,** and **natural killer cells** in the blood and tissues kill pathogen by **phagocytosis.**

d. Cytokine barriers :

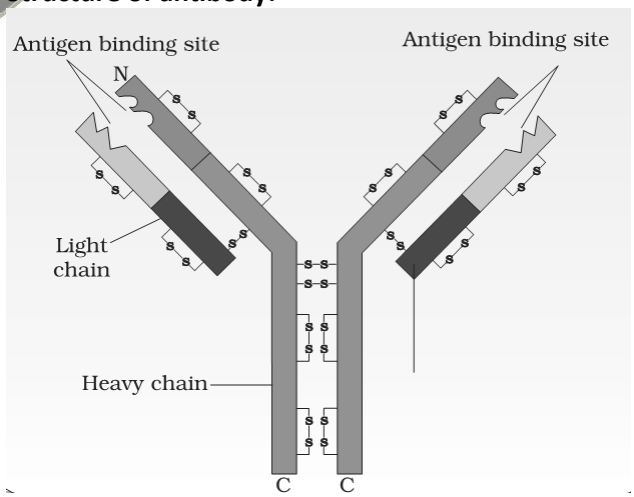
- Virus-infected cells secrete proteins called interferons which protect non-infected cells from further viral infection.

Acquired (specific) immunity:

- It is also known as **adaptive immunity**.
- This immunity developed **after birth** when encountered with pathogen.
- Features of acquired immunity
  - **Specificity:** distinguish specific foreign molecules.
  - **Diversity:** recognize vast variety of foreign molecules.
  - **Discrimination between self and non-self**: it is able to recognize and respond to molecules that are foreign or non-self. It will not respond to our own cell or molecules.
  - **Memory**: after responding to the foreign microbes and elimination, this immune system retains the memory of that encounter (**primary immuneresponse).** The second encounter with the same microbe evokes a heightened immune response. **(Secondary immune response)**

- Acquired immunity is carried out by two special types of lymphocytes:
  - **B-lymphocytes.**
  - **T-lymphocytes.**

- The B-lymphocytes produce a group of proteins in response to pathogen into the blood to fight with them called **antibody.**
- T-lymphocytes do not produce antibody but help B-cells to produce them.
- **Structure of antibody:**



- Each antibody has four polypeptide chains.
- Two small chains called light chains.
- Two longer chains called heavy chains.
- Antibody represented as H2L2.
- Different classes of antibody produced in out body are IgA, IgM, IgD, IgE and IgG.

HUMORAL IMMUNITY &
CELL MEDIATED IMMUNITY

HMI vs. CMI:

- Immune response by the B-cells by production of antibody is called **Antibody mediated immune response** or **humoral immune response.**
- Immune response by T-cells which detects and destroys the foreign cells and also cancerous cells called **cell mediated immune** response.
- Rejection of organs in transplantation are due to T-lymphocytes.
- Tissue matching, blood group matching are essential for organ transplantation.
- Immune-suppressants is required before and after transplantation.

Life cycle of HIV:

- After getting into the body the HIV enters into **macrophages** or **T-helper** cells.
- The viral RNA genome replicated to form viral DNA with the enzyme called **reverse transcriptase**.
- The viral DNA gets incorporated into the host cell's DNA by an enzyme called **integrase,** and directs the infected cells to produce virus particle.
- The macrophage continues to produce virus and acts as HIV factory.
- Virus released from macrophage attack T-helper cells.
- There is progressive reduction in the number of T-helper cells.
- Due to reduction of T-helper cells the person starts suffering from infections of other virus, fungi and even parasites like *Toxoplasma.*
- The patient becomes immuno deficient and more prone to other disease.

Diagnosis:

- ELISA (**enzyme linked Immuno-sorbent assay**)

Prevention of AIDS:

- AIDS has no cure, prevention is the best option.
- Safe blood for transfusion
- Use of disposable needles
- Free distribution of condoms.
- Prevention of drug abuse
- Advocating safe sex and promoting regular checkup.

CANCER:

- Uncontrolled cell division leads to production of mass of cell called cancer.
- Cancerous cell lost the property of **contact inhibition**.
- Cancerous cells undergo uncontrolled division giving rise to masses of cell called **tumors.**

Tumours of two types

- **Benign tumors:**
  - Normally remain confined to their original location
  - Do not spread to other location.
  - Cause little damage.
  - Can be completely cured by surgery.

- **Malignant tumors:**
  - Mass of proliferating cells called neoplastic or tumor cells.
  - These cells grow very rapidly.
  - Invade and damage surrounding tissues.
  - These cells actively divide and grow; they also starve the normal cells.
  - Cancerous cells escape from the site of origin and moves to distant place by blood, wherever they get lodged make the normal cell cancerous. This property is called **metastasis.**
- **Causes of cancer:**
- Normal cells transformed into cancerous neoplastic cells by physical, chemical and biological agents. These agents are called **carcinogens.**
- **Physical agents:** ionizing radiation like X-rays, gamma rays non-ionizing radiations like UV-rays.
- **Chemical agents:** Tobacco smoke, sodium azaide, Methyl ethane sulphonate.

- **Biological agents:**
  - Cancer causing viruses called **oncogenic viruses** have a gene called **viral oncogenes,** induce transformation of neoplastic cells.
  - **Cellular oncogenes** (c-onc) or **proto oncogenes** are present in normal cells, when activated lead to oncogenic transformation of the normal cells.
- **Cancer detection and diagnosis:**
- Biopsy and histopathological study of the tissues

- Radiography like X-rays, CT (computerized tomography)
- MRI (magnetic resonance Imaging).
- Presence of antibodies against cancer-specific antigen.
- **Tretment of cancer:**
- Surgery
- Radiation therapy
- Immunotherapy
- Chemotherapy
- Cryosurgery
- Laser therapy.
- **α-interferone** a response modifier used to detect the cancer.

- **DRUGS AND ALCOHOL ABUSE:**

Types of drugs

- **Opioid:**
- The drugs which bind to specific opioid receptor present in **central nervoussystem** and **gastrointestinal tract.**
- **Heroin** commonly called **smack**, chemically **diacetylmorphine.**
- It is white, odourless, bitter crystalline compound.
- Obtained by **acetylation of morphine.**
- Extracted from latex of poppy plant ***Papaver somniferum***.
- Generally taken by snorting and injection.
- Heroin is depressant and slows down body function.
- **Canabinoids:**
- Group of chemicals that interact with the canabinoid receptors of brain.
- Obtained from inflorescence of ***Cannabis sativa***.
- Flower top, leaves and resin of cannabis plant are used in various combinations to produce **marijuana, hashish, charas and ganja.**
- Generally taken by inhalation and oral ingestion
- Effect on **cardiovascular system** of the body.
- **Cocaine:**
- Coca alkaloid or cocaine is obtained from coca plant ***Erythroxylum coca.***
- It interferes with transport of neuro-transmitter **dopamine.**
- Cocaine is commonly called as **coke** or **crack** is usually snorted.
- Potent stimulating effect on central nervous system.
- Produces sense of **euphoria** and increased energy.
- Excessive dosage causes **hallucination.**

- Other plants with hallucinogenic properties are :
  - *Atropa belladonna*
  - Datura.

- Canabinoids are abused by some sports persons.
- **Medicinal use of drugs:**
- Barbiturates, amphetamines, benzo diazepines, lysergic acid diethyl amide (LSD) used as medicines to help patients cope with mental illnesses, depression and insomnia.
- Morphine is a very effective sedative and painkiller used for surgery patient
- Plant product with hallucinogenic property have used as folk-medicine, religious ceremonies and rituals.

- **Tobacco:**
- It is smoked, chewed or used as a snuff.
- Tobacco contains **nicotine an alkaloid.**
- Nicotine stimulates Adrenal glands to raise blood pressure and increased heart rates.
- Smoking tobacco is associated with cancer of lung, urinary bladder, and throat, bronchitis, emphysema, coronary heart disease, gastric ulcer etc.
- Smoking increased CO content of blood reduce oxygen carrying capacity of hemoglobin.
- Tobacco chewing is associated with cancer of oral cavity.

Adolescence and Drug/Alcohol Abuse:

- The period between 12-18 years of age may thought of an adolescent period.
- Adolescent is a bridge linking childhood and adulthood. It is the transition period between child hood and adulthood.
- Curiosity, need for adventure and excitement, and experimentation, are the common cause of drug/alcohol abuse.

- **Addiction and dependence:**

- Addiction is a psychological attachment to certain effects such as euphoria and a temporary feeling of well-being associated with drugs and alcohol.
- With repeated use of drugs the tolerance level of the receptors present in our body increases. Consequently the receptors respond only to higher doses of drugs or alcohol leading to greater intake and **addiction.**
- Use of drugs even once, can be a fore-runner to addiction.
- Dependence is the tendency of the body to manifest a characteristic and unpleasant **withdrawal syndrome** if regular dose of drugs/alcohol is abruptly discontinued.
- Withdrawal syndrome characterized by anxiety, shakiness, nausea and sweating.

- **Effects of Drug / Alcohol Abuse:**
- Immediate effects are reckless behavior, vandalism and violence.
- Excessive doses of drugs may lead to coma and death due to respiratory failure, heart failure or cerebral hemorrhage.
- Warning sign of drug and alcohol abuse among youth include:
    - Drop in academic performance,
    - Unexplained absence from school/college.
    - Lack of interest in personal hygiene
    - Withdrawal, isolation, depression fatigue, aggressive and rebellious behavior.
    - Deterioting relationship with family and friends.
    - Loss of interest in hobbies.
    - Change in eating and sleeping habits.
    - Fluctuation in weight and appetite.

- Intravenous drug user more prone to acquire infections like AIDS and hepatitis.
- The chronic use of drugs and alcohol damages nervous system and cause of **liver cirrhosis.**
- Use of drug and alcohol during pregnancy affect the foetus.

- **Prevention and control:**
- Avoid undue peer pressure.
- Education and counseling.
- Seeking help from parents and peers.
- Looking for danger signs.
- Seeking professional and medical help.

- **Abbreviations:**
- PMNL : Polymorpho-Nuclear Leukocytes
- CMI : Cell Mediated Immunity
- ELISA : Enzyme Linked Immuno sorbent Assay
- HLA : Human Leukocyte Antigen
- MALT : Mucosal Associated Lymphoid Tissue
- SCID : Severe Combined Immuno Deficiency
- NACO : National AIDS Control Organization
- MRI : Magnetic Resonance Imaging
- CT: computerized tomography.

Prepared by

SURENDRAN. K

HSST ZOOLOGY

GHSS KUNHIMANGALAM

KANNUR

surendranaduthila@gmail.com

BIODIVERSITY AND CONSERVATION

- **Biodiversity:** the term biodiversity refers to the totality of genes, species, and ecosystems of a region.
- Types of biodiversity described by **Edward Wilson:**
- **Genetic diversity:** Diversity within the species
    - Eg. Medicinal plant ***Rauwolfia vomitoria*** of Himalayan range. Its different varieties produces different types of chemical **reserpine.**
    - India has more than 50000 different strain of rice.
    - 1000 varieties of mango.

- **Species diversity:** Different species of a single individual. Eg. Frog varieties of western ghats.
- **Ecological diversity:** Different habitates harbour diverse species. Diversity in the ecosystem level like desert, rain forest, mangroves, coral reef, wetlands, estuaries etc.

Number of species on Earth.

- According to **IUCN** (2004), 1. 5 million of plants and animals are in our biosphere.
- **Robert May** places global species diversity at about 7 millions.
- More than 70 percent of all the species recorded are animals. Plants constitute about 22 percent.
- Among animals insects constitute 70 percent.

Number of species on Earth.

- India has only 2. 4 percent of the world's land area; but it comes up to 8. 1 percent of global species diversity
- So India is considered one of the mega diversity countries of the world.

Pattern of Biodiversity:

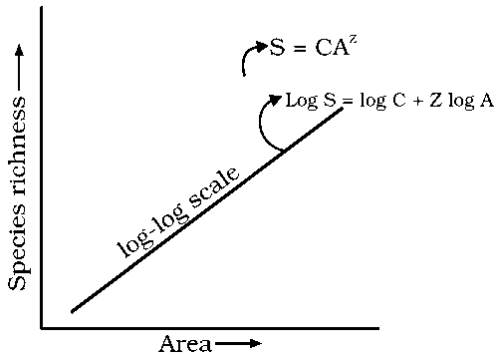
- **Latitudinal gradients:**
- Species diversity decreases as we move away from the equator towards the pole.
- Tropic (23. 5^{o} N to 23. 5^{o} S) harbors more species than temperate and pole
- The largely tropical Amazonian rain forest(lungs of Earth) in South America has the greatest biodiversity on earth:
- 40,000 species of plants, 3000 species of fishes, 1300 of birds, 427 amphibians, 378 reptiles and more than 1, 25,000 invertebrates are there in Amazon forest.

Why tropical rain forest has greater biodiversity:

- Unlike temperate regions subjected to frequent glaciations in the past, tropical latitudes have remained relatively undisturbed for millions of years and thus, had a long evolutionary time for species diversification.
- Tropical environments are less seasonal, relatively more constant and predictable, promotes niche specialization and lead to greater species diversity.
- There is more solar energy available in the tropics, which contribute to higher productivity.

Species area relationship:

- ALEXANDER VON HUMBOLDT
- Within a region species richness increases with increasing area but only up to a limit.
- The relation between species richness and area for a wide variety of taxa turns out to be a rectangular hyperbola.



- On a logarithmic scale the relationship is a straight line describe by the equation **LogS = logC +Z log A**
- Where S= species richness, A = Area, Z = slope of the line (regression coefficient), C = Y- intercept.
- With in a short region slope of the graph is narrow(0. 1-0. 2) However, for a very large area -ike the entire continent the slope of the line is steeper(0. 6-1. 2).

Importance of species diversity to the Ecosystem:

- Community with more species are generally stable than those with less species.
- A stable community should not show too much variation in productivity from year to year; it must be resistant to occasional disturbances (natural or man-made)
- Stable community is resistant to invasion by alien species.

David Tillman's long-term field experiment finds that:

  - Plots with more species showed less year to year variation in biomass
  - Increased diversity contributed to higher productivity.

- **The rivet popper hypothesis:**
  Paul Ehrlich
  - In an airplane (ecosystem) all parts are joined together by thousands of rivets (species).
  - If every passenger starts popping a rivet to take home (species extinct), it may not affect flight safety initially but as more and more rivets are removed the plane becomes dangerously weak.
  - Which rivet is removed may also be critical.
  - Loss of rivets on the wings (key species) is obviously a more serious threat to flight safety than loss of a few rivets on the seats or windows inside the plane.
- **Loss of Biodiversity:**
- The IUCN Red List (2004) documents the extinction of 784 species.
- Recent extinction includes:
  - Dodo (Mauritius).
  - Quake (Africa)
  - Thylacine (Australia)
  - Stiller's cow (Russia)
  - Three subspecies of tiger (Bali, Java, Caspian).

- Since the origin and diversification of life on earth there were **five episodes** of **mass extinction** of species.
- **The sixth mass Extinctions in progress now.**
- The current extinction rate is 100 to 1000 times faster.
- All others are pre-human period, this one is anthropogenic.

- **Effect of biodiversity loss:**
- Decline in plant production.
- Lowered resistance to environmental perturbations such as drought.
- Increased variability in certain ecosystem processes such as plant productivity, water use, and pest and disease cycle.

- **Causes of biodiversity loss:**
- The present loss is all due to human activity (anthropogenic)

There are four major causes **"The Evil Quartet"** are as follows:

I. Habitat loss and fragmentation:

- Most important cause driving animals and plants to extinct.
- The tropical rain forest reduced to 6 % from 14 % of earth land surface.
- The Amazonian rain forest is called as **'lungs of the planet** 'is being cut cleared for cultivating soya beans.
- Degradation of many habitat by pollution is also threatens the loss of diversity.
- Large areas are broken into figments also the cause of diversity loss.

II. Over-exploitation:

- When 'need' turns to 'greed' it leads to over-exploitation of natural resources.
- Many species extinctions in the last 500 years (Stiller's cow, passenger pigeons) were due to over-exploitation.
- Many marine fish populations around the world are over harvested.

III. Alien species invasion:

- The alien species became invasive and cause decline or extinction of indigenous species.
- **Nile perch** introduced into Lake Victoria in east Africa led to extinction of 200 species of **cichlid fish** in the lake.
- ***Parthenium*, (**carrot grass), ***Lantana***, and water hyacinth (***Eichornia)*** posed a thread to indigenous species.
- African cat fish ***Clarias gariepinus*** for aquaculture purposed is a threat to indigenous catfishes in our rivers.

IV. Co-extinction:

- When a species becomes extinct, the plant and animal species associated with it an obligatory way also become extinct.
- Extinction of **Host species** leads to extinction of the **parasite** also.
- Co-evolved **plant-pollinator** mutualism where extinction of one invariably lead to the extinction of the other.

- **BIODIVERSITY CONSERVATION:**
- **Why should we conserve Biodiversity?** Reason for conservation biodiversity is grouped into three categories.
- **Narrowly utilitarian, Broadly utilitarian**, **Ethical**

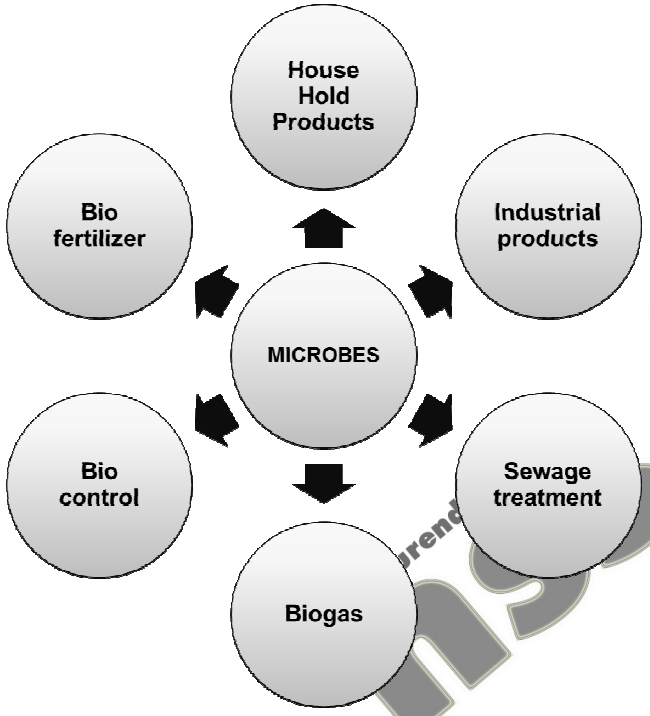
- **Narrowly utilitarian:**
- Human derive countless direct economic benefits from nature-
- Food (cereals, pulses, fruits), firewood, fiber, construction material.
- Industrial products (tannins, lubricants, dyes, resins, perfumes)
- Products of medicinal importance.
- **Bioprospecting**: exploring molecular genetic and species-level diversity for products of economic importance.
- **Broadly Utilitarian**
- Amazonian forest along produce 20% of oxygen during photosynthesis.
- **Pollinator layer**: bees, bumblebees, birds and bat that pollinate the plant without which seed cannot be produced by plants.
- Aesthetic pleasure we get from the biodiversity.
- **Ethical argument**
- We have a moral duty to care other creatures and pass on our biological legacy in good order to future generations.

- **How do we conserve biodiversity?**
- **In situ conservation:**
- When we conserve and protect the whole ecosystem, its biodiversity at all level is protected – we save the entire forest to save the tiger. This approach is called **in situ** (on site) conservation.
- Examples
  - **a. Biodiversity hot spot:** regions with very high levels of species richness and high degree of **endemism**. (species confined to that region and not found anywhere else)
    Hot spot in biodiversity is also regions of accelerated habitat loss.
- Out of 34 hot spot in the world, three hot spot located in India:
  - Western Ghats and Srilanka.
  - Indo-Burma.
  - Himalaya.

- Other protected area under in situ conservations are:
  - 14 biosphere reserve
  - 90 national park
  - 448 wild life sanctuary
- **Sacred groves:** tract of forest were set aside, and all the trees and wildlife within were venerated and given total protection.
- **Ex situ conservation:** threatened animals and plants are taken out from their natural habitat and placed in special setting where they can be protected and given special care.
- Zoological Park.
- Botanical garden
- Wildlife safari.
- Conservation of gamete by **cryopreservation.**
- Genetic strains are preserved in **seed bank.**
- **Convention on Biodiversity:**
- **"The earth Summit**" held in Rio de Jeneiro in 1992 called upon all nations to take appropriate measures for conservation of biodiversity and sustainable utilization of its benefits.
- **World Summit** on Sustainable development held in 2002 in Johannesburg, South Africa, 190 countries pledged their commitment to achieve by 2010 a significant reduction in the current rate of biodiversity loss at global, regional and local level.

MICROBES IN HUMAN WELFARE

- Microbes are of various types – protozoa, bacteria, fungi and microscopic plants viruses, viroids and also prions (proteinocious infectious agents)
- Microbes like bacteria and fungi can be grown in nutrient media to form colonies and can be seen in naked eyes.
- Some microbes' causes diseases and some are useful for human being.



1. MICROBES IN HOUSEHOLD PRODUCTS:

a. CURD

- **Lactic acid Bacteria:**
- Lactic acid Bacteria (LAB) grow in milk and convert it to curd.
- LAB produces acids that coagulate and partially digest milk proteins.
- A small amount of curd added to fresh milk as inoculums or starter.
- LAB improves nutritional quality of milk by increasing vitamin B_{12}
- LAB plays very important role in checking disease causing microbes.

b. DOUGH

- Dough, used to make *dosa* and *idli* is also fermented by bacteria.
- The puffed-up appearance of dough is due to the production of CO_2.

c. CHEESE

- Large holes in 'Swiss cheese' are due to production of large amount of CO_2 by a bacterium named ***Propionibacterium sharmanii.***
- The **'Roquefort cheese'** is ripened by specific fungi, which gives specific flavor.

d. OTHER PRODUCTS

- Baker's yeast **(*Saccharomyces cervisiae*)** is used to making bread.
- 'Toddy' a traditional drink is made by fermentation of sap from palms.

2. MICROBES IN INDUSTRIAL PRODUCTS:

Beverages, anti biotics, chemicals, enzymes etc.

- **Fermented Beverages:**
- **Yeasts** are used for production of beverages like wine, beer, whisky, brandy or rum.
- ***Saccharomyces cervisiae*** commonly called **'brewer's yeast** used for fermenting malted cereals and fruit juices to produce **ethanol.**
- The type of raw material used for fermentation and the processing, different types of alcoholic drinks are produced.
- **Wine and beer** are produced **without distillation.**
- **Whisky, brandy** and **rum** are produced by **distillation** of the fermented brooth.

- **Antibiotics:**
- **Antibiotics** are the chemical substances which are produced by some microbes and can kill or retard the growth of other microbes.
- The first antibiotic discovered is the penicillin, from a mould (fungus) ***Penicillium notatum.***
- Antibiotics have greatly improved our capacity to treat deadly diseases such as plague, whooping cough. Diphtheria and leprosy.

- **Chemicals**
- Citric Acid – *Aspergillus niger*
- Acetic Acid – *Acetobacter aceti*

- Butyric Acid – *Clostridium butyricum*
- *Lactic acid – Lacto bacillus*

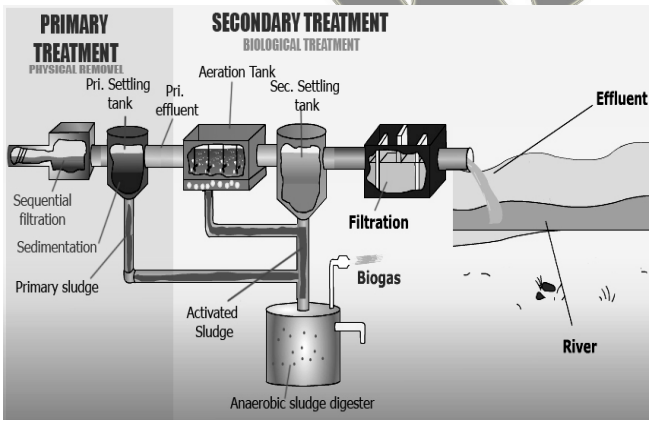
- **Enzymes**
- ***Saccharomyces cerevisiae*** (yeast) used for production of **ethanol.**
- **Lipases** are used in detergent produced by microbes.
- **Pectinase, proteases** and **cellulase,** make bottled fruit juices clearer.

Bio active molecules

Product	Obtained from	uses
Streptokinase	Streptococcus bacterium	Clot busters in myo cardial infraction
Cyclosporin A	Trichoderma poly sporum	Immuno suppressant
Statins	Monascus purpureus (yeast)	Blood cholesterol lowering agent

3. MICROBES IN SEWAGE TREATMENT:

- The waste water generated in cities and town containing human excreta. This municipal water-water is called sewage.
- Before disposal to the natural body sewage is treated in sewage treatment plants (STPs) to make it less polluting.
- Treatment is done by heterotrophic microbes naturally present in sewage.

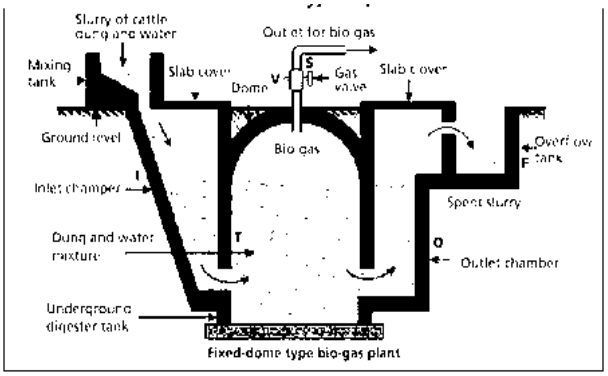


- **Primary treatment:**
- Involves the physical removal of particles through filtration and sedimentation.
- Initially **floating debris** is removed by **sequential filtration.**
- The **grit** (soil and small pebbles) are removed by **sedimentation.**
- All solids that settle form the **primary sludge**, and the supernatant forms the effluents.
- The effluents are from the primary settling tank taken for secondary treatment.
- **Secondary treatment or Biological treatment:**
- The primary effluent is passed into large aeration tanks.
- This allows vigorous growth of useful aerobic microbes into **flocs.**
- The growth of microbes consumes the major part of the organic matter in the effluent. This significantly reduces the **BOD (biochemical oxygen demand)** of the effluent.
- BOD refers to the amount of oxygen required to oxidize total organic matter by bacteria, present in one litre of water.
- BOD is the measures of the organic matter present in the water.
- **Greater the BOD of the waste water more is its polluting potential.**
- Once the BOD of sewage reduced significantly, the effluent is then passed into the settling tank where the bacterial 'flocs' are allowed to sediment. This sediment is called **activated sludge.**
- Small part of activated sludge is pumped back to aeration tank to serve as the inoculums.
- The remaining sludge is pumped into **anaerobic sludge digester.**
- In the anaerobic sludge digester there is other kinds of bacteria which grow anaerobically, digest the bacteria and fungi in the sludge.
- During this digestion bacteria produce **biogas,** (mixture of methane, hydrogen sulphide and carbon dioxide)
- The effluent from the secondary treatment plant is released into natural water body like rivers and streams.
- **Ganga Action Plan** and **Yamuna Action Plan** initiated by Ministry of Environment and Forest to save these major rivers of our country.
- It is proposed to build a large number of sewage treatment plants so that only treated sewage may be discharged into the rivers.

4. MICROBES IN PRODUCTION OF BIOGAS:

- **Biogas** is a mixture of gases (predominantly **methane**) produced by the microbial activity and is used as fuel.

- Certain bacteria grow anaerobically on cellulosic material, produce large amount of methane along with CO2 and H2S. These bacteria are collectively called **methanogens.** One common bacterium is *Methanobacterium.*
- These bacteria present in the rumen of cattle, plays essential role in nutrition of cattle by digesting cellulose. Hence the excreta (dung) used for the production of biogas.



5. MICROBES AS BIOCONTROL AGENTS:

- Biocontrol refers to the use of biological methods for controlling plant diseases and pests.
- Effect of use of chemical, insecticide and pesticide to control disease and pests:
  - These chemicals are toxic and extremely harmful to human beings and animals
  - Polluting our environment (soil, ground water), fruits, and vegetables.
  - Soil is polluted through use of weedicides to remove weeds.
- **Biological control of pest and disease:**
- Use of biocontrol measures will greatly reduce our dependence on toxic chemical and pesticides.
- The Ladybird and Dragonflies are used to get rid of aphids and mosquitoes.
- ***Bacillus thuringiensis*** (Bt) used to control butterfly caterpillars.
- Dried spores are mixed with water and sprayed onto vulnerable plants, where these are eaten by the insect larvae.
- In the gut of the larvae, the toxin is released and the larvae get killed.
- ***Trichoderma***a free living fungus used to control several plant pathogens.
- Baculoviruses are pathogen that attack insects and other arthropods
- The majority of **baculoviruses** used as biological control agents are in the genus ***Nucleopolyhedrovirus.***
- These viruses are excellent candidates for species-specific, narrow spectrum insecticidal application.
- They have no negative impacts on plants, mammals, birds, fish, etc.
- This is very use full in integrated pest managements (IPM).

6. MICROBES AS BIOFERTILIZERS:

- **Biofertilizers** are organisms that enrich the nutrient quality of the soil.
- Main biofertilizers are the bacteria, fungi and cyanobacteria.
- ***Rhizobium***form root nodules in legumes and fix atmospheric nitrogen.
- ***Azospirilium***and ***Azotobacter*** free living bacteria fix atmospheric nitrogen and thus increasing nitrogen content of the soil.
- **Mycorrhiza:** fungi symbiotically associated with root of plants.
- Many members of the genus ***Glomus*** form Mycorrhiza.
  - Provide **phosphorus** to the plants from the soil.
  - Make the plant resistant to **root-borne pathogen.**
  - Increase tolerance to **salinity and drought**.

- Cyanobacteria like ***Anabaena, Nostoc,*** and ***Oscillatoria*** etc:
  - Fix atmospheric nitrogen.
  - add organic matter to the soil and
  - Increase soil fertility.

<u>ABBREVEATIONS</u>

DO : Dissolved Oxygen
GAP : Ganga Action Plan
KVIC : Khadi and Village Industries Commission
TMV : Tobacco Mosaic Virus
YAP : Yamuna Action Plan
IPM: Integrated Pest Management

Practice Question Papers with Answer key

Prepared by

SURENDRAN. K

HSST ZOOLOGY

GHSS KUNHIMANGALAM

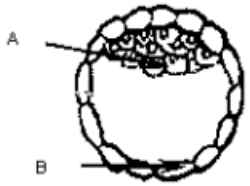
KANNUR

surendranaduthila@gmail.com

HSE II UNIT TEST Total Score 15
Time : 30 mts **1A**

Chapters : Human reproduction &Reproductive health

1) The milk produced by the mother for the first few days is important for the baby, not only energetically but also for some other reasons
   a. What is it called?.
   b) Mention its importance. (Score 2)
2) Corpus luteum is a structure formed during luteal phase of menstrual cycle. Mention the functions of corpus luteum (Score 1)
3) Complete the following (Score 1)
   Androgen-Leydig's cells,
   hCG,…….
4) The diagram of human blastula is given



a) Identify A and B. (Score 1)
b) Mention the fate of A. (Score 1)

5) Explain the signals and hormones responsible for producing fetal ejection reflex during parturition? (Score 2)
6) Give the functions of the following
   a) Sertoli cells b) LH (1x2=2)
7) Differentiate between the following terms
   Sermiogenesis, Spermiation (Score 1)
8) Complete the given table by selecting terms from brackets (Score 2)

(Condom,Cu T,saheli vasectomy, diaphragm, Tubectomy, cervical cap)

Methods of birth control	Device
i. Barrier	…….
ii. IUD	…….
iii. Surgical Method	…….
iv. Administering hormone	……..

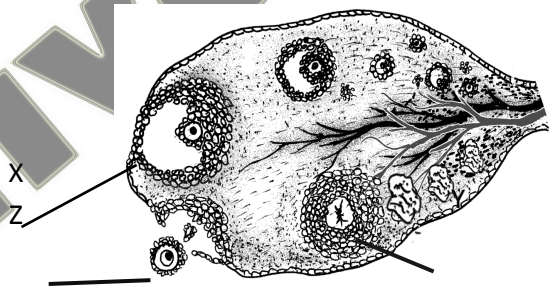
9) Discuss the merits and demerits of MTP (Score 2)

HSE II UNIT TEST Total Score 15
Time : 30 mts **1B**

Chapters : Human reproduction &Reproductive health

1) Testis are kept outside the abdominal cavity. Give reason (2score)
2) Name the following (1 Score)
a. First haploid structure in spermatogenesis
b. An unpaired male gland

3) Diagram of ovary is given
   a. Identify the structures labelled as X and Y
   b) Give the fate Z (2 score)



4) Give the functions of the following
   a. Placenta b) Acrosome (1x2=2)
5) Expand ART? Give two such methods (Score 2)
6) Comment on implantation. (Score 2)
7) Only one sperm can fertilize the egg. Explain how it is ensured? (Score 2)
8) Given below are four methods and their modes of action in achieving contraception, Match the following (Score 2)

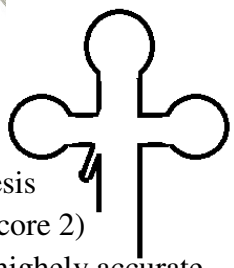
9) a) Contraceptive pills	Prevent Sperm reaching cervix
b) Condom	Prevent implantation
c) Vasectomy	Prevent ovulation
d) Copper T	Prevent entry of sperms to semen

HSE II UNIT TEST Total Score 1
Time : 30 mts

2A

Chapters : Principles of inheritance and variation, Molecular basis of inheritance

1) Give reason.
   i. Sex of child is determined by father.
   ii. Turner females are sterile
   (Score: 2)
2) If a woman who is not a carrier for hemophilia is married to a man who is a hemophiliac. What percentage of their male offspring could be expected to be hemophiliacs? Suggest why (Score 2)
3) Fill in the vacant columns: (Score 2)
   a. X Chromosome .....
   b. ..... Alfred Sturtevant
   c. Linkage .....
   d. ..... Hugo de vreis
4) Give the importance of the following
   a. mGppp
   b. 23Sr-RNA (Score 2)
5) Pick the odd one out of the given aminoacids. Give your logic for selection (Score 1)
   Val, Leu, Met, Cys, Arg
6) Identify the given structure



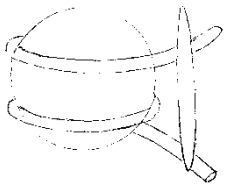
   Give its role in protein synthesis
   (Score 2)
7) DNA Polymerase enzyme is highely accurate and fast. Substantiate (Score 2)
8) Name the following (Score 2)
   Inducer in Lac-Operon
   Largest human gene

HSE II UNIT TEST Total Score 15
Time : 30 mts

2B

Chapters : Principles of inheritance and variation, Molecular basis of inheritance

1) Give reason.
   i. Drosophila is the ideal material for genetic study
   ii. Hemophilia is more common in males.
   (Score: 2)
2) A man with blood group 'o' filed a case against his wife whose blood group is 'AB', questioning the paternity of the son whose blood group is 'o'.Is his complaint genuine? Support your answer with facts. (Score 2)
3) Fill in the vacant columns: (Score 2)
   a. Trisomy of 21 chromosome .....
   b. ..... Turnors syndrome
   c. 44A+xxy .....
   d. ..... . Sickle cell anaemia
4) Give the importance of the following
   a. AUG,
   b. Ribozyme (Score 2)
5) Pick the odd one out of the given aminoacids. Give your logic for selection (Score 1)
   Thr, Ile,Trp,Gly,Ser
6) Identify the given structure



   Give its importance
   (Score 2)
7) DNA is more stable than RNA, Give two reasons (Score 2)
8) Name the following (Score 2)
   a. DNA finger printing technique was discovered by
   b. The continuously expressed gene in Lac-Operon is

HSE II UNIT TEST Total Score 15
Time : 30 mts

3A

Chapters : Evolution, Human health and Diseases

1) Write notes Special creation theory (2score)

2) Why are most mosquitoes now found to be DDT resistant although DDT was known to be a highly effective insecticide in the past? (1Score)

3) Classify the following examples of homology and analogy (2Score)
   a) Heart of fish crocodile
   b) Eye of octopus and mammal
   c) Fore limb of man and horse
   d) Wing of bird and butterfly

4) You are planning to conduct the Urey-Miller experiment in your laboratory. Write down the materials and pre requisites needed to conduct the experiment. (2Score)

5) There are appearance of dry, scaly lesions on various parts such as skin, nails and scalp a student.
   a. Identify the disease. ($^1/_2$ Score)
   b. Suggest few prophylactic methods ($1^1/_2$ Score)

6) Enlist the health hazards of drug abuse (2 Score)

7) AIDS: ELISA, TYPHOID: …… (1Score)

8) Differentiate between two different types of tumours (2 Score)

9) Give the immunological reason behind the graft rejection in organ transplantation (1Score)

HSE II UNIT TEST Total Score 15
Time : 30 mts

3B

Chapters : Evolution, Human health and Diseases

1) Write notes on Struggle for existence (2 Score)

2) The population of gray colored Biston betularia was almost replaced by the black variety during the industrial revolution in England. Explain the mechanism involved. (1Score)

3) Give the contributions of Lamark and Malthus in the evolutionary concepts. (2Score)

4) $P^2+2PQ+Q^2=1$. Explain how this expression is related to evolution? (2Score)

5) 'The Primary and secondary immune responses are carried out with the help of two types of lymphocystes'.
   a) Name the two types of lymphocytes (1Score)
   b) Explain the type of immunity evoked by the two types of lymphocytes (1Score)

6) Enlist the health hazards of Alcoholism (2 Score)

7) Cocaine : Crack ; Heroine : …….. (1 Score)

8) The malarial parasite requires two hosts to complete its life cycle.
   a). Name them (1Score)
   b). What is the cause for repeated fever and chilling in a malarial patient. (1Score)

9) Give the use of ã-interferone in medical field. (1 Score)

HSE II UNIT TEST Total Score 15

Time : 30 mts

4A

Chapters : Microbes in human welfare, Biodiversity and Conservation

1) There are LAB in our stomach too.
   a. Expand LAB
   b. Give the role of LAB in stomach (2 Score)
2) Discovery of first antibiotic was an accidental work. Substantiate (2 Score)
3) Explain the term 'bioprospecting' (1 score)
4) Give the main principles of 'Organic Farming'. (2Score)
5) Draw the graphical representation of
   logS=log C+ z log A (2Score)
6) Write notes on sixth mass extinction (2Score)
7) Suggest few methods for In-situ conservation (2Score)
8) Name the following
   a. Scientist who conducted long term ecological experiments using out door plants was
   b. The person who studied Species area relationship (2Score)

HSE II UNIT TEST Total Score 15

Time : 30 mts

4B

Chapters : Microbes in human welfare, Biodiversity and Conservation

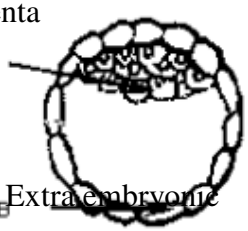
1) The dough which is used for making foods such as dosa and iddli gene a puffed-up appearance.
   a. What is the process involved here ?
   b. Name the gas responsible for the above said (2 Score)
2) Three water samples namely river water, untreateed sewage water and secondary effluent discharged from sewage treatment plant were subjected to BOD test, and the obtained values are 60 mg/L, 307 mg/L and 200 mg/L respectively. Which sample is most polluted ? Give reason. Define BOD mentioned in this question. (2 Score)
3) The invasion of an alien species is responsible for extinction of indigenous species. Give an example to support this statement (1 score)
4) Fuel crisis is one of main issues of the present times. Suggest a remedy for this problem by using microbes. (2Score)
5) Draw the graphical representation of $S=CA^Z$ (2Score)
6) "Natures biological library is burning" Give two causes for this situation (2Score)
7) Suggest few methods for Ex-situ conservation (2Score)
8) Name the following
   a. Sociobiologist who popularized the term bio diversity was
   b. The 'rivet popper hypothesis' was proposed by (2Score)

HSE II

1A

UNIT TEST ZOOLOGY ANSWER KEY Total Score 15

1) The milk produced by the mother for the first few days is important for the baby, not only energetically but also for some other reasons
   a) What is it called?. B)Mention its importance. Ans : a. Colostrum 1 score
   b. contains several antibodies absolutely essential to develop resistance for the new-born babies (Score 1)
2) Corpus luteum is a structure formed during luteal phase of menstrual cycle. Mention the functions of corpus luteum (Score 1)
   Ans : The corpus luteum secretes large amounts of progesterone which is essential for maintenance of the endometrium. Such an endometrium is necessary for implantation of the fertilized ovum and other events of pregnancy
3) Complete the following (Score 1)
   b)Androgen-Leydig's cells, hCG,……Ans : Placenta
4) The diagram of human blastula is given



   a) Identify A and B. (Score 1)
   b) Mention the fate of A. (Score 1)
   Ans: a. A Inner cell mass, B Trophectoderm /Trophoblast
   b. Inner cell mass becomes embryo, Trophectoderm becomes Extra embryonic membranes (½ scores each)
5) Explain the signals and hormones responsible for producing fetal ejection reflex during parturition? (Score 2)
   Ans : The signals for parturition originate from the fully developed fetus and the placenta which induce mild uterine contractions called foetal ejection reflex. This trigger release of oxytocin from the maternal pituitary. Oxytocin acts on the uterine muscle and causes stronger uterine contractions, which in turn stimulates further secretion of oxytocin. The stimulatory reflex between the uterine contraction and oxytocin secretion continues resulting in stronger and stronger contractions.
6) Give the functions of the following
   a) Sertoli cells b) LH (1x2=2)
   Ans : Sertoli cells are nurse cells and they nourish the developing sperms
   LH helps the synthesis of androgen in males/ It causes ovulation in females
7) Differentiate between the following terms Sermiogenesis, Spermiation (Score 1)
   Ans : Spermiogenesis : Process of transformation of spermatid into functional sperms
   Spermiation : Process of release of sperms from seminiferous tubules
8) Complete the given table by selecting terms from brackets (Score 2)
   (Condom,Cu-T,saheli,vasectomy,diaphragm,Tubectomy,cervical cap)

Methods of birth control	Device	Ans
Barrier	……	Cervical cap
IUD	……	CuT
Surgical Method	……	Tubectomy/Vasectomy
Administering hormone	……	Saheli

9) Discuss the merits and demerits of MTP (Score 2)

Ans : Merits: To get rid of unwanted pregnancies either due to casual unprotected intercourse or failure of the contraceptive used during coitus or rapes. MTP is useful when continuation of the pregnancy could be harmful or even fatal either to the mother or to the foetus or both.

Demerits : After 2nd trimester it is dangerous. MTP if done by un qualified quacks is lethal. Misuse of MTP for femle foeticide (two points from each aspects, ½ score each)

HSE II Answer key 1B

1) Testis are kept outside the abdominal cavity. Give reason (2score)
   Ans : The position of scrotum helps in maintaining the low temperature of the testes (2–2.5°C lower than the normal internal body temperature) necessary forspermatogenesis
2) Name the following (1/2 Score each)
   a) First haploid structure in spermatogenesis Ans : Seconday spermatocyte
   b) An unpaired male gland Ans : Prostate
3) Diagram of ovary is given
   a) Identify the structures labelled as X and Y
   b) Give the fate Z

Ans : a) X Graafian follicle , Y Corpus luteum (1/2 scores each)
b) Z is ovum. If ferilix=zation takes place it develops into embryo (1/2 Score) If no fertilization it is expelled out. (1/2 score)

4) Give the functions of the following a) . Placenta b) Acrosome (1x2=2)

Ans : a) The placenta facilitate the supply of oxygen and nutrients to the embryo and also removal of carbon dioxide and excretory/waste materia produced by the embryo. It helps in the transport of substances to and from the embryo. Placenta also acts as an endocrine tissue and produce hormones like human chorionic gonadotropin (hCG), human placental lactogen (hPL), estrogens, progestogens, etc. (Any Two points)
b) The acrosome is filled with enzymes that help fertilisation of the ovum

5) Expand ART? Give two such methods (Score 2)
   Ans : assisted reproductive technologies 1 score
   IVF, ET, IUT, ZIFT, GIFT, ICSI (any two with definition ½ score each)
6) Comment on implantation. (Score 2)
   Ans : Blastocyst into the uterus. The trophoblast layer of it then gets attached to the endometrium and the inner cell mass gets differentiated as the embryo. After attachment, the uterine cells divide rapidly and covers the blastocyst. As a result, the blastocyst becomes embedded in the endometrium of the uterus. This is called implantation and it leads to pregnancy.
7) Only one sperm can fertilize the egg. Explain how it is ensured? (Score 2)
   Ans : Just after fertilization the entire egg is covered by fertilization membrane. This prevents poly spermy /When a sperm comes in contact with the zona pellucida layer of the ovum it induces changes in the membrane that block the entry of additional sperms.
8) Given below are four methods and their modes of action in achieving contraception, Match the following (Score 2)

a) Contraceptive pills	Prevent Sperm reaching cervix	(b)
b) Condom	Prevent implantation	(d)
c) Vasectomy	Prevent ovulation	(a)
d) Copper T	Prevent entry of sperms to semen	(c)

HSE II Zoology unit test-Answer key

2A

1) Give reason.
   i. Sex of child is determined by father.
   Ans : Father is heterozugous, produce two types of spoerms. Mother homozygous, only one type of egg, the sperm that fuses with egag determines sex of child. (1)
   ii. Turner females are sterile
   Ans : Such females are sterile as ovaries are rudimentary. So they are sterile(1)

2) If a woman who is not a carrier for hemophilia is married to a man who is a hemophiliac. What percentage of their male offspring could be expected to be hemophiliacs? Suggest why (Score 2)

Ans: No males will be haemiophilic. Haemophilia is X linked disease. The Xchromosome of a male is inherited from mother. Here mother is not haemophilic.

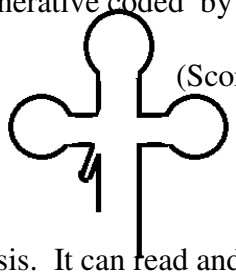
3) Fill in the vacant columns: (Score 2)

a.	X Chromosome	Henking
b.	Chromoasome map	Alfred Sturtevant
c.	Linkage	TH morgan
d.	Mutation	Hugo de vreis

4) Give the importance of the following
a) mGppp: It forms the cap of m-RNA during tanscription
b) 23Sr-RNA: it act as enzyme called Ribozyme during translation (Score 2)

5) Pick the odd one out of the given aminoacids. Give your logic for selection (Score 1)
Val, Leu, Met,Cys, Arg (Ans: Met . It is non degenerative coded by only a single codon)

6) Identify the given structure
Give its role in protein synthesis (Score 2)



Ans : t-RNA
It carries amino acids to the siate of protein synthesis. It can read and pair with codons of m-RNA during translation.

7) DNA Polymerase enzyme is highely accurate and fast. Substantiate (Score 2)
These enzymes are highly efficient enzymes as they have to catalyse polymerisation of a large number of nucleotides in a very short time. E. coli that has only 4.6×10^6 bp (compare it with human whose diploid content is 6.6×10^9 bp), completes the process of replication within 38 minutes; that means the average rate of polymerisation has to be approximately 2000 bp per second. Not only do these polymerases have to be fast, but they also have to catalyse the reaction with high degree of accuracy. Any mistake during replication would result into mutations.

8) Name the following (Score 2)
a) Inducer in Lac-Operon: Lactose
b) Largest human gene: Distrophin

Zoology unit test- Answer key

2B

1) Give reason.
   i. Drosophila is the ideal material for genetic study
   Ans : They could be grown on simple synthetic medium in the laboratory. They complete their life cycle in about two weeks, and a single mating could produce a large number of progeny flies. Also, there was a clear differentiation of the sexes – the male and female flies are easily distinguishable. Also it has many types of hereditary variations that can be seen with low power microscopes. (any two points 1)
   ii. Hemophilia is more common in males.
   Ans. Haemophilia is x linked disease. It expresses easly in males as there is only on X chromosome in males. (1)

2) A man with blood group 'o' filed a case against his wife whose blood group is 'AB', questioning the paternity of the son whose blood group is 'o'.Is his complaint genuine? Support your answer with facts. (Score 2)

Ans : It is not possible for a lady with AB blood group to give birth to a O child

3) Fill in the vacant columns: (Score 2)

a.	Trisomy of 21 chromosome	....Downs syndrome.....
b.	..44A+XO...	Turnors syndrome
c.	44A+xxy	.....Kline felters syndrome.....
d.	....Autosomal recessive gene....	Sickle cell anaemia

4) Give the importance of the following

c) AUG : It is starting codon, it codes for methionine

d) Ribozyme : 23Sr-RNA, acting as enzyme during translation (Score 2)

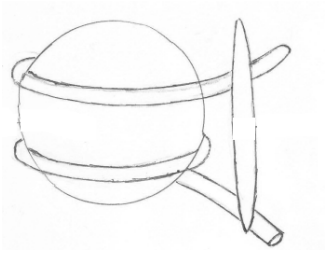
5) Pick the odd one out of the given aminoacids. Give your logic for selection (Score 1)

Thr, Ile,Trp,Gly,Ser

Ans Trp, others are coded by more than one codons

6) Identify the given structure

Give its importance (Score 2)



Ans : Nucleosome

It helps in packing of DNA (2.2 m) with in tiny nucleus of 10^{-6} m

7) DNA is more stable than RNA, Give two reasons (Score 2)

Ans : DNA is thermally stable, It lacks 2'OH group so less reactive, being double stranded lesser chance of mutation, Presence of Thymine provide additional stability.

8) Name the following (Score 2)

a) DNA finger printing technique was discovered by : Alec Jeffre

b) The continuously expressed gene in Lac-Operon is : Repressor gene

HSE II | UNIT TEST ZOOLOGY ANSWER KEY | Total Score 15 Time : 30 mts

3A

Chapters : Evolution, Human health and Diseases

1) Write notes Special creation theory (2score)

Ans : This is a Conventional concept on the origin of life. This theory has three connotations. One, that all living organisms (species or types) that we see, today were created as such. Two, that the diversity was always the same since creation and will be the same in future also. Three, that earth is about 4000 years old.

2) Why are most mosquitoes now found to be DDT resistant although DDT was known to be a highly effective insecticide in the past? (1Score)

Ans Only the sensitive mosquitos die due to DDT, where as the resistant ones will survive. They produce new generations of mosquitos which will be DDT resistant. This is due to natural selection.

3) Classify the following examples of homology and analogy (2Score)

a) Heart of fish crocodile (Homomologous)
b) Eye of octopus and mammal (Analogous)
c) Fore limb of man and horse (Homologous)
d) Wing of bird and butterfly (Analogous)

4) You are planning to conduct the Urey-Miller experiment in your laboratory. Write down the materials and pre requisites needed to conduct the experiment. (2Score)

Ans : Boiling chmber, Vacum pump, Discharge chamber, Electriodes with high voltage, Condensor, Water trap, Gases like CH4, NH3 etc/ A write up on Urey Milller expt.

5) There are appearance of dry, scaly lesions on various parts such as skin, nails and scalp a student.

a) Identify the disease. ($\frac{1}{2}$ Score) Ans : Ring worm disease

b) Suggest few prophylactic methods ($1\frac{1}{2}$ Score)

Ans : Maintenance of personal and public hygiene, keeping the body clean; consumption of clean drinking water, food, vegetables, fruits, etc. Public hygiene includes proper disposal of waste and excreta; periodic cleaning and disinfection of water reservoirs, Avoid contact with infected persons, or their belongingness, /any other correct 3points ½ scores each.

6) Enlist the health hazards of drug abuse (2 Score)

Ans : refer text page 161,162 any 4 points

7) AIDS: ELISA, TYPHOID: ……Ans Widal test (1Score)

8) Differentiate between two different types of tumours (2 Score)

Benign tumours: normally remain confined to their original location and do not spread to other parts of the body and cause little damage.

Malignant tumors: a mass of proliferating cells called neoplastic or tumor cells. These cells grow very rapidly, invading and damaging the surrounding normal tissues. As these cells actively divide and grow they also starve the normal cells by competing for vital nutrients. Cells sloughed from such tumors reach distant sites in the body, they start a new tumor there. This property called metastasis.

9) Give the immunological reason behind the graft rejection in organ transplantation (1Score)

The body is able to differentiate 'self' and 'nonself' and this cell-mediated immune response is responsible for the graft rejection.

HSE II UNIT TEST ZOOLOGY 3B Total Score 15
Time : 30 mts

Chapters : Evolution, Human health and Diseases

1) Write notes on Struggle for existence (2 Score)
Ans : When number of individuals increase on earth they will compete with each other for life requirements . They compete for food, shelter, mating etc. They also struggle with adverse physical factors,climatic conditions etc. This is struggle for existance

2) The population of gray colored Biston betularia was almost replaced by the black variety during the industrial revolution in England. Explain the mechanism involved
Ans : Natural Selection (1Score)

3) Give the contributions of Lamark and Malthus in the evolutionary concepts. (2Score)
Ans : Lamark : Use and disuse theory/Theory of acquired characters +Explanation
Malthus: relation between population increase and resource increase + explanation

4) $P^2+2PQ+Q^2=1$. Explain how this expression is related to evolution? (2Score)
Ans: This is Hardy- Weinberg Equation. For a non evolving polulation this will be always constant. Any change in Hardy wienberg equation is a measure of evolution.

5) 'The Primary and secondary immune responses are carried out with the help of two types of lymphocystes'.
a) Name the two types of lymphocytes (1Score)
T lymphocytes and B lymphocytes
b) Explain the type of immunity evoked by the two types of lymphocytes(1Score)
T Lymphocytes : Cellular immunity , B Lymphocytes: Humloral immunity

6) Enlist the health hazards of Alcoholism (2 Score)
Refer text book Page number : 161,162 Any 4 points

7) Cocaine : Crack ; Heroine : …Smack…….. (1 Score)

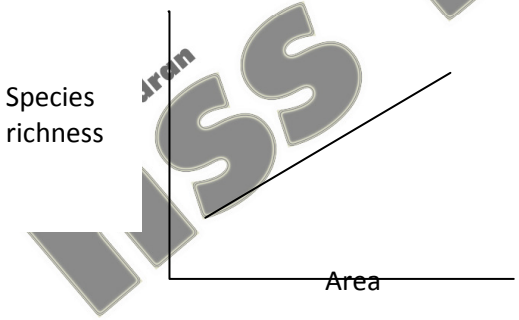
8) The malarial parasite requires two hosts to complete its life cycle.
a). Name them : toMan and female Anopheles mosquito (1Score)
b). What is the cause for repeated fever and chilling in a malarial patient. (1Score)
Malarial parasites initially multiply within the liver cells and then attack the red blood cells (RBCs) resulting in their rupture. The rupture of RBCs is associated with release of a toxic substance, haemozoin, which is responsible for the chill and high fever recurring every three to four days.

9) Give the use of ã-interferone in medical field. (1 Score)
They are biological response modifiers such as and activates immune system and helps in destroying the tumor./They are used in treatment of cancer

HSE II UNIT TEST ZOOLOGY –ANSWER KEY 4A Total Score 15

Chapters : Microbes in human welfare, Biodiversity and Conservation

1) There are LAB in our stomach too.
   a. Expand LAB : Ans Lactic Acid Bacteria
   b. Give the role of LAB in stomach (2 Score)
   Ans :LAB play very beneficial role in checking disease- causing microbes in stomach.
2) Discovery of first antibiotic was an accidental work. Substantiate (2 Score)
   Alexander Fleming while working on Staphylococci bacteria, once observed a mould growing in one of his unwashed culture plates around which Staphylococci could not grow. He found out that it was due to a chemical produced by the mould and he named it Penicillin after the mould Penicillium notatum
3) Explain the term 'bioprospecting' (1 score)
   Exploring molecular,genetic and species-level diversity for products of economic importance
4) Give the main principles of 'Organic Farming'. (2Score)
   Avoid use of chemical insecticides /fertilizers, Only bio control methods, No killing of insects and others, keeping them in manageable levels, Keeping the balance of nature, biodiversity furthers health
5) Draw the graphical representation of logS=log C+ z log A (2Score)



graph 1 score

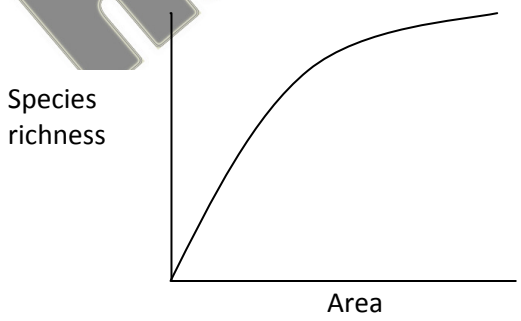
labelling 1 score

6) Write notes on sixth mass extinction (2Score)
   Large scale extinction of species now a days. Mainly due to human activities, 100-1000 times faster than previous versions, if the current trends continue of nearly half of all the species on earth might be wiped out within the next 100 years.
7) Suggest few methods for In-situ conservation (2Score)
   Bio sphere reserves, Wild life sanctuary, Sacred Groves, etc, Breif explantion
8) Name the following
   a) Scientist who conducted long term ecological experiments using out door plants was : David Tilman
   b) The person who studied Species area relationship : Alexander von Humboldt (2Score)
   c)

HSE II UNIT TEST ZOOLOGY 4B Total Score 15
Time : 30 mts

Chapters : Biodiversity and Conservation Microbes in human welfare,

1) The dough which is used for making foods such as dosa and iddli gene a puffed-up appearance.
   a. What is the process involved here ? :ANS :Alcoholic fermentration
   b. Name the gas responsible for the above said ANS CO_2 (2 Score)
2) Three water samples namely river water, untreateed sewage water and secondary effluent discharged from sewage treatment plant were subjected to BOD test, and the obtained values are 60 mg/L, 307 mg/L and 200 mg/L respectively. Which sample is most polluted ? Give reason. Define BOD mentioned in this question. (2 Score)
   Ans : sample with 307 mg/L is most polluted. Greater BOD means highly polluted water. Lesser the BOD lesser pollution.
3) The invasion of an alien species is responsible for extinction of indigenous species. Give an example to support this statement (1 score)
   Ans The Nile perch introduced into Lake Victoria in east Africa led eventually to the extinction of an ecologically unique assemblage of more than 200 species of cichlid fish in the lake. You must be familiar with the environmental damage caused and threat posed to our native species by invasive weed species like carrot grass (Parthenium), Lantana and water hyacinth (Eicchornia). The recent illegal introduction of the African catfish Clarias gariepinus for aquaculture purposes is posing a threat to the indigenous catfishes in our rivers.
4) Fuel crisis is one of main issues of the present times. Suggest a remedy for this problem by using microbes. (2Score)
   Ans : Microbes can be used in energy Production. Few bacteria, which grow anaerobically on cellulosic material, produce large amount of methane along with CO and H. These bacteria are collectively called methanogens, and one such common bacterium is Methanobacterium. The biogas thus produced is used for cooking and lighting./A write up about biogas plant
5) Draw the graphical representation of $S=CA^Z$ (2Score)



6) "Natures biological library is burning" Give two causes for this situation (2Score)
   Habitat loss and fragmentation, Alien Species invasion, Co-extinction, Over exploitation
   Any two with explanations
7) Suggest few methods for Ex-situ conservation (2Score)
8) Name the following
   a) Sociobiologist who popularized the term bio diversity was : Edward Wilson
   b) The 'rivet popper hypothesis' was proposed by used by : Paul Erlich (2Score)

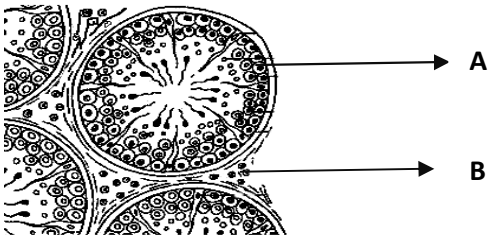
HSE MODEL EXAMINATION

ZOOLOGY

HSE II MAX SCORE 30 TIME 1 HOUR+10MTS COOL OFF

General instructions to candidates: * There is a cool off time of 10 minutes in addition to the writing time of 1 hr. *You are not allowed to write your answers nor to discuss anything with others during the cool off time. *Use the cool off time to get familiar with the questions and to plan your answers. *Read questions carefully before answering. * Draw diagrams wherever necessary

1. Identify the labelled parts A and B in the figure. Give their function. **ചിത്രത്തിൽ അടയാളപ്പെടുത്തിയ ഭാഗങ്ങൾ ഏതെന്ന് എഴുതുക. അവയുടെ ധർമ്മം എഴുതുക** (2Score)



2. Complete the coloumns A,B,C and D
പട്ടിക പൂർത്തിയാക്കുക (2 Score)

……A……	Thuringin	bio control
Trichoderma polysporum	……B……	Immunosuppressant
Saccharomyces crevisiae	Ethyl alcohol	……C……
……D……	Nitrates and nitrites	Biological Nitrogen fixation

3. Arrange the following terms in two coloumns and give suitable titles for each coloumn. **താഴെ കൊടുത്തിരിക്കുന്ന വാക്കുകളെ 2 കോളങ്ങളിലായി എഴുതുക. കോളങ്ങൾക്ക് ഉചിതമായ തലക്കെട്ട് നൽകുക.** (2 Score)

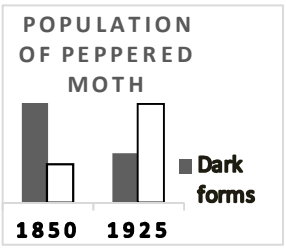
   Zoological park, cryopreservation, sacred groves, botanical gardens, biosphere reserves, national parks

4. A single base pair change in the gene of beta globulin result sickle cell anemia. **ബീറ്റാ ഗ്ലോബിലി നിലെ ജീനിന്റെ ഒരൊറ്റ ബേസ് ജോയറിലെ വ്യതിയാനം സിക്കിൾസെൽ അനീമിയക്ക് കാരണമാവുന്നു.**
   a. Identify this type of mutation **ഇത് ഏതുതരം മ്യൂട്ടേഷനാണ് ?** (½ score)
   b. Which features of genetic code can be explained by this. **ജെനിട്ടിക്ക് കോഡിന്റെ ഏതെല്ലാം പ്രത്യേകതകളാണ് ഇതിൽ നിന്ന് വ്യക്തമാവുന്നത്?** (1 Score)

5. A women who was pregnant (8 weeks), on clinical examination it was found to have conceived a defective foetus with serious genetic defect. **എട്ടുമാസം ഗർഭിണിയായ ഒരു സ്ത്രീയുടെ ക്ലിനിക്കൽ പരിശോധനയിൽ ഗർഭസ്ഥശിശു ഗുരുതരമായ ജനിതക വൈകല്യങ്ങളുള്ളതാണെന്ന് മനസ്സിലായി.**
   a. Name the clinical test used here . **ഇവിടെ ഉപയോഗിച്ച ക്ലിനിക്കൽ ടെസ്റ്റ് ഏതാണ്?** (1 score)
   b. What suggestive measure can be recommended? **എന്ത് പരിഹാരമാണ് ഇതിൽ നിങ്ങൾക്ക് നിർദ്ദേശിക്കാനുള്ളത്** (1 Score)

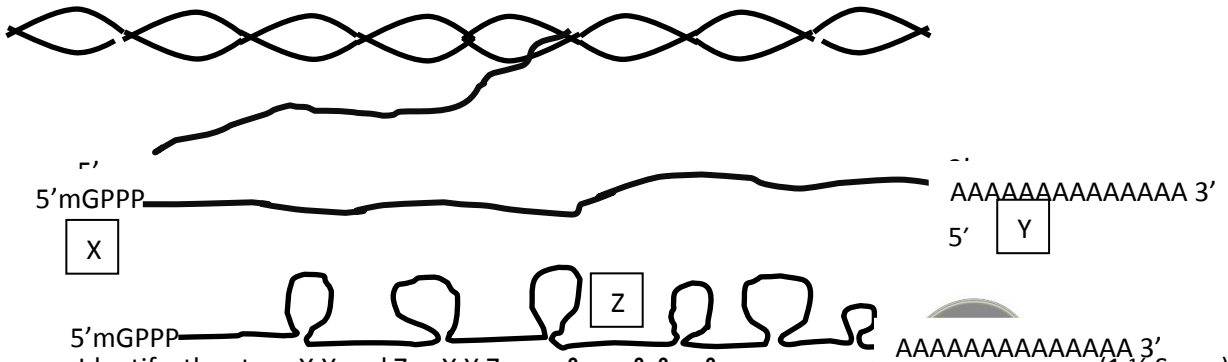
6. Parturition is a complex neuro endocrine process. Justify the statement.
പ്രസവം സങ്കീർണ്ണമായ neuro endocrine process **ആണ്. സാധൂകരിക്കുക** (2 score)

7. Observe the given graph and attempt following questions . **തന്നിരിക്കുന്ന ഗ്രാഫ് നിരീക്ഷിച്ച് താഴെ കൊടുത്തിരിക്കുന്ന ചോദ്യങ്ങൾക്ക് ഉത്തരം എഴുതുക**



   a. Name evolutionary principle involved in this . **ഇതിലെ പരിണാമ തത്ത്വം ഏതാണ്?** (1 score)
   b. Give another example for the same principle. **ഇതേ തത്ത്വത്തിന് മറ്റ് ഒരുദാഹരണം എഴുതുക** (1 score)

8. Sequence of coding strand in a transcription unit is given. Write down the sequence of m-RNA. **ഒരു ട്രാൻസ്ക്രിപ്ഷൻ യൂണിറ്റിലെ കോഡിങ്ങ് സ്ട്രാന്റിലെ സ്വീകൻസ് നൽകിയിരിക്കുന്നു.** m-RNA **യുടെ സ്വീകൻസ് എഴുതുക** 5'
ATTCGGACTGACCTACTGACTAGGAT 3' (1Score)
9. Prepare a flow chart to showing human evolution **മനുഷ്യപരിണാമത്തിന്റെ ഫ്ളോ ചാർട്ട് വരക്കുക.** (2 Score)
10. Study the given diagram. **താഴെ തന്നിരിക്കുന്ന ചിത്രം പഠിക്കുക**



a. Identify the steps X,Y and Z. X,Y,Z **എന്നിവ തിരിച്ചറിയുക** (1 ½ Score)
b. There are no such complexities in prokaryotes. Give reason. **പ്രോകാരിയോട്ടുകളിൽ ഇത്തരം സങ്കീർണ്ണതകളില്ല. കാരണം എഴുതുക** (1 score)

11. Correct and rewrite the given expression **താഴെ കൊടുത്ത ചിത്രം ശരിയാക്കി മാറ്റി വരയ്ക്കുക.**
DNA ---------→DNA----------→Protein----------→m-RNA (1 Score)
Translation Replication Transcription
12. The pattern of inheritance of Mendelian disorders can be traced in a family history. **മെൻഡേലിയൻ രോഗങ്ങളുടെ പാരമ്പര്യം ഒരു കുടുംബത്തിന്റെ ജനിതക ചരിത്രത്തിൽ രേഖപ്പെടുത്താവുന്നതാണ്.**
a. Name this technique of tracing genetic history. **ജനിതക ചരിത്രം രേഖപ്പെടുത്തുന്ന രീതി ഏതാണ്?** (1 Score)
b. Draw to show how male, female, sex unspecified, mating between blood relatives are represented in this method. **ആൺ, പെൺ, ലിംഗം വ്യക്തമാക്കപ്പെടാത്തത്, രക്ത സാമ്യതയുള്ള ബന്ധുക്കൾ തമ്മിലുള്ള മേറ്റിങ്ങ് എന്നിവ ഈ രിതി പ്രകാരം ചിത്രീകരിക്കുന്നത് എങ്ങിനെ** (1 Score)

13. Surveys and statistics show that drug and alcohol abuse has been increasing especially among the youth. **മദ്യത്തിന്റെയും മയക്കുമരുന്നിന്റെയും ഉപയോഗം യുവാക്കളുടെ ഇടയിൽ വർദ്ധിച്ചുവരുന്നതായി സർവ്വേകൾ സൂചിപ്പിക്കുന്നു.**
a. What are the harmful effects of alcohol abuse? **മദ്യത്തിന്റെ ദൂഷ്യഫലങ്ങൾ ഏവ?** (2 Score)
b. How can you protect your self from such an addiction **ഇത്തരം ആസക്തികളിൽ നിന്നും നിങ്ങൾക്ക് എങ്ങിനെ സ്വയം സംരക്ഷിക്കാം?** (2 Score)

14. World AIDS day is going to observe in your school. Prepare two slogans in connection with this to create awareness against AIDS. **ലോക എയ്ഡ്സ് ദിനം നിങ്ങളുടെ സ്കൂളിൽ ആചരിക്കുന്നു. എയ്ഡ്സിനെക്കുറിച്ച് ജനങ്ങൾക്ക് അവബോധം പകരാനുതകുന്ന 2 മുദ്രാവാക്യങ്ങൾ രചിക്കുക** (2 Score)
15. Name the scientists connected with following. **താഴെകൊടുത്തവയുമായി ബന്ധപ്പെട്ട ശാസ്ത്രജ്ഞൻമാരുടെ പേര് എഴുതുക** (2 Score)
a. Rivet popper hypothesis
b. Species – area relation ship

Prepared by

SURENDRAN. K

HSST ZOOLOGY

GHSS KUNHIMANGALAM

KANNUR

surendranaduthila@gmail.com