VIJAYABHERI

MALAPPURAM DISTRICT PANCHAYATH
EDUCATIONAL

PROJECT 2021-22

STEP-UP

ZOOLOGY

2nd Year

(Supporting Material for Higher secondary/VHSE)

വിദ്യാഭ്യാസപരമായി ഏറ്റവും പുറകിൽ നിന്നിരുന്ന മലപ്പുറം ജില്ല കഴിഞ്ഞ കുറച്ചു വർഷങ്ങൾ കൊണ്ടുണ്ടാക്കിയ നേട്ടങ്ങൾ അഭൂതപൂർവമാണ്. എസ്.എസ്.എൽ.സി, പ്ലസ്ടു, വി.എച്ച്.എസ്.ഇ ഫലത്തിന്റെ കാര്യത്തിൽ മാത്രമല്ല എ പ്ലസ്സ് ലഭിച്ച വിദ്യാർത്ഥികളുടെ എണ്ണത്തിലും വിവിധ മത്സരപരീക്ഷകളിലും നമ്മൾ ഏറെ മുന്നേറി. പൊതുവിദ്യാഭ്യാസ സംരക്ഷണത്തിന്റെ കാര്യത്തിൽ മറ്റു ജില്ലകൾക്ക് നമ്മൾമാതൃകയാണ്. മലപ്പുറം ജില്ലാ പഞ്ചായത്ത് ആവിഷ്കരിച്ചു നടപ്പിലാക്കി കൊണ്ടിരിക്കുന്ന വിജയഭേരി വിദ്യാഭ്യാസ പദ്ധതി, തദ്ദേശ സ്വയംഭരണ സ്ഥാപനങ്ങളുടെ ഇടപെടലുകൾ, ജനപ്രതിനിധികൾ, എസ്. എസ്. കെ, ഡയറ്റ്, വിദ്യാഭ്യാസ ഓഫീസർമാർ ഒപ്പം എല്ലാ നല്ല പ്രവർത്തനങ്ങൾക്കും കൂടെ നിൽക്കുന്ന അധ്യാപകർ എന്നിവരാണ് ഈ നേട്ടങ്ങൾക്കു പിന്നിൽ.

നേട്ടങ്ങൾ ആഘോഷിക്കുന്നതിനോടൊപ്പം അടിയന്തിര ശ്രദ്ധ പതിയേണ്ടുന്ന മേഖലകൾ ഇനിയും ഏറെയുണ്ട്. 10-ാം ക്ലാസ്സിൽ നിന്നും വിജയം നേടി പ്ലസ്സ് 1, വി. എച്ച്.എസ്.ഇ ക്ലാസ്സുകളിൽ എത്തുന്ന വിദ്യാർത്ഥികളിൽ നല്ലൊരു ശതമാനം വിദ്യാർത്ഥികൾ ഹയർ സെക്കണ്ടറി സിലബസ് പിന്തുടരുന്നതിന് ഏറെ പ്രയാസം അനുഭവിക്കുന്നവരാണ്. കോവിഡ് കാരണം സ്കൂൾ പ്രവർത്തി ദിനങ്ങൾ നഷ്ടപ്പെട്ടതോടെ ഭൂരിപക്ഷം വിദ്യാർത്ഥികളും പഠന പ്രയാസങ്ങൾ അനുഭവിക്കുന്നു ഈയൊരു പശ്ചാത്തലത്തിൽ പ്ലസ്ടു , വി. എച്ച്. എസ്. ഇ തലത്തിൽ വിവിധ വിഷയങ്ങൾ അനായാസകരമായി പഠിക്കുന്നതിനും എല്ലാ വിദ്യാത്ഥികളും പ്ലസ്ടു, വി. എച്ച്.എസ്.ഇ പരീക്ഷകളിൽ മികച്ച വിജയം ഉറപ്പു വരുത്തുന്നതിനായി **സ്റ്റെപ് - അപ് 22** എന്ന പേരിൽ പ്രത്യേക മെറ്റീരിയൽ വിജയഭേരി പദ്ധതിയുടെ ഭാഗമായി തയ്യാറാക്കി സ്കൂളുകളിലെത്തിക്കുകയാണ്. തീർച്ചയായും ഈ മെറ്റീരിയൽ അധ്യാപകർക്കും വിദ്യാർത്ഥികൾക്കും ഏറെ സഹായകരമാകുമെന്ന് പ്രതീക്ഷിക്കുന്നു.

ഈ പഠനസഹായി സമയബന്ധിതമായി പൂർത്തീകരിക്കുന്നതിന് നേതൃത്വം നൽകിയ മലപ്പുറം ഡയറ്റ്, ഹയർ സെക്കണ്ടറി ജില്ലാ കോർഡിനേറ്റർ / അസിസ്റ്റന്റ് കോർഡിനേറ്റർ, ശില്പശാലയിൽ പങ്കെടുത്ത അധ്യാപകർ എന്നിവർക്കുള്ള നന്ദിയും കടപ്പാടും പ്രത്യേകം അറിയിക്കുന്നു.

സ്കൂൾതലത്തിൽ അനുയോജ്യമായ സമയം കണ്ടെത്തി രക്ഷിതാക്കളുടെ സഹകരണത്തോടെ ഈ പഠനപ്രവർത്തനങ്ങൾ വിദ്യാർത്ഥികൾക്ക് നൽകണം. അതിനായി എല്ലാ അധ്യാപകരുടെയും സഹകരണം പ്രതീക്ഷിക്കുന്നു.

പ്രസിഡണ്ട്	ചെയർപേഴ്സൺ	അസി: ഡയറക്ടർ	ആർ.ഡി.ഡി	പ്രിൻസിപ്പാൾ
ജില്ലാ പഞ്ചായത്ത്	ആരോഗ്യ വിദ്യാഭ്യാസ	വി.എച്ച്. എസ്.ഇ	മലപ്പുറം	ഡയറ്റ്
മലപ്പുറം	സ്ഥിരം സമിതി	മലപ്പുറം		മലപ്പുറം

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1. HUMAN REPRODUCTION

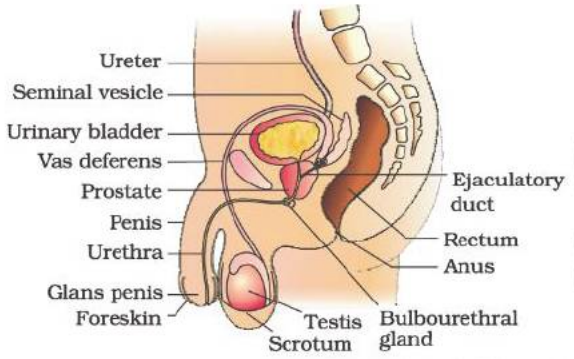
MALE REPRODUCTIVE SYSTEM

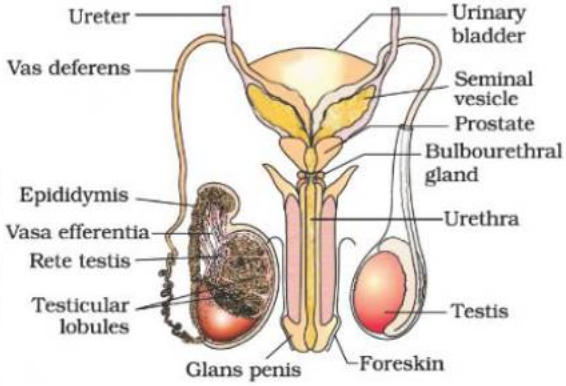
Paired testes
Primary sex organ.
Produce sperms & androgens (testosterone).

Accessory ducts (conducts sperms)
- Rete testis
- Vasa efferentia
- Epididymis
- Vas deferens
- Ejaculatory duct

Accessory glands (secretes seminal plasma)
- Prostate (1)
- Seminal vesicles (2)
- Bulbo-urethral glands (Cowper's glands) -2

External genitalia (Penis)
- Copulatory organ





Soon after the birth or at the 8th month of pregnancy testes descent into the **scrotum.** The low temperature of scrotum helps for proper functioning of testes and for **sperm production.**

Seminal plasma + sperms → Semen

FEMALE REPRODUCTIVE SYSTEM

Paired ovaries
Primary sex organ. Produce ovum and oestrogen & progesterone)

Accessory ducts

Fallopian tubes (Oviducts)
- Infundibulum
- Ampulla
- Isthmus

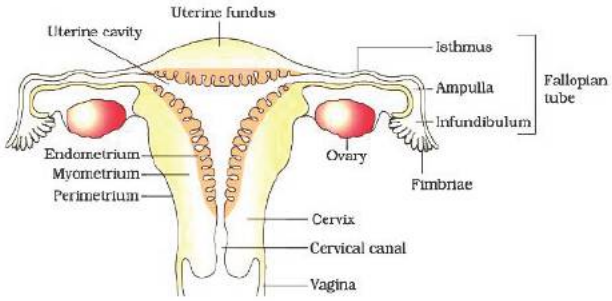
Uterus
- Fundus
- Body
- Cervix

Vagina

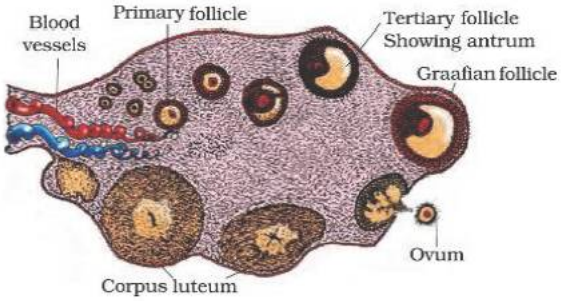
External genitalia (Vulva)
- Mons pubis
- Labia majora
- Labia minora
- Hymen
- Clitoris

Sequence of milk conduction in mammary glands:

Mammary alveoli → mammary tubules → mammary duct → mammary ampulla → lactiferous duct.



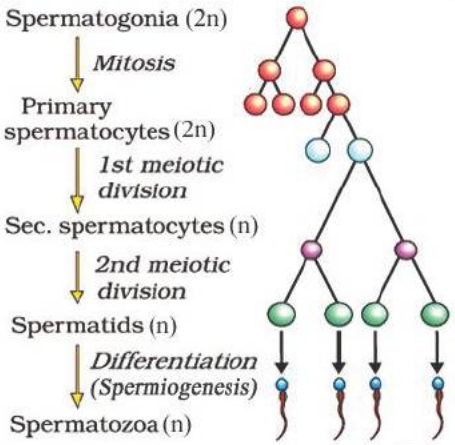
Female Reproductive System

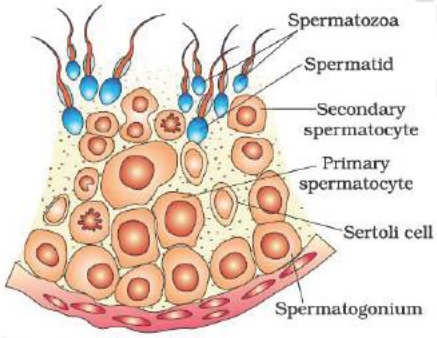


Structure of ovary

GAMETOGENESIS (SPERMATOGENESIS & OOGENESIS)

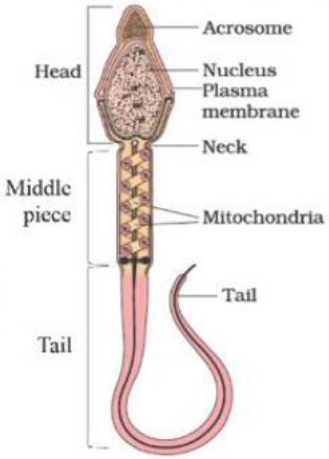
SPERMATOGENESIS (Formation of sperms)





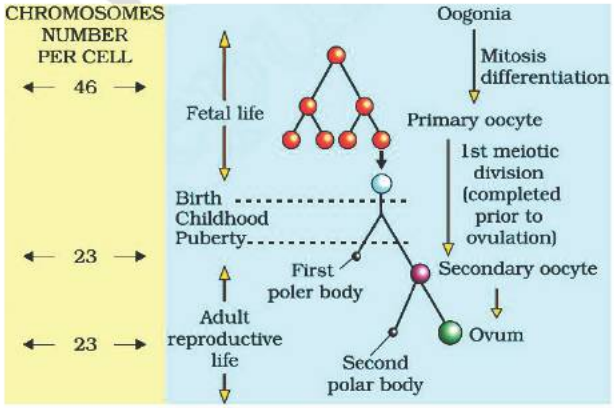
Sectional view of a seminiferous tubule

Structure of sperm

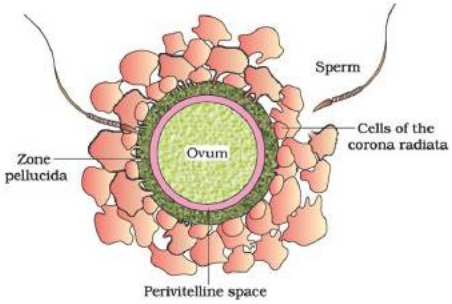


Acrosome: Releases lytic enzymes to penetrate the layers of ovum.
Mitochondria: Provides energy for tail movement.
After spermiogenesis, sperm heads are embedded in Sertoli cells to get nourishment. Then they are released to lumen of seminiferous tubules. It is called **spermiation.**

Oogenesis (Formation of ovum)



Structure of ovum (egg)

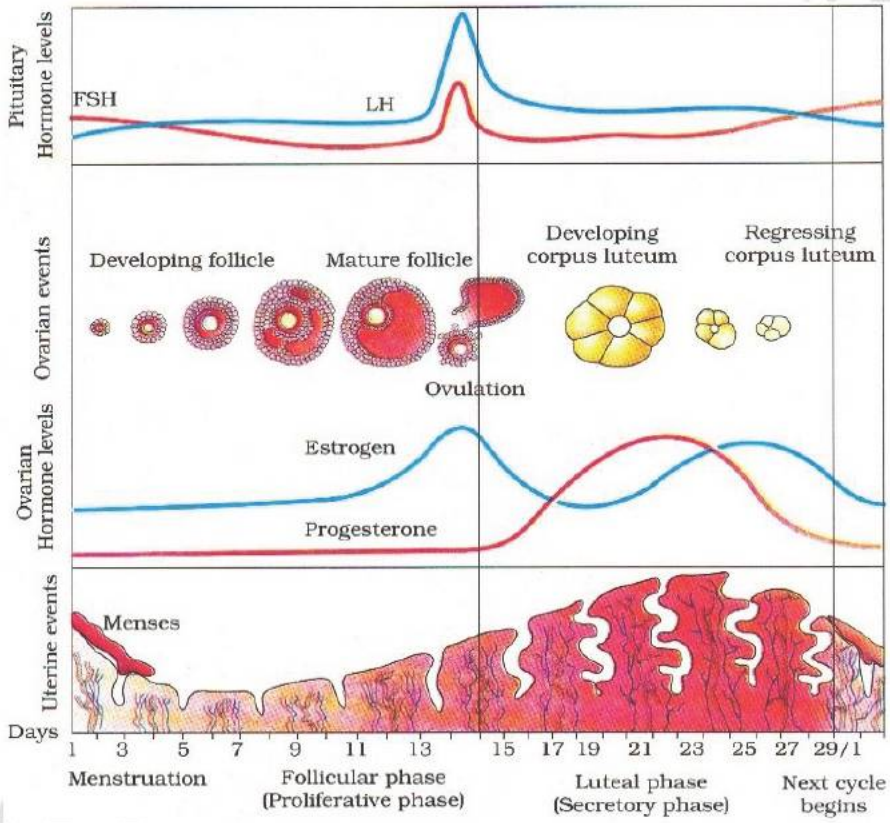


3 membranes: Plasma membrane, Zona pellucida & Corona radiata.

MENSTRUAL CYCLE (REPRODUCTIVE CYCLE)

Phases	Days	Main events
1. **Menstrual phase**	1-5th day	Menstrual flow (bleeding).
2. **Follicular (Proliferative) phase**	5-13th day	○ Primary follicles → Graafian follicles. ○ Proliferation of ruptured uterine endometrium.
3. **Ovulatory phase**	14th day	LH surge → rupture of Graafian follicle → ovulation.
4. **Secretory (Luteal) phase**	15-28th day	Corpus luteum forms → progesterone → endometrium maximum vascular, thick and soft.

- **Menarche:** The first menstruation during puberty.
- **Menopause:** Permanent stopping of menstrual cycle at the age of **50.**



FERTILIZATION AND IMPLANTATION

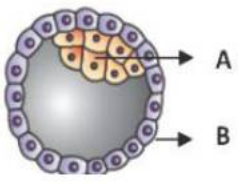
Sperms → Vagina → Cervical canal → Uterus → Isthmus

Ovum (from ovary) → Fimbriae → Infundibulum

} Fertilization in **Ampullary region** → **Zygote**

Zygote → cleavage → morula (8-16 blastomeres) → blastocyst → embryo

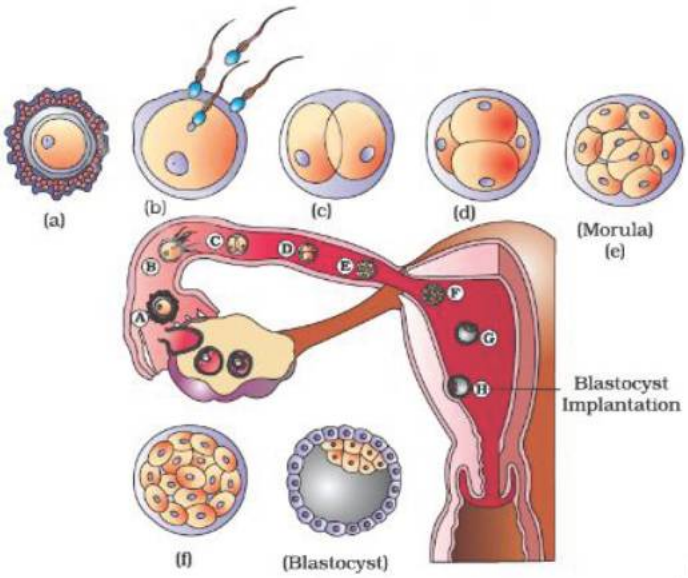
Blastocyst:



A. Inner cell mass: Becomes embryo.

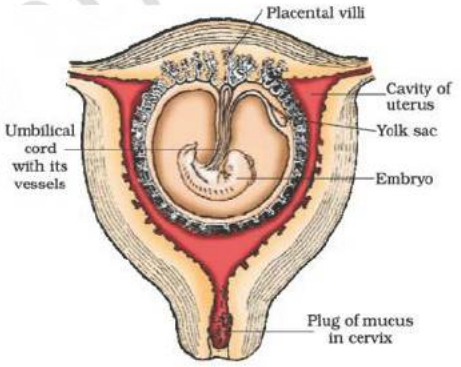
B. Trophoblast: Gives nourishment to inner cell mass. Also, it is attached to endometrium.

After attachment, blastocyst is embedded in endometrium. It is called **implantation.**



PREGNANCY AND EMBRYONIC DEVELOPMENT

Placenta: A structural & functional unit b/w foetus & uterine wall formed by interdigitation of chorionic villi & uterine tissue.



Functions of placenta:

- Supply **O_2, nutrients** etc. from mother to foetus.
- Remove **CO_2 and excretory wastes** from foetus.
- Acts as an endocrine gland. It secretes **Human chorionic gonadotropin (hCG), human placental lactogen (hPL), oestrogens, progesterone** & **relaxin.**

Changes in embryo during pregnancy	
After one month	Heart
End of second month	Limbs and digits
End of 12 weeks (first trimester)	Major organs (limbs, external genital organs etc.)
5th month	Hair on the head. First movement of foetus.
End of 24 weeks (2nd trimester)	Fine body hair, eyelids separate, eye lashes.
End of 9 months	Ready for delivery.

PARTURITION AND LACTATION

- Signals from foetus & placenta → mild uterine contractions **(fetal ejection reflex)** → **oxytocin** from pituitary → stronger uterine muscle contractions → further secretion of oxytocin → **Parturition** (giving birth).
- **Lactation**: Production of milk from mammary glands.
- **Colostrum:** Yellowish milk produced during the initial few days of lactation. It is rich in antibodies essential to develop resistance for the new born babies.

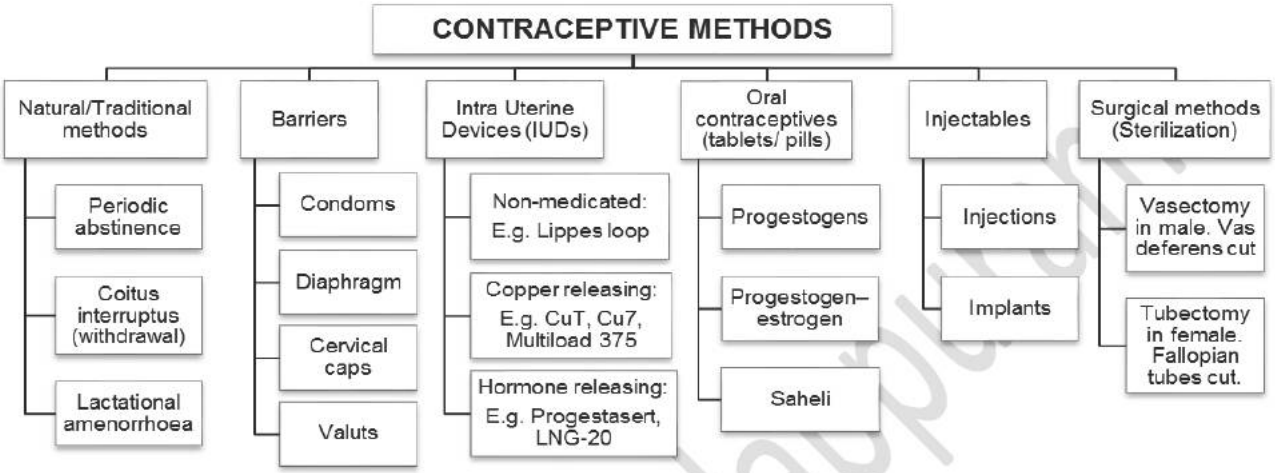
VIDEO CLASS  SLIDES OF THIS CHAPTER  QUESTION BANK 

2. REPRODUCTIVE HEALTH

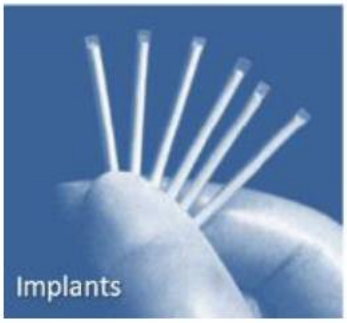
Reproductive & Child Health Care Programme (RCH): To give awareness about reproduction related aspects.

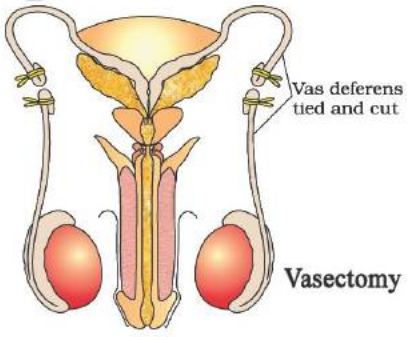
MMR: Maternal Mortality Rate.

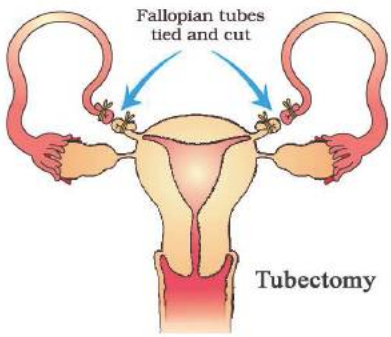
IMR: Infant Mortality Rate.



- **Periodic abstinence:** Avoid coitus during fertile period of the menstrual cycle.
- **Coitus interruptus (withdrawal):** Withdraw penis from the vagina before ejaculation.
- **Lactational amenorrhea:** It is the absence of menstrual cycle & ovulation due to lactation after parturition. Breastfeeding increases lactation. This helps to prevent conception. This is effective up to 6 months following parturition.







CDRI (Central Drug Research Institute): Developed ***Saheli*** (Once a week, non-steroidal, oral pill).

MEDICAL TERMINATION OF PREGNANCY (MTP) OR INDUCED ABORTION

- Safe during first trimester.
- **Importance:** To avoid unwanted pregnancies (casual intercourse or rapes) and harmful pregnancies.
- **Problems:** Performed illegally. Female foeticide. Misuse of amniocentesis.
- **Amniocentesis:** Analysis of foetal cells from amniotic fluid. It is used to test genetic disorders, survivability of foetus etc. it is misused for foetal sex determination.

SEXUALLY TRANSMITTED DISEASES (STD) OR SEXUALLY TRANSMITTED INFECTIONS (STI)

- E.g. Gonorrhoea, syphilis, genital herpes, chlamydiasis, genital warts, trichomoniasis, hepatitis-B & HIV leading to AIDS.
- **Early symptoms**: Itching, fluid discharge, slight pain, swellings, etc. in the genital region.
- If not consult a doctor, it leads to PID (Pelvic Inflammatory Disease), infertility, ectopic pregnancies, abortions, still births, genital cancer etc.
- **Prevention:** Avoid sex with unknown/multiple partners, Use condoms, Consult doctor.

INFERTILITY AND ASSISTED REPRODUCTIVE TECHNOLOGIES

ART	**Assisted Reproductive Technologies:** To correct infertility problems.
IVF	***In Vitro* Fertilization:** Test tube baby programme. Fertilization of ovum with sperm in laboratory. This is followed by Embryo transfer (ET).
ET	Embryo Transfer. 2 types: ZIFT & IUT.
ZIFT	**Zygote Intra Fallopian Transfer:** Transfer of zygote or early embryo (up to 8 blastomeres) into fallopian tube.
IUT	**Intra Uterine Transfer:** Transfer of embryo with more than 8 blastomeres into the uterus.
GIFT	**Gamete Intra Fallopian Transfer:** Transfer of an ovum into the fallopian tube of another female who cannot produce ovum, but can provide suitable environment for fertilization and development.
ICSI	**Intra Cytoplasmic Sperm Injection:** A single sperm is injected directly into an egg. After fertilization, the embryo is implanted into the woman's uterus.
AI	**Artificial Insemination:** Semen is artificially introduced into the vagina or the uterus of the female. Useful for male partner having inability to inseminate female or low sperm counts.
IUI	**Intra Uterine Insemination:** Artificial insemination into the uterus.

VIDEO CLASS

SLIDES OF THIS CHAPTER

QUESTION BANK

3. PRINCIPLES OF INHERITANCE & VARIATION

Gregor Mendel conducted experiments on **garden peas (*Pisum sativum*).**

He selected 7 pairs of true breeding pea varieties.

7 Characters	Dominant	Recessive
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

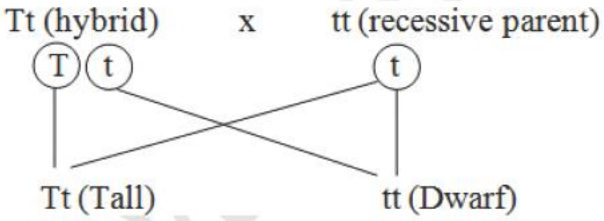
INHERITANCE OF ONE GENE

Monohybrid cross: A cross involving 2 plants differing in a character pair.

Monohybrid phenotypic ratio = **3:1**

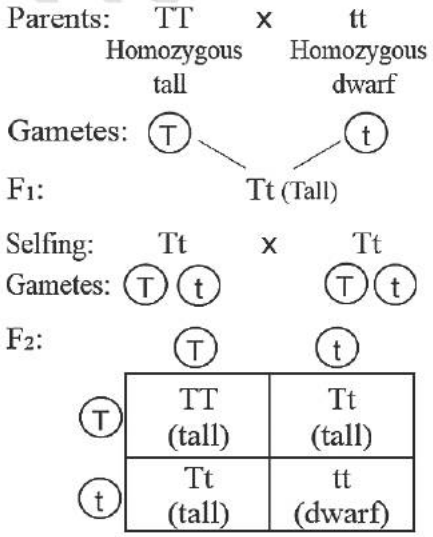
Monohybrid genotypic ratio = **1:2:1**

- **Backcross:** Cross b/w a hybrid & its any parent.
- **Testcross:** Cross b/w an organism with dominant phenotype & a recessive individual.



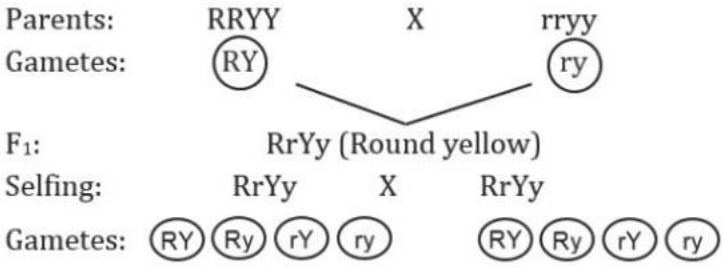
Hence monohybrid test cross ratio= **1:1**

Test cross is used to find out the unknown genotype of a character.



INHERITANCE OF TWO GENES

Dihybrid cross: Cross b/w two parents differing in 2 pairs of characters. E.g. Cross b/w pea plant with round & yellow seeds (RRYY) and wrinkled & green seeds (rryy).



F2:

	(RY)	(Ry)	(rY)	(ry)
(RY)	RRYY *Ro. Yel*	RRYy *Ro. Yel*	RrYY *Ro. Yel*	RrYy *Ro. Yel*
(Ry)	RRYy *Ro. Yel*	RRyy *Ro. Gr*	RrYy *Ro. Yel*	Rryy *Ro. Gr*
(rY)	RrYY *Ro. Yel*	RrYy *Ro. Yel*	rrYY *Wri. Yel*	rrYy *Wri. Yel*
(ry)	RrYy *Ro. Yel*	Rryy *Ro. Gr*	rrYy *Wri. Yel*	rryy *Wri. Gr*

Dihybrid Phenotypic ratio= 9:3:3:1

MENDEL'S LAWS OF INHERITANCE

First Law (Law of Dominance)

- *Characters are controlled by **factors.***
- *Factors occur in pairs.*
- *In a dissimilar factor pair, one factor dominates the other.*

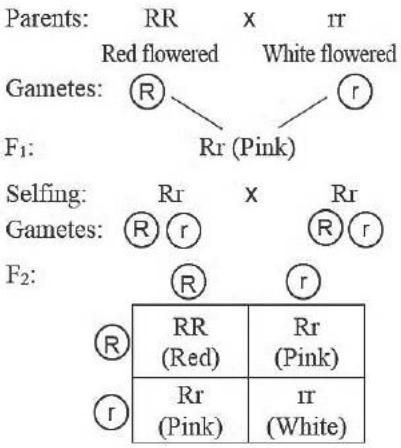
Second Law (Law of Segregation)

"During gamete formation, factors (alleles) of a character pair segregate each other such that a gamete receives only one of the 2 factors".

3rd Law: Law of Independent Assortment

"When two pairs of traits are combined in a hybrid, segregation of one pair of characters is independent of the other pair of characters".

- **Incomplete Dominance:** It is an inheritance in which heterozygous offspring shows intermediate character b/w two parental characteristics. E.g. Flower colour in 4'O clock plant and snapdragon (*Antirrhinum*).
  Phenotypic ratio= 1: 2: 1
  Genotypic ratio= 1: 2: 1



- **Co-dominance:** The inheritance in which both alleles of a gene are expressed in a hybrid. E.g. ABO blood grouping in human. ABO blood groups are controlled by the gene **I**.
  The gene **I** has three alleles I^A, I^B & **i**.

Alleles from parent 1	Alleles from parent 2	Genotype of offspring	Blood types (phenotype)
I^A	I^A	$I^A I^A$	A
I^A	I^B	$I^A I^B$	AB
I^A	i	I^Ai	A
I^B	I^A	$I^A I^B$	AB
I^B	I^B	$I^B I^B$	B
I^B	i	I^Bi	B
i	i	ii	O

When I^A and I^B are present together, they both express (AB group).

- **Multiple allelism:** **More than two alleles** of a gene govern same character. E.g. ABO blood grouping (3 alleles: I^A, I^B & i).
- **Pleiotropy:** A single gene exhibits multiple phenotypic expressions. E.g. Starch synthesis in pea, phenylketonuria.

  Starch synthesis in pea plant:

  BB gene: Effective starch synthesis, produce large starch grains.

  bb gene: Lesser starch synthesis, produce small starch grains.

  Starch grain size also shows **incomplete dominance.**

CHROMOSOMAL THEORY OF INHERITANCE (Sutton & Boveri)

- Chromosomes are **vehicles of heredity.**
- Two identical chromosomes form a **homologous pair.**
- Homologous pair **segregates** during gamete formation.
- Independent pairs **segregate independently**.

Genes (factors) are present on chromosomes. Hence genes and chromosomes show similar behaviours.

T.H Morgan proved chromosomal theory of inheritance using fruit flies (***Drosophila melanogaster)***.

Morgan's experiment to study sex linked genes:

Linkage: Physical association of two genes on a chromosome.

Recombination: Generation of non-parental gene combination.

Drosophila is suitable material for genetic study because,

- They can grow on simple synthetic medium.
- Short generation time (life cycle: 12-14 days).
- Breeding can be done throughout the year.
- Hundreds of progenies per mating.
- Male and female flies are easily distinguishable.

Cross 1: Yellow-bodied, white-eyed female X Brown-bodied, red-eyed male (wild type)

Cross 2: White-eyed, miniature winged female X Red eyed, large winged male (wild type)

Morgan intercrossed their F_1 progeny. He found that

- The two genes did not segregate independently.
- Parental gene combinations were much higher than non-parental type. This is due to **linkage.**
- Genes of eye colour & body colour were tightly linked (only **1.3%** recombination). Genes of eye colour & wing size were loosely linked (**37.2%** recombination).
- **Tightly linked genes** show **low recombination. Loosely linked** genes show **high recombination.**

MECHANISMS OF SEX DETERMINATION

Sex chromosomes include X & Y.

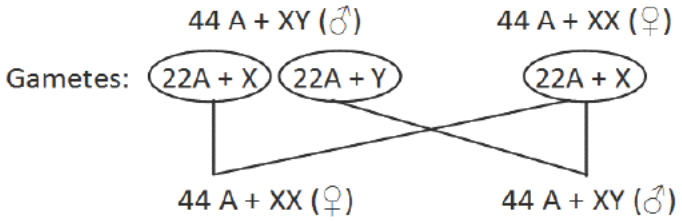
Autosomes are chromosomes other than sex chromosomes.

a. **XX-XO mechanism:** Male heterogametic, i.e. XO (Gametes with X and without X) and female homogametic, i.e. XX (gametes with X-chromosomes). E.g. grasshopper.

b. **XX-XY mechanism:** Male heterogametic (X & Y) & female homogametic (X only). E.g. Human & *Drosophila.*

c. **ZZ-ZW mechanism:** Male homogametic (ZZ) and female heterogametic (Z & W). E.g. Birds.

Sex Determination in Humans (XX-XY)



Thus the sperm determines whether the offspring male or female.

MUTATION

Sudden heritable change in DNA. 2 types:

- ✓ **Point mutation**: Change in a single base pair. E.g. sickle cell anaemia.
- ✓ **Frame-shift mutation:** Deletion or insertion of base pairs resulting in the shifting of DNA sequences.

Mutagens: Agents which induce mutation. 2 types.

- **Physical mutagens:** UV radiation, α, β, γ rays, X-ray etc.
- **Chemical mutagens:** Mustard gas, phenol, formalin etc.

PEDIGREE ANALYSIS

Analysis of genetic traits in several generations of a family. It helps to understand whether a trait is dominant or recessive.

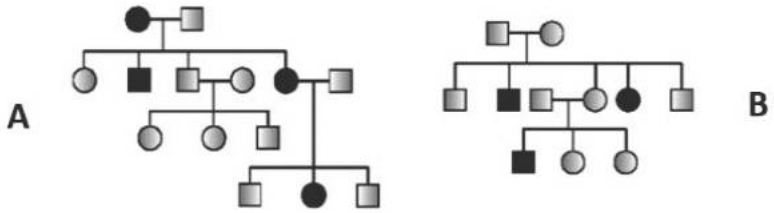
Representation of family genetic history is called **family tree (pedigree).**

Male: □ Female: ○ Sex unspecified: ◇ Affected individual: ■ ● ◆

Mating: □—○ Mating b/w relatives (consanguineous mating): □═○

Parents above & children below 

Parents with affected male child  Five unaffected offspring 



Pedigree analysis of (A) Autosomal dominant trait (E.g. Myotonic dystrophy)
(B) Autosomal recessive trait (E.g. Sickle-cell anaemia)

GENETIC DISORDERS

1. Mendelian disorders: Due to change in gene.

- **Haemophilia (Royal disease):** Sex linked recessive disease. A blood clotting protein is affected.

  The disease is controlled by 2 alleles, **H** (normal) & **h** (haemophilic).

  In females, haemophilia is very rare because it happens only when mother is at least carrier and father haemophilic.

- **Sickle-cell anaemia:** Autosome linked recessive disease.

  RBC becomes sickle shape.

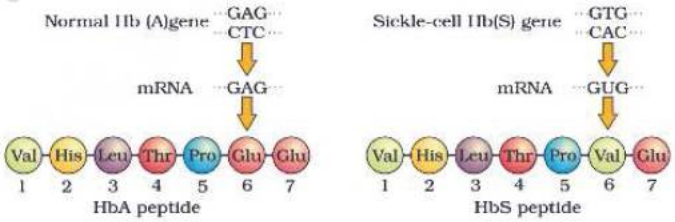
  Homozygous dominant (Hb^AHb^A): normal

  Heterozygous (Hb^AHb^S): carrier; sickle cell trait

  Homozygous recessive (Hb^SHb^S): affected

  It is due to substitution of **Glutamic acid** by **Valine** at the **6th position** of **β-globin chain** of haemoglobin.

  This is due to the single base substitution at the sixth codon of the **β-globin gene** from **GAG** to **GUG.**



- **Thalassemia:** Autosome-linked recessive disease. Reduced synthesis of α or β globin chains of haemoglobin. 2 types:
  - **α Thalassemia:** Reduced synthesis of **α globin** due to mutation of genes **HBA1 & HBA2** on **chromosome 16.**
  - **β Thalassemia:** Reduced synthesis of **β globin** due to mutation of gene **HBB** on **chromosome 11.**

  Thalassemia is a **quantitative problem**. Sickle-cell anaemia is a **qualitative problem.**

- **Colour blindness:** Sex-linked recessive disorder due to defect in red or green cone of eye. Fail to discriminate red & green colour. It is rare in females because the genes are X-linked.

- **Phenylketonuria:** Inborn error of metabolism. Autosomal recessive disease. Due to mutation of a gene coding for ***phenyl alanine hydroxylase*** enzyme (it converts ***phenylalanine*** to ***tyrosine).***

  Affected individual lacks this enzyme. So, phenylalanine becomes ***phenyl pyruvic acid.*** They accumulate in brain causing mental retardation. These are also excreted through urine.

2. Chromosomal disorders: Due to change in number or structure of chromosome.

Disorders	Genetic constitution	Features
Down's syndrome: Presence of an additional chromosome number 21 (21 trisomy).	45 A + XX or 45 A + XY	▪ Short stature, small round head. Broad flat face. ▪ Furrowed big tongue and partially open mouth. ▪ Retarded physical, psychomotor & mental development.
Klinefelter's Syndrome: Presence of an additional X-chromosome in male.	44 A + XXY	▪ Development of breast (Gynaecomastia). ▪ Sterile.
Turner's syndrome: Absence of an X chromosome in female.	44 A + X0	▪ Sterile, Ovaries are rudimentary. ▪ Lack of other secondary sexual characters. ▪ Dwarf.

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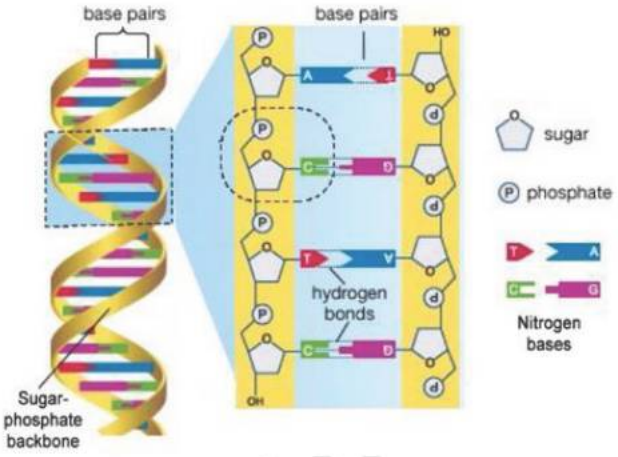
SLIDES OF THIS CHAPTER

QUESTION BANK

4. MOLECULAR BASIS OF INHERITANCE

THE DNA

- DNA & RNA are **polynucleotides** (polymer of **nucleotides)**.
- **Nucleoside=** A nitrogen base + pentose sugar (by **N-glycosidic bond).**
- **Nucleotide=** A nitrogen base + A pentose sugar **(ribose** in **RNA & deoxyribose** in **DNA)** + a phosphate group.
- Nitrogen bases are 2 types:
  - **Purines: Adenine (A)** and **Guanine (G).**
  - **Pyrimidines: Cytosine (C), Thymine (T)** & **Uracil (U).**
- **A=T (2 hydrogen bonds) C≡G (3 hydrogen bonds).**
- **Phosphodiester bond=** Bond b/w sugar & phosphate.

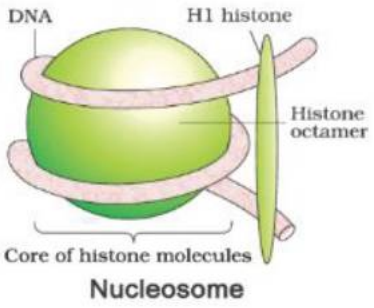


Erwin Chargaff's rule: In DNA, the proportion of A is equal to T and the proportion of G is equal to C.

$$\therefore \quad [A] + [G] = [T] + [C] \qquad \text{or } [A] + [G] / [T] + [C] = 1$$

PACKAGING OF DNA HELIX

- DNA (-ve charge) is wrapped around histone octamer (+ve charge) to give **nucleosome.**
- Nucleosomes condense → chromatin → chromosome.
- Higher level packaging of chromatin needs **non-histone chromosomal (NHC)** proteins.
- Chromatin has 2 forms:
  - **Euchromatin:** Loosely packed, light stained and transcriptionally active region.
  - **Heterochromatin:** Densely packed, dark stained and inactive region.



THE SEARCH FOR GENETIC MATERIAL

1. Griffith's Transforming Principle experiment:

- S-strain → Inject into mice → Mice die
- R-strain → Inject into mice → Mice live
- S-strain (Heat killed) → Inject into mice → Mice live
- S-strain (Hk) + R-strain (live) → Inject into mice → Mice die

Conclusion: Some *transforming principle* transferred from hk S-strain to R-strain. Thus R-strain transformed to S strain.

2. Biochemical characterization of transforming principle:

- By **Avery, MacLeod & McCarty.**
- They purified biochemicals from heat killed S cells using suitable enzymes.
- Digestion of DNA with *DNase* inhibited transformation. It proves that DNA was the transforming principle.

3. Hershey-Chase Experiment (Blender Experiment):

- Bacteriophage viruses + radioactive phosphorus (P^{32}) → **radioactive DNA** → Infected with *E. coli*.
- Bacteriophage viruses + radioactive sulphur (S^{35}) → **radioactive protein** → Infected with *E. coli*.
- **Blending** to remove virus particles from bacteria.
- **Centrifugation** to separate lighter virus particles from heavier bacterial cells.
- Bacteria infected with viruses having radioactive DNA were radioactive. i.e., DNA had passed from the virus to bacteria.
- Bacteria infected with viruses having radioactive proteins were not radioactive. i.e., proteins did not enter the bacteria from the viruses. This proves that DNA is the genetic material.

PROPERTIES OF GENETIC MATERIAL (DNA v/s RNA)

Properties	Reasons for stability (less reactivity) of DNA	Reasons for mutability (high reactivity) of RNA
• Replication. • Chemical and structural stability. • Show mutations for evolution. • Express as Mendelian Characters.	• Double stranded • Presence of thymine • Absence of 2'-OH in sugar	• Single stranded • Presence of Uracil • Presence of 2'-OH in sugar

To store genetic information, DNA is better due to its stability. But for transmission of genetic information, RNA is better.

CENTRAL DOGMA OF MOLECULAR BIOLOGY

It is proposed by **Francis Crick.**

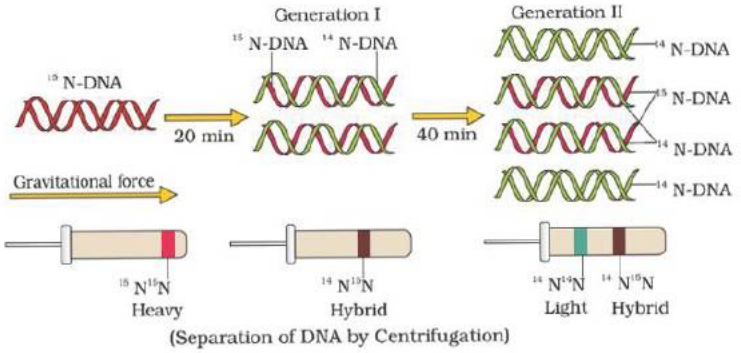
DNA REPLICATION

- Replication is the copying of DNA from parental DNA.
- **Watson & Crick** proposed **Semi-conservative model** of replication.

Messelson & Stahl's Experiment:

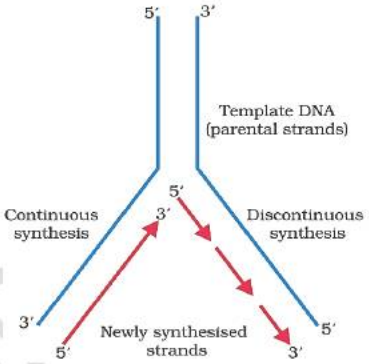
- They grew ***E. coli*** in **$^{15}NH_4Cl$ medium** (^{15}N = heavy isotope). As a result, new heavy DNA (^{15}N DNA) formed.
- Heavy DNA can be distinguished from normal DNA (light DNA or ^{14}N DNA) by centrifugation in cesium chloride density gradient.

- *E. coli* cells from ^{15}N medium were transferred to ^{14}N medium. In next generation, density of DNA was intermediate b/w ^{15}N DNA & ^{14}N DNA. i.e., one strand is old (**^{15}N**) and one strand is new (**^{14}N**).



Process of Replication:

- DNA replication starts at a point called ***origin.***
- DNA replicates in the **5'→3' direction.**
- ***Deoxyribonucleoside triphosphates*** act as substrate.
- 2 strands unwind and separate to form ***replication fork.***
- In presence of ***DNA polymerase,*** nucleotides join to form new strand.
- One strand undergoes **Continuous** synthesis.
- Other strand undergoes **discontinuous** synthesis forming **Okazaki fragments.** They join to form a new strand by ***DNA ligase.***



Replication fork

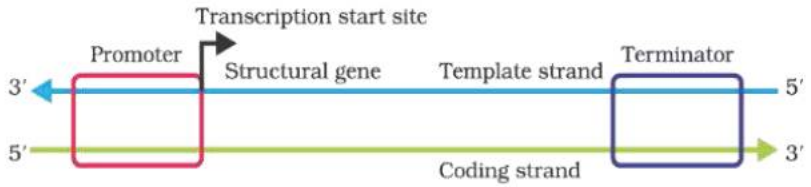
TRANSCRIPTION

- Formation of RNA from one strand of the DNA.

  3'-ATGCATGCATGCATGCATGCATGC-5' **template strand.**
  5'-TACGTACGTACGTACGTACGTACG-3' **coding strand.**
- In transcription, both strands are not copied because
  - The **code for proteins is different in both strands.**
  - **2 RNA molecules** form **double stranded RNA.**

3 regions of a Transcription Unit

- **A promoter:** Binding site for *RNA polymerase.*
- **Structural gene:** Region b/w promoter and terminator.
- **A terminator:** The site where transcription stops.



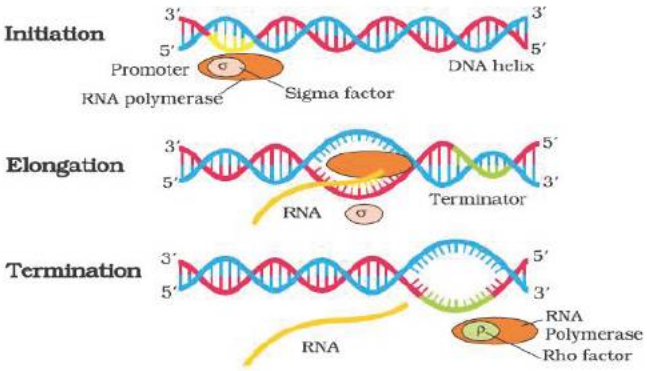
Structural gene in a transcription unit is 2 types:

- **Monocistronic structural genes (split genes)**: Seen in eukaryotes. It contains ***exons*** and ***introns.***
- **Polycistronic structural genes**: Seen in prokaryotes. Here, there are no split genes.

Transcription in prokaryotes (bacteria):

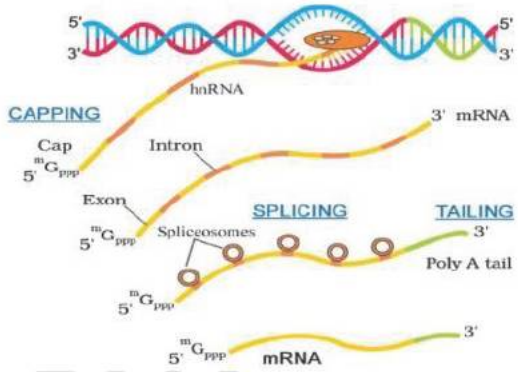
- **Initiation:** *RNA polymerase* binds at promoter site → unwinding of DNA. An *initiation factor (σ factor)* in *RNA polymerase* initiates RNA synthesis.
- **Elongation:** RNA chain is synthesized in 5'-3' direction. Activated *ribonucleoside triphosphates* are added.

- **Termination:** A *termination factor (ρ factor)* binds to the *RNA polymerase* and terminates the transcription.



Transcription in eukaryotes: There are 2 additional complexities:

1. **There are 3 *RNA polymerases:*** *RNA polymerase I, II & III.*
2. **Primary transcripts (hnRNA)** contain exons & introns. To remove introns, it undergoes the following processes and become mRNA:
   - **Splicing:** Introns are removed and exons are joined.
   - **Capping: Methyl guanosine triphosphate (cap)** is added to the 5' end of hnRNA.
   - **Tailing (Polyadenylation): Adenylate residues** (200-300) are added at 3'-end.



GENETIC CODE

- It is the sequence of nucleotides (nitrogen bases) in mRNA that contains information for protein synthesis.

Salient features of genetic code:

- **Triplet code.** 61 codons code for amino acids. **UAA, UAG & UGA** are **stop codons (Termination codons).**
- Genetic code is **universal.**
- **No punctuations** b/w adjacent codons.
- An amino acid is coded by many codons. So the code is **degenerate.**
- AUG has dual functions: Codes for Methionine + initiator codon.

TYPES OF RNA

- **mRNA (messenger RNA):** Provide template for translation (protein synthesis).
- **rRNA (ribosomal RNA):** catalytic role during translation.
- **tRNA (transfer RNA): Adapter molecule.** Brings amino acids for protein synthesis and reads the genetic code. It has **an Anticodon loop** & **an amino acid acceptor end.**

TRANSLATION (PROTEIN SYNTHESIS)

1. **Charging (aminoacylation) of tRNA:** Amino acids are activated (amino acid + ATP) + tRNA.
2. **Initiation:** Ribosome binds to mRNA at the **start codon (AUG).** So the **initiator tRNA** (with methionine) binds. Its **anticodon (UAC)** recognises start codon **AUG.**

3. **Elongation:** Second aminoacyl tRNA binds to ribosome. Its anticodon binds to second codon. A peptide bond is formed between first and second amino acids. This process continues.
4. **Termination:** It occurs when a **release factor** binds to stop codon.

mRNA has sequences that are not translated **(untranslated regions or UTR).** They are required for efficient translation.

REGULATION OF GENE EXPRESSION

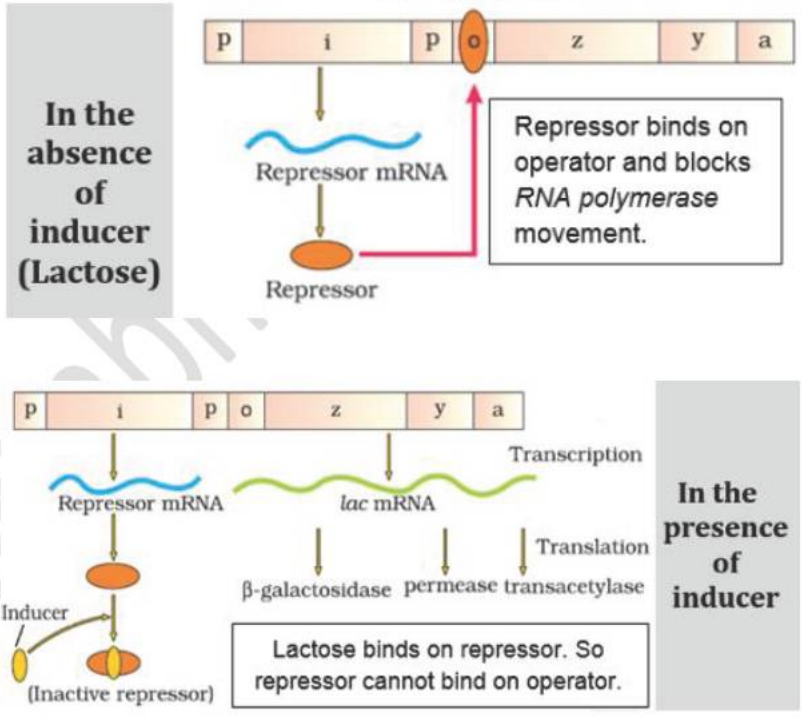
Levels of gene expression in eukaryotes:

Transcriptional level, **Processing** level, **Transport** of mRNA from nucleus to the cytoplasm and **Translational** level.

Lac Operon:

All the genes regulating lactose metabolism in ***E. coli***. It consists of

a) **A regulatory or inhibitor (i) gene:** Codes for repressor protein.
b) **3 structural genes:**
   - **z gene:** Codes for ***β galactosidase.*** It hydrolyses lactose to galactose and glucose.
   - **y gene:** Codes for ***permease.*** It increases permeability of the cell to lactose.
   - **a gene:** Codes for a ***transacetylase.***



HUMAN GENOME PROJECT (HGP)

First mega project for sequencing of nucleotides and mapping of all genes in human genome.

Goals of HGP

a. Identify all the genes in DNA.
b. Sequencing of 3 billion base pairs of human DNA.
c. Store this information in **databases.**
d. Improve tools for data analysis.

e. Transfer related technologies to other sectors.
f. Address the **ELSI.**

Methodologies of HGP: 2 approaches.

- **Expressed Sequence Tags (ESTs):** Focused on identifying all the genes that are expressed as RNA.
- **Sequence annotation:** Sequencing whole genome.

Procedure of sequencing:

Isolate DNA from a cell → Convert into random fragments → Clone in a host using vectors → Sequencing of fragments using Automated DNA sequencers (Frederick Sanger method) → Arrange the sequences based on overlapping regions→ Alignment of sequences using computer programs.

Salient features of Human Genome

a. Contains 3164.7 million bases & 30,000 genes.
b. **99.9%** nucleotide bases are same in all people.
c. Chromosome I has most genes **(2968)** and Y has the fewest **(231).**
d. Major portion of genome is made of **Repeated (repetitive) sequences.**
e. **1.4 million** locations have single-base DNA differences. They are called **SNPs (Single nucleotide polymorphism or 'snips').**

DNA FINGERPRINTING (DNA PROFILING)

- Technique to identify similarities & differences of the DNA fragments of 2 individuals.
- It is developed by **Alec Jeffreys.**

Basis of DNA fingerprinting

- DNA carries non-coding **repeated sequences** called **variable number tandem repeats (VNTR).**
- VNTR is specific in each person.

Steps (Southern Blotting Technique)

a. **Isolation** of DNA.
b. **Digestion** of DNA by **restriction endonucleases.**
c. **Separation** of DNA fragments by **gel electrophoresis.**
d. **Transferring (blotting)** DNA fragments to **nitrocellulose** or **nylon membrane**.
e. **Hybridization** by radioactive **VNTR** probe.
f. Detection of hybridized DNA by **autoradiography.**

Application of DNA fingerprinting:

- **Forensic tool** to solve paternity, rape, murder etc.
- For the diagnosis of **genetic diseases.**
- To determine **phylogenetic status** of animals.

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SLIDES OF THIS CHAPTER

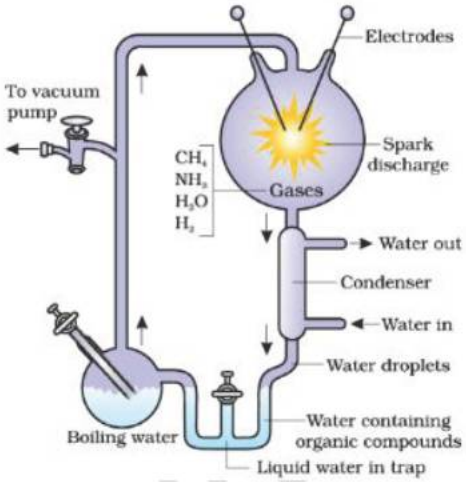
QUESTION BANK

5. EVOLUTION

THEORIES OF ORIGIN OF LIFE

1. **Spontaneous generation:** Life came out of decaying & rotting matter like straw, mud etc. **Louis Pasteur** disproved this theory.
2. **Biogenesis:** Life originates from pre-existing life.
3. **Panspermia:** Units of life spores were transferred to planets including earth.
4. **Chemical evolution:** By **Oparin** & **Haldane.** Life was originated from inorganic & organic molecules.

Miller experiment to prove Chemical evolution. As a result, some amino acids are formed.



EVIDENCES FOR EVOLUTION

Paleontological evidences: Study of ***extinct animals*** and ***geological period.***

Morphological & Anatomical evidences

a. Homologous organs: The organs having fundamentally similar structure and origin but different functions. This phenomenon is called **Homology.**

E.g. 1. Human hand, Whale's flippers, Bat's wing & Cheetah's foot.

2. Thorns of *Bougainvillea* and tendrils of *Cucurbita*.

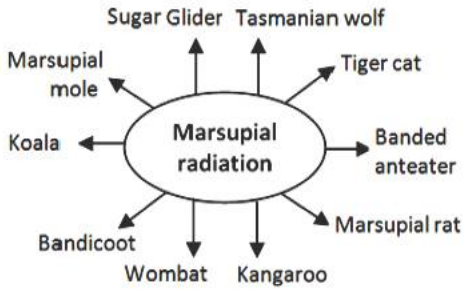
Origin of homologous organs is due to ***Divergent evolution*** (**related species** become **less similar** in different environmental condition).

b. Analogous organs: The organs having similar function but different structure & origin. This phenomenon is called **Analogy.** E.g. Wings of insects & wings of birds, Sweet potato & Potato, Eye of the octopus & of mammals.

Origin of analogous organs is due to ***Convergent evolution*** (**unrelated species** become more **similar** in similar environmental condition).

Adaptive radiation

It is the evolution of different species in a geographical area. E.g. Darwin's finches, Australian marsupials (Marsupial radiation), Placental mammals in Australia.



Natural selection

It is the process in which the organisms with better, favourable & heritable variation are survived and reproduced. E.g.

- **In England, before industrialization (1850s):** More white-winged moths than dark winged (melanised) moths.

  After industrialization (1920): More dark-winged and less white winged.

Reason:

Before industrialization: Due to covering of white lichens on the trees, white winged moths survived but dark winged moths were picked out by predators.

After industrialization: No lichens. Tree trunks became dark due to smoke and soot. So, predators identified white winged moths easily. Dark winged moths survived.

- Development of resistant varieties in organisms against ***herbicides, pesticides, antibiotics*** or ***drugs*** etc.

These are the examples for natural selection by **anthropogenic action** (evolution due to human activities).

THEORIES OF BIOLOGICAL EVOLUTION

Theory of Inheritance of Acquired characters: Proposed by Lamarck. It states that evolution occurred by the inheritance of acquired characters. E.g. Long neck of giraffe.

Theory of Natural selection: Proposed by **Charles Darwin.**
Key concepts: Branching descent & Natural selection.
Natural selection is based on these facts: **Heritable minor variations, Overproduction, Limited natural resources, Struggle for existence & Survival of the fittest.**

MECHANISM OF EVOLUTION

- **Hugo de Vries** conducted experiments on evening primrose and proposed that evolution takes place through **mutation.**
- Mutation is the origin of variation for evolution.
- **Darwinian variation** is minor, slow and directional. It results in **gradual evolution.**
- **Mutational variation** is sudden, random & directionless. Here, speciation is by **saltation** (single step, large mutation).

HARDY-WEINBERG PRINCIPLE

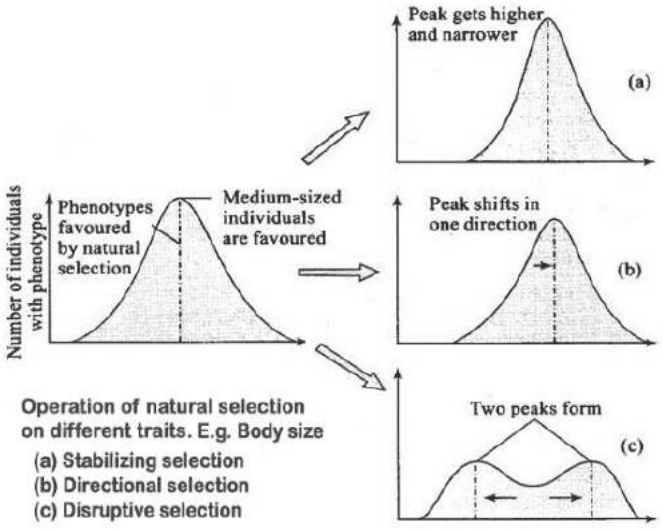
It states that *allele frequencies in a population are stable and is constant from generation to generation in the absence of disturbing factors.*

$$p^2 + 2pq + q^2 = 1$$

Factors affecting Hardy-Weinberg equilibrium:

- Gene migration
- Genetic drift
- Mutation
- Genetic recombination
- Natural selection.

Gene migration: Gene flow from one population to another.



Genetic drift: Gene flow by chance. Original drifted population becomes founders **(founder effect).**

Natural selection: It is 3 types.

- **Stabilizing selection:** Here, more individuals acquire mean character value and variation is reduced.
- **Directional selection:** Individuals of one extreme are more favoured.
- **Disruptive selection:** Individuals of both extremes are more favoured.

ORIGIN AND EVOLUTION OF MAN

Dryopithecus → Ramapithecus → Australopithecus → Homo habilis → Homo erectus → Homo neanderthalensis → Homo sapiens.

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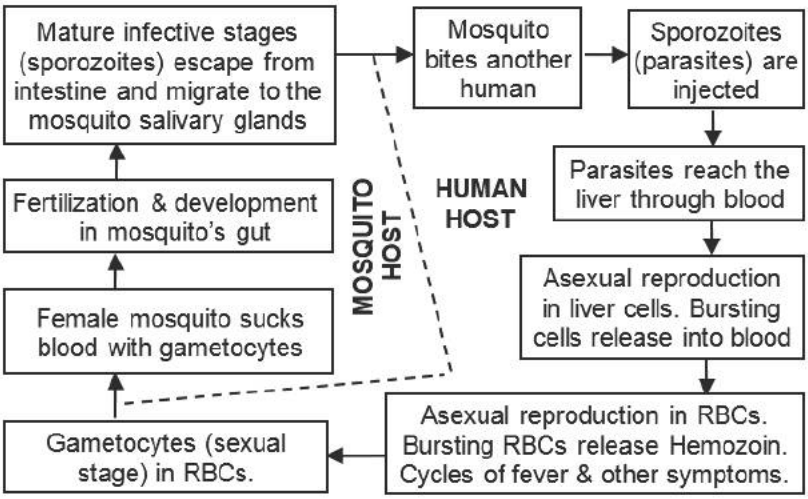
SLIDES OF THIS CHAPTER 

QUESTION BANK 

6. HUMAN HEALTH AND DISEASES

COMMON INFECTIOUS DISEASES IN HUMAN

Disease	Pathogen	Transmission	Symptoms
Typhoid	*Salmonella typhi* **Group: Bacterium** **Widal test:** To confirm the disease.	Food & water → small intestine.	High fever, weakness, stomach pain, constipation, headache & loss of appetite. Intestinal perforation.
Pneumonia	*Streptococcus pneumoniae* & *Haemophilus influenzae* **Group: Bacterium**	Inhaling droplets from patients, Sharing contaminated objects.	Respiratory problems, fever, chills, cough, headache. In severe cases, lips and finger nails turn gray to bluish colour.
Common cold	*Rhinovirus* **Group: Virus**	Inhaling droplets from cough or sneezes. Contaminated objects.	Nasal congestion & discharge, sore throat, cough, hoarseness, headache, tiredness.
Malaria	*Plasmodium sp.* **Group: Protozoa**	Female *Anopheles* mosquito.	Haemozoin toxin causes chill and high fever recurring every 3-4 days.
Amoebiasis (Amoebic dysentery)	*Entamoeba histolytica* **Group: Protozoa**	Houseflies transmit parasites from faeces to food & water.	Constipation, abdominal pain & cramps, stools with mucus and blood clots.
Ascariasis	*Ascaris* **Group: Helminth**	Soil, water, vegetables, fruits etc. contaminated with faeces.	Internal bleeding, muscular pain, fever, anaemia, blockage of intestinal passage.
Filariasis (Elephantiasis)	*Wuchereria* (Filarial worms) **Group: Helminth**	Female *Culex* mosquito.	Chronic inflammation and deformity of limbs & genital organs.
Ringworm	*Microsporum, Trichophyton* & *Epidermophyton* **Group: Fungus**	From soil or towels, cloths, comb etc.	Dry, scaly lesions on skin, nails, scalp etc. Itching.



Life cycle of Plasmodium

IMMUNE SYSTEM

LYMPHOID ORGANS

The organs where origin/ maturation & proliferation of lymphocytes occur.

2 types: Primary & Secondary.

a) **Primary lymphoid organs:** Here, immature lymphocytes differentiate into antigen-sensitive lymphocytes. E.g. **Bone marrow & thymus.**

b) **Secondary lymphoid organs:** The organs, to which matured lymphocytes migrate, interact with antigens and proliferate to **effector cells.** E.g. Spleen, lymph nodes, tonsils, Peyer's patches, Mucosa associated lymphoid tissue (MALT) & appendix.

IMMUNITY

2 types: Innate and Acquired.

1. Innate immunity: *Non-specific* inborn immunity. It includes 4 types of **Barriers:**

a. **Physical barriers:** E.g. ***Skin***, ***Mucus***.
b. **Physiological barriers:** E.g. gastric HCl, saliva, tear etc.
c. **Cellular barriers:** *Phagocytes* like *WBC, macrophages* etc.
d. **Cytokine barriers:** Virus infected cells → ***interferon*** → protect non-infected cells from viral infection.

2. Acquired immunity

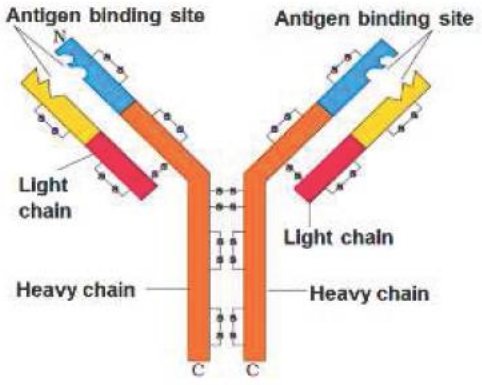
Pathogen specific immunity developed during lifetime.

First encounter of a pathogen → *primary response* in low intensity.

Second encounter → strong *secondary (anamnestic) response.*

These responses are carried out by

- *B-lymphocytes (B-cells):* Produce *antibodies.*
- *T-lymphocytes (T-cells):* Help B-cells to produce antibodies.



Structure of antibody

Types of Acquired immune responses:

1. **Humoral immune response/ Antibody mediated immunity (AMI):** It is mediated by *antibodies.*
2. **Cell-mediated response / cell-mediated immunity (CMI):** It is mediated by ***T-lymphocytes.***

Types of Acquired immunity:

- **Active immunity:** Here, antibodies are produced in host body. It is developed during natural infection by microbes or by injecting microbes during immunization.
- **Passive immunity:** Here, readymade antibodies are given to the body. E.g. Foetus gets antibodies from mother through Placenta, infants gets antibodies (IgA) in colostrum.

Types of Immunization:

1. Active Immunization (Vaccination)

- **Vaccine** (inactivated pathogen or its antigenic proteins) is introduced into body for the development of antibodies.
- E.g. Polio vaccine, Hepatitis B vaccine, DPT vaccine etc.

2. Passive Immunization

- It is the direct injection of pre-formed antibodies or antitoxin. It requires for quick immune response.
- E.g. Immunization against Tetanus, snake venom etc.

Autoimmunity

Due to genetic and other unknown reasons, the body attacks self-cells resulting in damage to the body. It is called **auto-immune disease.** E.g. *Rheumatoid arthritis.*

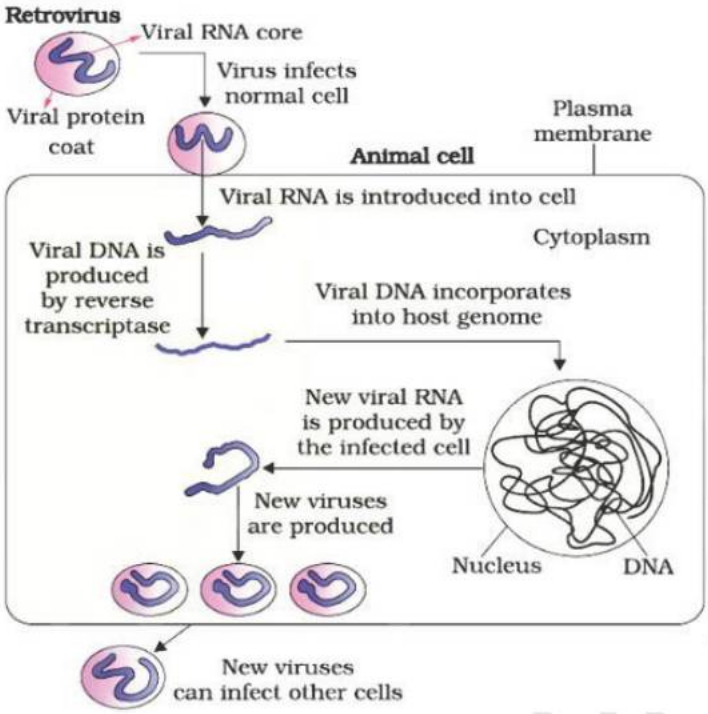
Allergies

- Exaggerated response of the immune system to some antigens found in the environment.
- **Allergens:** E.g. mites in dust, pollens, animal dander etc.
- **Symptoms:** Sneezing, watery eyes, running nose, difficult breathing, wheezing etc.
- Antibodies produced against the **allergens** are **IgE type.**
- **Asthma** is a respiratory disease due to allergy.
- **Treatment:** Drugs like *anti-histamine*, *adrenaline* and *steroids* quickly reduce the symptoms.
- Modern-day life style & protected environment provided early in life results in low immunity and more sensitivity to allergens. So children in metro cities suffer from allergies and asthma.

AIDS (Acquired Immuno Deficiency Syndrome)

- It is caused by **HIV (Human Immunodeficiency Virus),** a **retrovirus** having RNA genome.
- **Transmission:** Sexual contact with infected person, Transfusion of contaminated blood, Sharing of infected needles, From mother to child through placenta.
- **Diagnosis: ELISA test** (Enzyme-linked immuno-sorbent Assay).
- **Treatment:** Anti-retroviral drugs.
- **Prevention:** Educate people about AIDS, Make blood safe from HIV, Use disposable needles and syringes, Condoms, Control drug abuse.

Replication of retrovirus:



Life cycle of HIV:

HIV enters body → To macrophages (acts as HIV factory) → RNA becomes viral DNA in presence of *Reverse transcriptase* → Viral DNA incorporates into host DNA→ produce virus particles → HIV enters helper T-cells (T_H lymphocytes) → Replicates & produce progeny viruses → Attack other T_H cells → T_H cells decrease → Weaken immunity.

CANCER

- It is an abnormal and uncontrolled multiplication of cells to form tumour.
- Normal cells show **contact inhibition** (contact with other cells inhibits their uncontrolled growth). Cancer cells do not have this property.

Types of Tumours:

- **Benign tumours:** Confined to the place of its origin. Cause little damage.
- **Malignant tumours:** Tumour cells (neoplastic cells) invade and damage surrounding tissues. Cells from tumours reach other sites via blood and form a new tumour. It is called **metastasis**.

Causes of cancer (Carcinogens):

- **Physical agents:** Radiations like X-rays, gamma rays, UV etc.
- **Chemical agents:** Tobacco smoke, vinyl chloride, nicotine, etc.
- **Biological agents:** Oncogenic viruses, c-onc (cellular oncogenes or proto oncogenes) etc.

Cancer detection and diagnosis:

- **Biopsy:** Histopathological studies of suspected tissue.
- **Imaging techniques:** Radiography, CT scan & MRI.
- Use of **antibodies** against cancer-specific antigens.
- **Molecular biology technique:** To detect cancer related genes.

Treatment of cancer: Radiotherapy, Chemotherapy, Immunotherapy & Surgery.

DRUGS, SMOKING AND ALCOHOL ABUSE

DRUGS

1. **Opioids:** E.g. morphine, heroin, brown sugar.

   Morphine is extracted from latex of ***Papaver somniferum*** **(poppy plant).** It is a sedative & painkiller. Used in surgery.

   Heroin (*smack* or diacetylmorphine) is obtained by acetylation of morphine. It is a depressant.

2. **Cannabinoids:**

   Obtained from ***Cannabis sativa*** **(Hemp plant).**

   Includes *marijuana, hashish, charas & ganja.*

   They affect cardiovascular system.

3. **Coca alkaloid or cocaine (coke or crack):**

   It is obtained from coca plant ***Erythroxylum coca*.**

   It interferes with transport of neurotransmitter dopamine.

   It stimulates CNS producing euphoria & increased energy.

SMOKING

- Tobacco contains **nicotine** etc.
- Smoking causes cancers of lung, urinary bladder and throat, bronchitis, emphysema, coronary heart disease, gastric ulcer etc. Tobacco chewing causes oral cancer.
- Smoking increases CO content in blood and reduces oxyhaemoglobin. This causes O_2 deficiency in the body.

ADOLESCENCE & DRUG/ALCOHOL ABUSE

Causes of drug/alcohol use in Adolescence

- Curiosity and Experimentation.
- Need for adventure and excitement.
- Stress from pressure to excel in academics or examination.
- Television, movies, newspapers, internet etc.
- Peer pressure.

- **Addiction:** Psychological attachment with drugs & alcohol.
- **Dependence:** Body manifests unpleasant ***withdrawal syndrome*** if drugs/alcohol is abruptly discontinued. This results in anxiety, shakiness, nausea and sweating.

Effects of Drug/alcohol abuse

- Reckless behaviour, vandalism and violence.
- Coma and death.
- Damage of nervous system and liver cirrhosis.
- Causes mental and social distress to family and friends.
- Social problems like stealing and spread of diseases.

Warning signs of drug/alcohol abuse in Adolescence period

- Drop in academic performance and absence from school.
- Lack of interest in personal hygiene.
- Withdrawal and isolation.
- Depression, fatigue, aggressive and rebellious behaviour.
- Loss of interest in hobbies.
- Deteriorating relationships with family and friends.

Side effects of anabolic steroid abuse

In males:

- Acne, premature baldness.
- Mood swings & depression, increased aggressiveness.
- Reduced testicles & decreased sperms.
- Enlargement of Breast & prostate gland.

In females:

- Masculinisation, excessive hair growth
- Mood swings & depression, increased aggressiveness
- Abnormal menstrual cycle, deepening of voice
- Enlargement of clitoris

Prevention and control

- Avoid undue peer pressure.
- Education and counselling.
- Seeking help from parents and peers.
- Looking for danger signs.
- Seeking professional and medical help.

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SLIDES OF THIS CHAPTER

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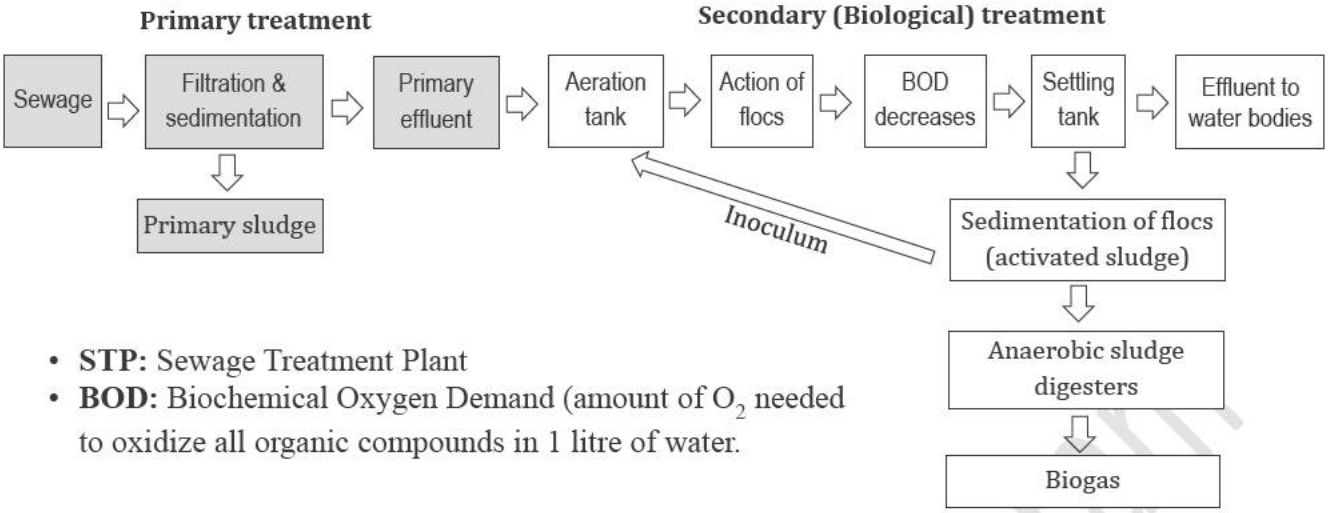
7. MICROBES IN HUMAN WELFARE

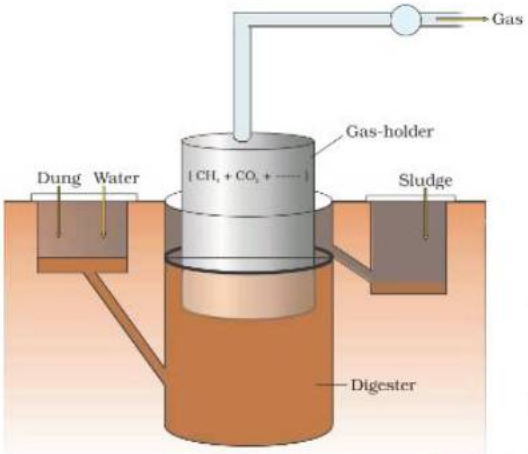
Microbes	Group	Uses
1. *Lactobacillus* (LAB)	Bacterium	Lactic acid, milk to curd
2. *Acetobacter aceti*	Bacterium	Acetic acid
3. *Aspergillus niger*	Fungus	Citric acid
4. *Clostridium butyilicum*	Bacterium	Butyric acid
5. *Propionibacterium shermanii*	Bacterium	In Swiss cheese formation
6. *Saccharomyces cerevisie (Baker's yeast* or *Brewer's yeast)*	Fungus	Production of beverages, bread by fermenting dough, ethanol etc.
7. *Monascus purpureus*	Fungus (a yeast)	Statins (blood cholesterol lowering agents)
8. *Penicillium notatum*	Fungus (mould)	Penicillin (First antibiotic discovered by Alexander Fleming).
9. *Streptococcus*	Bacterium	*Streptokinase* (a clot buster)
10. *Trichoderma polysporum*	Fungus	Cyclosporine A (immunosuppressive agent)
11. *Methanobacterium (methanogens)*	Bacterium	Biogas (CH_4) production i.e., source of energy
12. *Azospirillum*	Bacterium	Nitrogen fixation, biofertilizer
13. *Azotobacter*	Bacterium	Nitrogen fixation, biofertilizer
14. *Rhizobium*	Bacterium	Nitrogen fixation, biofertilizer
15. *Cyanobacteria (blue green algae)*	Bacteria	Nitrogen fixation, biofertilizer
16. *Mycorrhiza*	Fungi (E.g. *Glomus)* + plant	Biofertilizer
17. *Bacillus thuringiensis* (Bt)	Bacterium	Biocontrol of butterfly caterpillar
18. *Baculoviruses* (mainly *nucleopolyhedrovirus)*	Virus	Biocontrol of insects and other arthropods. Used in Integrated Pest Management (IPM).
19. *Trichoderma sp*	Fungus	Biocontrol

- **Lipases:** Used in detergent to remove oily stains from the laundry.
- **Pectinases & Proteases:** To clarify bottled juices.

Steps of Sewage treatment:



- **STP:** Sewage Treatment Plant
- **BOD:** Biochemical Oxygen Demand (amount of O_2 needed to oxidize all organic compounds in 1 litre of water.



Technology of biogas production in India was developed by:

- **IARI:** Indian Agricultural Research Institute
- **KVIC:** Khadi & Village Industries Commission.

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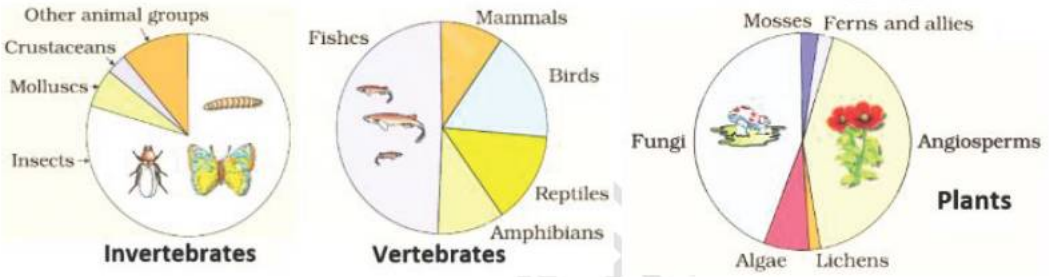
8. BIODIVERSITY & CONSERVATION

Edward Wilson popularized the term biodiversity.

LEVELS OF BIODIVERSITY

1. **Genetic diversity:** Diversity shown by a single species at **genetic level.** E.g. ***Rauwolfia vomitoria*** shows genetic variation in **reserpine.**
2. **Species diversity:** Diversity at **species level.** E.g. Western Ghats have greater amphibian species than Eastern Ghats.
3. **Ecological diversity:** Diversity at **ecosystem level.** E.g. deserts, rain forests, mangroves etc.

TOTAL NUMBER OF SPECIES ON EARTH (GLOBAL SPECIES DIVERSITY)



Biologists are not sure about number of prokaryotic species because

- Conventional taxonomic methods are not suitable to identify microbial species.
- In laboratory, many species cannot be cultured.

PATTERNS OF BIODIVERSITY

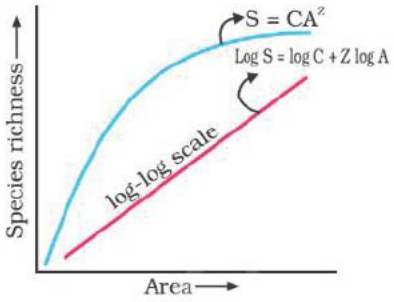
i. Latitudinal gradients

Species diversity decreases from the equator to the poles.
Biodiversity (species richness) is highest in tropics because

- It had more evolutionary time.
- Relatively constant environment.
- It receives more solar energy.

ii. Species- Area relationship

Study of **Alexander von Humboldt**: Within a region, species richness increases with increasing explored area, but only up to a limit.



$$S = CA^z$$

S= Species richness A= Area
C= Y-intercept Z= slope of the line (regression co-efficient)

For small areas, Z value= **0.1 to 0.2.**

For large areas (e.g. entire continents), **Z value= 0.6 to 1.2.**

IMPORTANCE OF SPECIES DIVERSITY

Rivet popper hypothesis: Proposed by **Paul Ehrlich.** In an airplane (ecosystem), if passengers pop a **rivet** (extinction of a **species**), it may not affect flight safety **(functioning of ecosystem).** But as more rivets are removed, plane becomes dangerously weak.

LOSS OF BIODIVERSITY

IUCN Red List (2004): E.g. Dodo, Quagga, Thylacine, Stellar's sea cow etc.

Causes of Biodiversity losses ('The Evil Quartet')

1. **Habitat loss & fragmentation:** Most important cause.
2. **Over-exploitation:** Stellar's sea cow, Passenger pigeon etc. extinct due to over exploitation.
3. **Alien species invasions:** Cause extinction of **indigenous species.** E.g. **Nile Perch** introduced in **Lake Victoria** caused extinction of **cichlid fish, African Catfish** is a threat to indigenous catfishes in our rivers.
4. **Co-extinction:** When a species extinct, the species associated with it also extinct. E.g. **Parasites – host, Plant – pollinator.**

BIODIVERSITY CONSERVATION

There are 3 categories of reasons for conservation.

a. **Narrowly utilitarian arguments:** Human derive economic benefits from nature.

b. **Broadly utilitarian arguments:** Biodiversity has ecosystem services. E.g. production of O_2, Pollination, Aesthetic pleasures.

b. **Ethical arguments:** Every species has an **intrinsic value**. We have to care them.

Types of Biodiversity conservation:

a. ***In situ*** **conservation (on site):** Conservation of organisms within natural or human-made ecosystems. E.g.

- **National Park:** Reserved for the welfare of wildlife where private ownership, cultivation, grazing etc. are prohibited. E.g. **Eravikulam National Park.**
- **Sanctuary:** Protection only to the animals. Collection of timbers, minor forest products and private ownership are allowed. E.g. **Periyar wildlife sanctuary.**
- **Biosphere Reserves:** Areas of land or coastal ecosystems for conservation and sustainable use.
- **Sacred forests (Sacred groves):** Forest fragments which are communally protected based on religious beliefs.

b. ***Ex situ*** **conservation (off site):** Conservation of organisms outside their habitats. E.g. genetic resource centres, zoological parks, wildlife safari parks, botanical gardens, gene banks, cryopreservation etc.

Hotspots: The regions with very high species richness, high **endemism** but most threatened. There are **34 hotspots** in the world. **3 hotspots** cover India's biodiversity regions- Western Ghats & Sri Lanka, Indo-Burma and Himalaya.

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