COMPLETE STUDY MATERIALS

+2 ZOOLOGY

Chapter 1 Reproduction in Organisms

1. Asexual reproduction

i) Reproduction by a single parent without the involvement of gamete formation is **asexual reproduction** and the offspring produced are genetically identical.

ii) Asexual reproduction is usually by amitotic or mitotic division of the somatic (body) cells, hence is also known as somatogenic or blastogenic reproduction.

2. **Sexual reproduction** When two parents participate in the reproductive process involving two types of gametes (ova and sperm), it is called **sexual reproduction.**

3. What are the different mode of asexual reproduction. The different modes of asexual reproduction seen in animals are fission, sporulation, budding, gemmule formation, fragmentation and regeneration.

4. **Fission type?**

i) Fission is the division of the parent body into two or more identical daughter individuals. Four types of fission are seen in animals.

ii) They are **binary fission, multiple fission, sporulation and strobilation.**

5. binary fission type?

i) In **binary fission**, the parent organism divides into two halves and each half forms a daughter individual.

ii) The nucleus divides first amitotically or mitotically (karyokinesis), followed by the division of the cytoplasm (cytokinesis). The resultant offsprings are genetically identical to the parent.

6. Depending on the plane of fission, binary fission is of the following types

i) Simple irregular binary fission
ii) Transverse binary fission
iii) Longitudinal binary fission
iv) Oblique binary fission

7. **Simple binary fission**

i) Simple binary fission is seen in *Amoeba* like irregular shaped organisms.

ii) where the plane of division is hard to observe. The contractile vacuoles cease to function and disappear. The nucleoli disintegrate and the nucleus divides mitotically.

iii) The cell then constricts in the middle, so the cytoplasm divides and forms two daughter cells.

8. **transverse binary fission**

i) In **transverse binary fission**, the plane of the division runs along the transverse axis of the individual. e.g. *Paramecium* and *Planaria*.

ii) In *Paramecium* the macronucleus divides by amitosis and the micronucleus divides by mitosis.

9. **longitudinal binary fission**

i) In **longitudinal binary fission**, the nucleus and the cytoplasm divides in the longitudinal axis of the organism.

ii) In flagellates, the basal granule is divided into two and the new basal granule forms a flagellum in the other daughter individual. e.g. *Vorticella* and *Euglena.*

10. **oblique binary fission**

i) In **oblique binary fission** the plane of division is oblique. It is seen in dinoflagellates. e.g.Ceratium.

11. In **multiple fission?**

i) In **multiple fission** the parent body divides into many similar daughter cells simultaneously.

ii) If multiple fission produces four or many daughter individuals by equal cell division and the young ones do not separate until the process is complete, then this division is called **repeated fission** e.g. *Vorticella*

12.**sporozoites.**

i) In Plasmodium, multiple fission occurs in the schizont and in the oocyte stages.

ii) When multiple fission occurs in the schizont, the process is called schizogony and the daughter individuals are called merozoites When multiple fission occurs in the oocyte, it is called sporogony and the daughter individuals are called sporozoites

13. **pseudopodiospore**

- When conditions become favourable, the encysted *Amoeba* divides by multiple fission and produces many minute amoebae called pseudopodiospore or amoebulae.

14. **strobilation**

- In some metazoan animals, a special type of transverse fission called **strobilation** occurs
- In the process of strobilation, several transverse fissions occur simultaneously giving rise to a number of individuals which often do not separate immediately from each other e.g. *Aurelia*. **Plasmotomy** is the division of multinucleated parent into many multinucleate daughter individuals with the division of nuclei.
- Nuclear division occurs later to maintain normal number of nuclei. Plasmotomy occurs in *Opalina* and *Pelomyxa (*Giant *Amoeba}*

15. **budding**

- In **budding**, the parent body produces one or more buds and each bud grows into a young one.
- ii).The buds separate from the parent to lead a normal life. In sponges, the buds constrict and detach from the parent body and the bud develops into a new sponge.

16. **endogenous budding**

- In ***Noctiluca***, hundreds of buds are formed inside the cytoplasm and many remain within the body of the parent. This is called **endogenous budding.**

17.Morphallaxis

i) In morphallaxis the whole body grows from a small fragment e.g. *Hydra* and *Planaria*.

ii) When *Hydra* is accidentally cut into several pieces, each piece can regenerate the lost parts and develop into a whole new individual

iii) The parts usually retain their original polarity, with oral ends, by developing tentacles and aboral ends, by producing basal discs.

18. **Epimorphosis.**

i) Epimorphosis is the replacement of lost body parts. It is of two types, namely **reparative** and **restorative** regeneration.

ii) In reparative regeneration, only certain damaged tissue can be regenerated, whereas in restorative regeneration severed body parts can develop. e.g. star fish, tail of wall lizard.

19. **syngamy?**

i) The types of sexual reproduction seen in animals are syngamy (fertilization)and conjugation.

ii) In **syngamy,** the fusion of two haploid gametes takes place to produce a diploid zygote.

iii) Depending upon the place where the fertilization takes place, it is of two types. In **external fertilization, Internal fertilization.**

20. external fertilization

In **external fertilization,** the fusion of male and female gametes takes place outside the body of female organisms in the water medium. e.g. sponges, fishes and amphibians.

21. **internal fertilization**

In **internal fertilization,** the fusion of male and female gametes takes place within the body of female organisms. e.g. reptiles, aves and mammals.

22. **autogamy,**fertilization) are prevalent among living organisms. In **autogamy,** the male and female gametes are produced by the same cell or same organism and both the gametes fuse together to form a zygote e.g. *Actinosphaerium* and *Paramecium*.

23. **exogamy**

In **exogamy,** the male and female gametes are produced by different parents and they fuse to form a zygote. So it is biparental. e.g. Human – dioecious or unisexual animal.

24. **hologamy**

In lower organisms, sometimes the entire mature organisms do not form gametes but they themselves behave as gametes and the fusion of such mature individuals is known as **hologamy** e.g. *Trichonympha*

25. **Paedogamy.**

Paedogamy is the sexual union of young individuals produced immediately after the division of the adult parent cell by mitosis.

26. **merogamy**

division of the adult parent cell by mitosis. In **merogamy,** the fusion of small sized and morphologically different gametes (merogametes) takes place.

27. **isogamy**

The fusion of morphological and physiological identical gametes (isogametes) is called **isogamy**. e.g. *Monocystis*,

28. **anisogamy**

whereas the fusion of dissimilar gametes is called **anisogamy** (*Gr*. *An*-without; iso-equal; *gam*-marriage).

29. **Conjugation?**

i) Conjugation is the temporary union of the two individuals of the same species.

ii) During their union both individuals, called the conjugants exchange certain amount of nuclear material (DNA) and then get separated.

iii) Conjugation is common among ciliates, e.g. *Paramecium, Vorticella* and bacteria (Prokaryotes).

30. **Phases of life cycle**

- **Phases of life cycle:** Organisms have three phases – Juvenile phase, reproductive phase and senescent phase.
- **Juvenile phase/ vegetative phase** is the period of growth between the birth of the individual upto reproductive maturity.
- During **reproductive phase/ maturity phase** the organisms reproduce and their offsprings reach maturity period.
- On the basis of time, breeding animals are of two types: **seasonal breeders** and **continuous breeders**.
- Seasonal breeders reproduce at particular period of the year such as frogs, lizards, most birds, deers etc., Continuous breeders continue to breed throughout their sexual maturity e.g. honey bees, poultry, rabbit etc.,
- **Senescent phase** begins at the end of reproductive phase when degeneration sets in the structure and functioning of the body.

31. **PARTHENOGENESIS**

- Development of an egg into a complete individual without fertilization is known as parthenogenesis. It was first discovered by Charles Bonnet in 1745.
- Parthenogenesis is of two main types namely, Natural Parthenogenesis and Artificial Parthenogenesis.

32. N**atural parthenogenesis**

- In certain animals, parthenogenesis occurs regularly, constantly and naturally in their life cycle and is known as **natural parthenogenesis.**
- **artificial parthenogenesis**, the unfertilized egg (ovum) is induced to develop into a complete individual by physical or chemical stimuli. e.g., Annelid and seaurchin eggs
- Natural parthenogenesis may be of two types, viz., complete and incomplete.
- **Complete parthenogenesis** is the only form of reproduction in certain animals and there is no biparental sexual reproduction. These are no male organisms and so, such individuals are represented by females only.
- **Incomplete parthenogenesis** is found in some animals in which both sexual reproduction and parthenogenesis occurs. e.g. In honeybees; fertilized eggs (zygotes) develop into queen and workers, whereas unfertilized eggs develop into drones (male).

33. Oviparous

- *Ovum*-egg-, *Parere*- to produce) animals (egg laying animals), the young hatch from eggs laid outside the mother's body. e.g. reptiles and birds (their eggs are covered by hard calcareous shells), invertebrates, fishes etc.

- 34. **Viviparous** (*L., Vivus* - alive, *Parere* - to produce) animals give rise to young ones.
- Viviparity is a type of development in which the young ones are born alive after being nourished in the uterus through the placenta.
- Majority of mammals including human beings are viviparous.

- 35. In **Ovoviviparous** animals, the embryo develops inside the egg and remains in the mother's body until they are ready to hatch This method of reproduction is similar to viviparity but the embryos have no placental connection with the mother and receive their nourishment from the egg yolk.
- Ovoviviparity is seen in fishes like shark.

CHAPTER :2

HUMAN REPRODUCTION

1. mesovarium

The ovary remains attached to the pelvic wall and the uterus by an ovarian ligamentcalled **mesovarium**

2. fundus

The major portion of the uterus is the body and the rounded region superior to it, is the **fundus**

3. what are the uterus has three layers of tissues.

- The wall of the uterus has three layers of tissues. The outermost thin membranous serous layer called the **perimetrium**.
- the middle thick muscular layer called **myometrium** and the inner glandular layer called **endometrium**.
- The endometrium undergoes cyclic changes during the menstrual cycle while myometrium exhibits strong contractions during parturition.

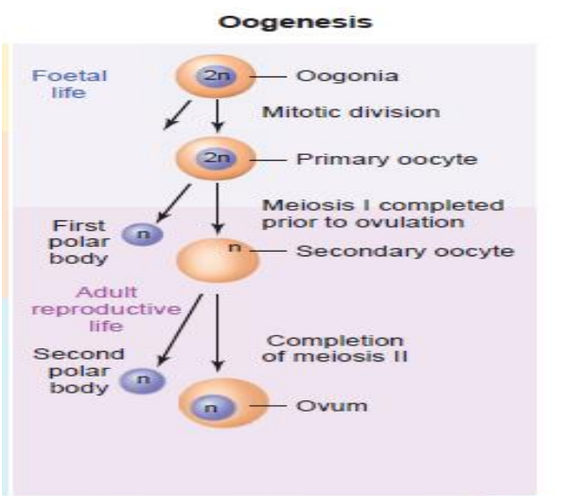
4. Bartholin's glands

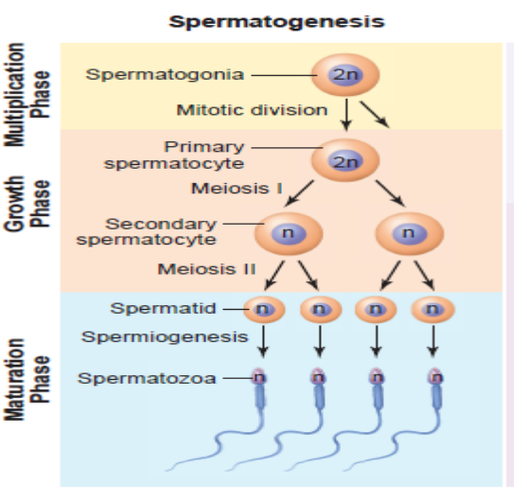
- The **Bartholin's glands** (also called greater vestibular glands) are located posterior to the left and right of the opening of the vagina.

5. Skene's glands

- They secrete mucus to lubricate the vagina and are homologous to the bulbourethral glands of the male.
- The **Skene's glands** are located on the anterior wall of the vagina and around the lower end of the urethra.

6. spermatogenesis





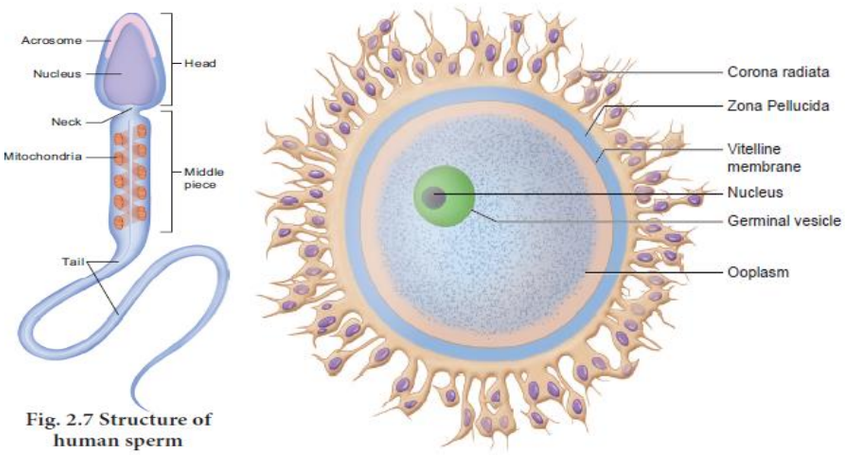


Fig. 2.7 Structure of human sperm

7. The ovum is surrounded by three coverings

- The ovum is surrounded by three coverings namely an inner thin transparent **vitelline membrane**,
- middle thick **zona pellucida** and outer thick coat of follicular cells called **corona radiata**.
- Between the vitelline membrane and zona pellucida is a narrow perivitelline space.

8. Menstural cycle

- The **menstrual or ovarian cycle** occurs approximately once in every 28/29 days during the reproductive life of the female from **menarche** (puberty) to **menopause** except during pregnancy.
- The cycle of events starting from one menstrual period till the next one is called the menstrual cycle during which cyclic changes occurs in the endometrium every month.
    - Cyclic menstruation is an indicator of normal reproductive phase

9. Menstrual cycle comprises of the following phases

1. Menstrual phase
2. Follicular or proliferative phase
3. Ovulatory phase
4. Luteal or secretory phase

10. corpus albicans

- In the absence of fertilisation, the corpus luteum degenerates completely and leaves a scar tissue called **corpus albicans**
- ii) It also initiates the disintegration of the endometrium leading to menstruation, marking the next cycle.

11. POLY CYSTIC OVARY SYNDROME (PCOS

i) COS is a complex endocrine system disorder that affects women in their reproductive years. Polycystic means 'many cysts'. It refers to many partially formed follicles on the ovaries, which contain an egg each. But they do not grow to maturity or produce eggs that can be fertilized.

ii) Women with PCOS may experience irregular menstrual cycles, increased androgen levels, excessive facial or body hair growth (**hirsutism**), acne, obesity, reduced fertility and increased risk of diabetes.

iii) Treatment for PCOS includes a healthy lifestyle, weight loss and targeted hormone therapy.

12. Disposal of Napkins

i) The ecofriendly way to dispose menstrual waste scientifically and hygienically is to destroy the sanitary napkins using incinerators.

ii) Measures are being taken to install incinerators and napkin vending machines in washrooms of schools , colleges and public facilities.

13. Menopause

i) Menopause is the phase in a women's life when ovulation and menstruation stops.

ii) The average age of menopause is 45-50 years.

iii) It indicates the permanent cessation of the primary functions of the ovaries.

14. blastocyst

i) At this point the embryo consists of a fluid filled hollow ball of about 100 cells, called the **blastocyst.**

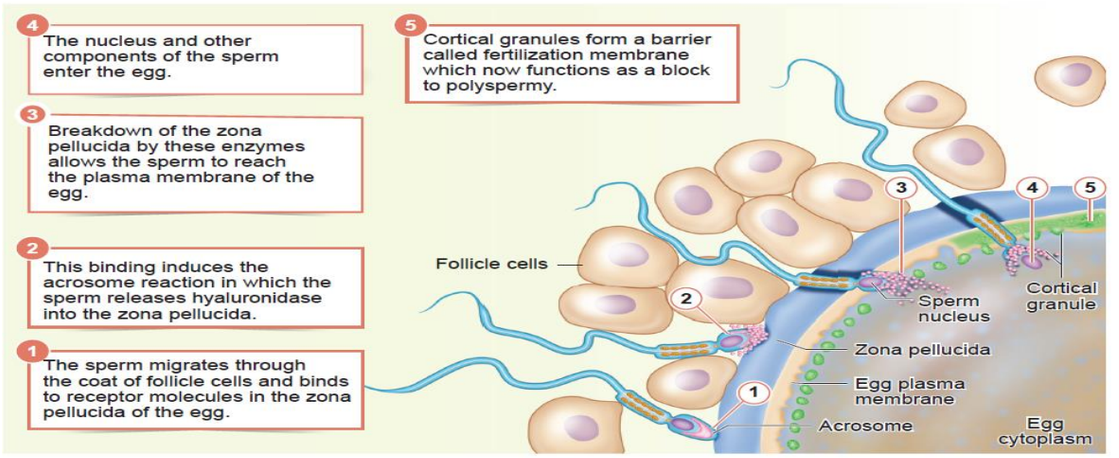


Fig. 2.10 Events of fertilisation

15. Monozygotic

➢ Monozygotic (Identical) twins are produced when a single fertilised egg splits into two during the first cleavage. They are of the same sex, look alike and share the same genes.

16. Dizygotic

i) Dizygotic (Fraternal) twins are produced when two separate eggs are fertilised by two separate sperms. The twins may be of the same sex or different sex and are non-identical.

17. Siamese

i) Siamese (United) twins are the conjoined twins who are joined during birth.

18. gastrulation.

i) the transformation of the blastocyst into a gastrula with the primary germ layers by the movement of the blastomeres is called **gastrulation**.

19. organogenesis.

i) Each germ layer gives rise to specific tissues, organs and organ systems during organogenesis.

20. gestation period

i) Human pregnancy lasts for about 280 days or 40 weeks and is called the **gestation period**

21. Parturition

i) **Parturition** is the completion of pregnancy and giving birth to the baby.

ii) The series of events that expels the infant from the uterus is collectively called "labour".

22. Braxter-Hick's contractions

I) pregnancy the uterus undergoes periodic episodes of weak and strong contractions.
ii) These contractions called **Braxter-Hick's contractions** lead to false labour.

23. neurohumoral reflex called **Foetal ejection reflex** or **Ferguson reflex**

i) The descent of the foetus causes dilation of cervix of the uterus and vaginal canal resulting in a **neurohumoral reflex** called **Foetal ejection reflex** or **Ferguson reflex**

24. parturition or **childbirth**

i) This initiates the secretion of oxytocin from the neurohypophysis which in turn brings about the powerful contraction of the uterine muscles and leads to the expulsion of the baby through the birth canal.
ii) This sequence of events is called as. **parturition** or **childbirth.**

25. the "**Let-Down" reflex**

i) Oxytocin causes the "**Let-Down" reflex**-the actual ejection of milk from the alveoli of the mammary glands.
ii) During lactation, oxytocin also stimulates the recently emptied uterus to contract, helping it to return to pre **-pregnancy size.**

26. Colostrum

i) Colostrum, a nutrient rich fluid produced by the human female immediately after giving birth, is loaded with immune, growth and tissue repair factors.
ii) It acts as a natural antimicrobial agent to actively stimulate the maturation of the infant's immune system.
iii) No artificial feed can substitute the first milk, with all its natural benefits and therefore should be definitely fed to the baby after birth.

CHAPTER 3

Reproductive Health

'1. **Reproductive and Child Health Care** (RCH).

- Major tasks carried out under these programmes are: Creating awareness and providing medical assistance to build a healthy society.
- Introducing sex education in schools to provide information about adolescence and adolescence related changes.
- Educating couples and those in the marriageable age groups about theavailable birth control methods andfamily planning norms.
- Creating awareness about care for pregnant women, post-natal care of mother and child and the importance of breast feeding.
- Encouraging and supporting governmental and non-governmental agencies to identify new methods and/or to improve upon the existing methods of birth control.

2. **Female foeticide**

- **Female foeticide** refers to 'aborting the female in the mother's womb'; whereas female **infanticide** is 'killing the female child after her birth'.
- These have resulted in imbalance in sex ratio. In **UNDP's GII** 2018 (United nations developmental programmes gender inequality index) reflected that India was ranked at 135 out of 187 countries due to availability of very few economic opportunities to women as compared to men..

3. **Natural method**

- **Natural method** is used to prevent meeting of sperm with ovum.
- i.e., Rhythm method (safe period), coitus interruptus, continuous abstinence and lactational amenorrhoea.

4. **Periodic abstinence/rhythm method**

- Ovulation occurs at about the 14th day of the menstrual cycle.
- Ovum survives for about two days and sperm remains alive for about 72 hours in the female reproductive tract.
- Coitus is to be avoided during this time.

5. **Tubectomy**
   - **Tubectomy** is the surgical sterilisation in women. In this procedure, a small portion of both fallopian tubes are cut and tied up through a small incision in the abdomen or through vagina.
     - This prevents fertilization as well as the entry of the egg into the uterus.

6. **Vasectomy**
   - **Vasectomy** is the surgical procedure for male sterilisation. In this procedure, both vas deferens are cut and tied through a small incision on the scrotum to prevent the entry of sperm into the urethra.
   - Vasectomy prevents sperm from heading off to penis as the discharge has no sperms in it.

7. Prevention of STDs

- Avoid sex with unknown partner/ multiple partners
- use condoms
- . In case of doubt, consult a doctor for diagnosis and get complete treatment.

8. The risk factors for cervical cancer

- Having multiple sexual partners
- Prolonged use of contraceptive pills

9. Infertility

Inability to conceive or produce children even after unprotected sexual cohabitation is called infertility.

10. Other causes of infertility

- Pelvic inflammatory disease (PID), uterine fibroids and endometriosis are the most common causes of infertility in women.
- Low body fat or anorexia in women. i.e. a psychiatric eating disorder characterised by the fear of gaining weight.
- Undescended testes and swollen veins (varicocoele) in scrotum .
- Tight clothing in men may raise the temperature in the scrotum and affect sperm production.
- Under developed ovaries or testes.
- Female may develop antibodies against her partner's sperm.
- Males may develop an autoimmune response to their own sperm.

11. **Assisted Reproductive Technology**.
   - A collection of procedures, which includes the handling of gametes and/or embryos outside the body to achieve a pregnancy, is known as **Assisted Reproductive Technology**.

12. Intra-uterine insemination (IUI)

- This is a procedure to treat infertile men with low sperm count.
- The semen is collected either from the husband or from a healthy donor and is introduced into the uterus through the vagina by a catheter after stimulating the ovaries to produce more ova.
- The sperms swim towards the fallopian tubes to fertilize the egg, resulting in normal pregnancy.

13. *In vitro* fertilization (IVF) or Test tube baby

- In this technique, sperm and eggs are allowed to unite outside the body in a
- Laboratory
- One or more fertilized eggs may be transferred into the woman’s uterus, where they may implant in the uterine lining and develop.
- Excess embryos may be cryopreserved (frozen) for future use. Initially, IVF was used to treat women with blocked, damaged, or absent fallopian tubes.
- Today, IVF is used to treat many causes of infertility. The basic steps in an IVF treatment cycle are ovarian stimulation, egg retrieval, fertilization, embryo culture, and embryo transfer.

14. **Cryopreservation**
   - (or freezing) of embryos is often used when there are more embryos than needed for a single IVF transfer.
   - Embryo cryopreservation can provide an additional opportunity for pregnancy, through a **Frozen embryo transfer** (FET), without undergoing another ovarian stimulation and retrieval.

15. Zygote intra-fallopian transfer (ZIFT)

- As in IVF, the zygote upto 8 blastomere stage is transferred to the fallopian tube by laparoscopy. The zygote continues its natural divisions and migrates towards the uterus where it gets implanted.

16. Intra uterine transfer (IUT)

- Embryo with more than 8 blastomeres is inserted into uterus to complete its further development.

17. Gamete intra-fallopian transfer (GIFT)

- Transfer of an ovum collected from a donor into the fallopian tube.
- In this the eggs are collected from the ovaries and placed with the sperms in one of the fallopian tubes. The zygote travels toward the uterus and gets implanted in the inner lining of the uterus.

18. Intra-cytoplasmic sperm injection (ICSI)

- In this method only one sperm is injected into the focal point of the egg to fertilize.
- The sperm is carefully injected into the cytoplasm of the egg.
- Fertilization occurs in 75 - 85% of eggs injected with the sperms.
- The zygote is allowed to divide to form an 8 celled blastomere and then transferred to the uterus to develop a protective pregnancy.

19. Surrogacy

- Surrogacy is a method of assisted reproduction or agreement whereby a woman agrees to carry a pregnancy for another person, who will become the newborn child's parent after birth.
- Through *in vitro* fertilization (IVF), embryos are created in a lab and are transferred into the surrogate other's uterus.

20. Male infertility prevention

- Azoospermia is defined as the absence of spermatozoa in the ejaculate semen on at least two occasions and is observed approximately in 1% of the population.
  - **Micro-testicular sperm extraction (TESE)** Microsurgical sperm retrieval from the testicle involves a small midline incision in the scrotum, through which one or both testicles can be seen.
  - Under the microscope, the seminiferous tubules are dilated and small amount of testicular tissue in areas of active sperm production are removed and improved for sperm yield compared to traditional biopsy techniques.

21. Amniocentesis

- Amniocentesis involves taking a small sample of the amniotic fluid that surrounds the foetus to diagnose for chromosomal abnormalities .
- Amniocentesis is generally performed in a pregnant woman between the 15_{th} and 20_{th} weeks of pregnancy by inserting a long, thin needle through the abdomen into the amniotic sac to withdraw a small sample of amniotic fluid.
- The amniotic fluid contains cells shed from the foetus.

22. Chorionic villus sampling (CVS)

- CVS is a prenatal test that involves taking a sample of the placental tissue to test for chromosomal abnormalities.

23. Foetoscope

- Foetoscope is used to monitor the foetal heart rate and other functions during late pregnancy and labour.
- The average foetal heart rate is between 120 and 160 beats per minute.
- An abnormal foetal heart rate or pattern may mean that the foetus is not getting enough oxygen and it indicates other problems.
- A hand-held doppler device is often used during prenatal visits to count the foetal heart rate. During labour, continuous electronic foetal monitoring is often used

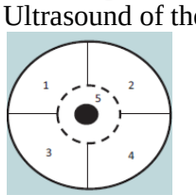
24. VERY IMPORTENS DATES…

- Vitamin E is known as anti-sterility vitamin as it helps in the normal functioning of reproductive structures.
- Sex hormones were discovered by Adolf Butenandt.

- 11th July is observed as World Population Day.
- 1st December is observed as World AIDS Day.
- NACO (National AIDS Control Organisation) was established in 1992.
- Syphilis and gonorrhoea are commonly called as international diseases.

25. BREAST SELF EXAMINATION AND EARLY DIAGNOSIS OF CANCER

- Breast is divided into 4 quadrants and the center (Nipple) which is the 5th quadrant.
- Each quadrant of the breast is felt for lumps using the palm of the opposite hand.
- The examination is done in both lying down and standing positions, monthly once after the 1st week of menstrual cycle.

- This way if there are lumps or any deviation of the nipple to one side or any blood discharge from the nipple we can identify cancer at an early stage.
- Mammograms are done for women above the age of 40 years and for young girls and women below 40 years. Ultrasound of the breast aids in early diagnosis.
- 

CHAPTER 4 Principles of Inheritance and Variation

1. heredity and variations

- ✓ genetics is a branch of biology that deals with the study of heredity and variations.
- ✓ It describes how characteristics and features pass on from the parents to their offsprings in each successive generation.
- ✓ The unit of heredity is known as the gene. Gene is the inherited factor that determines the biological character of an organism.
- ✓ A variation is the degree by which the progeny differs from their parents.

2. **multiple allelism**.

- ✓ When three or more alleles of a gene that control a particular trait occupy the same locus on the homologous chromosome of an organism, they are called multiple alleles and their inheritance is called **multiple allelism**.

3. ABO blood group

- ✓ Karl Landsteiner discovered two kinds of antigens called antigen ‘A’ and antigen ‘B’ on the surface of RBC’s of human blood.

4. ased on the presence or absence of these antigens three kinds of blood groups, type ‘A’, type ‘B’, and type ‘O’ (universal donor)were recognized. The fourth and the rarest blood group ‘AB’ (universal recipient) was discovered in 1902 by two of Landsteiner’s students on De Castelle and

Sturli.**Genetic basis of the human ABO blood groups**

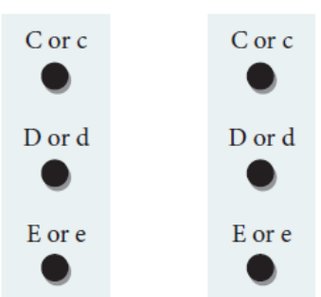
Table 4.1 Genetic basis of the human ABO blood groups

Genotype	ABO blood group phenotype	Antigens present on red blood cell	Antibodies present in blood plasma
I^AI^A	Type A	A	Anti -B
I^Ai^o	Type A	A	Anti -B
I^BI^B	Type B	B	Anti -A
I^Bi^o	Type B	B	Anti -A
I^AI^B	Type AB	A and B	Neither Anti -A nor Anti-B
i^oi^o	Type O	Neither A nor B	Anti -A and anti - B

5. **Rhesus or Rh – Factor**
   - ✓ The Rh factor or Rh antigen is found on the surface of erythrocytes.
   - ✓ It was discovered in 1940 by Karl Landsteiner and Alexander Wiener in the blood of rhesus monkey, *Macaca rhesus* and later in human beings.
   - ✓ The term 'Rh factor' refers to "immunogenic D antigen of the Rh blood group system. An individual having D antigen are Rh D positive (Rh+) and those without D antigen are Rh D negative (Rh-)".

6. **Fisher and Race hypothesis:**

   Rh factor involves three different pairs of alleles located on three different closely linked loci on the chromosome pair. This system is more commonly in use today, and uses the 'Cde' nomenclature.



7. **Fischer and Race hypothesis – Rh Blood Type - Homologous Chromosome pair (showing 3 loci and 2 alleles per locus)**
   - ✓ In the above Fig. 4.1, three pairs of Rh alleles (Cc, Dd and Ee) occur at 3 different loci on homologous chromosome pair-1.
   - ✓ The possible genotypes will be one C or c, one D or d, one E or e from each chromosome. For e.g. CDE/cde; CdE/cDe; cde/cde; CDe/CdE etc.,

- ✓ All genotypes carrying a dominant 'D' allele will produce Rh+positive phenotype and double recessive genotype 'dd' will give rise to Rh-negative phenotype.

8. **Wiener Hypothesis**
   - ✓ Wiener proposed the existence of eight alleles (R1, R2, R0, Rz, r, r1, r11, ry) at a single Rh locus.
   - ✓ All genotypes carrying a dominant 'R allele' (R1, R2 ,R0 ,Rz) will produce Rh+positive phenotype and double recessive genotypes (rr, rr1, rr11, rry) will give rise to Rh-negative phenotype.
9. **Erythoblastosis foetalis**
   - ✓ Usually no effects are associated with exposure of the mother to Rh positive antigen during the first child birth, subsequent Rh positive children carried by the same mother,
   - ✓ may be exposed to antibodies produced by the mother against Rh antigen, which are carried across the placenta into the foetal blood circulation.
   - ✓ This causes haemolysis of foetal RBCs resulting in haemolytic jaundice and anaemia. This condition is known as **Erythoblastosis foetalis or Haemolytic disease of the new born (HDN).**

10.autosomes.

- ✓ Sex chromosomes determine the sex of the individual in dioecious or unisexual organisms.
- ✓ The chromosomes other than the sex chromosomes of an
- ✓ individual are called autosomes.

11.**Y CHROMOSOME**
   - ✓ The human Y chromosome is only 60 Mb in size with 60 functional genes whereas X chromosomes are 165 Mb in size with about 1,000 genes.

12.**Prevention of Eryhroblastosis foetalis**
   - ✓ If the mother is Rh negative and foetus is Rh positive, anti D antibodies should be administered to the mother at 28th and 34th week of gestation as a prophylactic measure.
   - ✓ If the Rh negative mother delivers Rh positive child then anti D antibodies should be administered to the mother soon after delivery.
   - ✓ This develops passive immunity and prevents the formation of anti D antibodies in the mothers blood by destroying the Rh foetal RBC before the mother's immune system is sensitized.
   - ✓ This has to be done whenever the woman attains pregnancy.

13.**Heterogametic Sex Determination:**
   - ✓ In heterogametic sex determination one of the sexes produces similar gametes and the other sex produces dissimilar gametes.

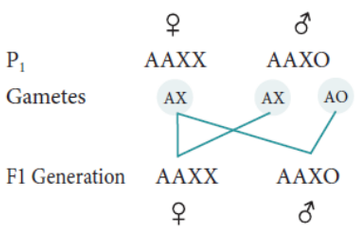
- ✓ The sex of the offspring is determined at the time of fertilization

14.**Heterogametic Males**

- ✓ In this method of sex determination the males are heterogametic producing dissimilar gametes while females are homogametic producing similar gametes.
- ✓ It is of two kinds XX-XO type and XX-XY type.

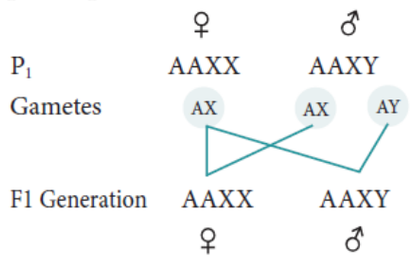
15.XX-XO Type
type of sex determination

- ✓ This method of sex determination is seen in bugs, some insects such as cockroaches and grasshoppers.
- ✓ The female with two X chromosomes are homogametic (XX) while the males with only one X chromosomeare heterogametic (XO).
- ✓ The presence of an unpaired X chromosomes determines the male sex.
- ✓ The males with unpaired 'X' chromosome produce two types of sperms, one half with X chromosome and other half without X chromosome.
- ✓ The sex of the offspring depends upon the sperm that fertilizes the egg



16.**XX-XY type (Lygaeus Type) type of sex determination**

- ✓ This method of sex determination is seen in human beings and in *Drosophila*.
- ✓ The females are homogametic with XX chromosome, while the males are heterogametic with X and Y chromosome.
- ✓ Homogametic females produce only one kind of egg, each with one X chromosome, while the heterogametic males produce two kinds of sperms some with X chromosome and some with Y chromosome.
- ✓ The sex of the embryo depends on the fertilizing sperm. An egg fertilized by an 'X' bearing sperm produces a female, if fertilized by a 'Y' bearing sperm, a male is produced



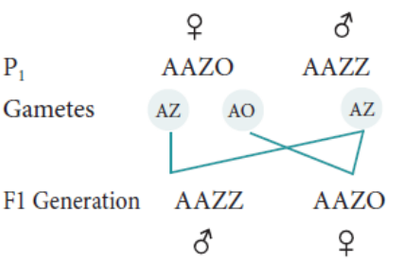
17.**Heterogametic Females**

- ✓ In this method of sex determination, the homogametic male possesses two 'X' chromosomes as in certain insects and certain vertebrates like fishes, reptiles and birds producing a single type of gamete; while females produce dissimilar gametes.
- ✓ The female sex consists of a single 'X' chromosome or one 'X' and one 'Y' chromosome. Thus the females are heterogametic and produce two types of eggs.
- ✓ To avoid confusion with the XX-XO and XX-XY types of sex determination, the alphabets 'Z' and 'W' are used here instead of X and Y respectively.
- ✓ Heterogametic females are of two types, ZO-ZZ type and ZW-ZZ type.

18. **ZO-ZZ Type**

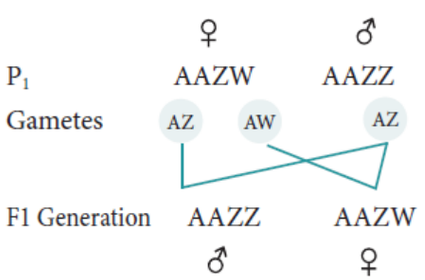
type of sex determination

- ✓ This method of sex determination is seen in certain moths, butterflies and domestic chickens.
- ✓ In this type, the female possesses single 'Z' chromosome in its body cells and is heterogametic (ZO) producing two kinds of eggs some with 'Z' chromosome and some without 'Z' chromosome, while the male possesses two 'Z' chromosomes and is homogametic (ZZ).



19.**ZW-ZZ type**

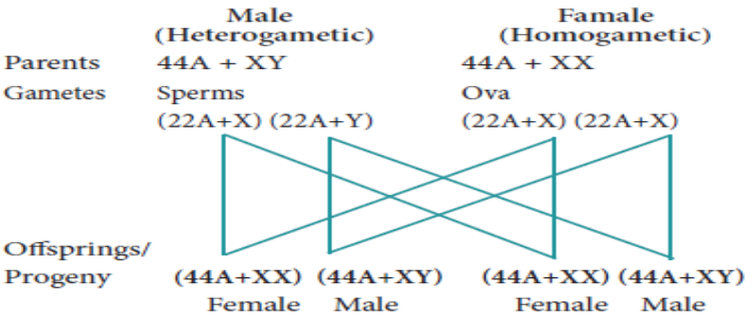
- ✓ This method of sex determination occurs in certain insects (gypsy moth) and in vertebrates such as fishes, reptiles and birds.
- ✓ In this method the female has one 'Z' and one 'W' chromosome (ZW) producing two types of eggs, some carrying the Z chromosomes and some carry the W chromosome.
- ✓ The male sex has two 'Z' chromosomes and is homogametic (ZZ) producing a single type of sperm



20.**Sex determintion in human beings**

- ✓ Genes determining sex in human beings are located on two sex chromosomes, called allosomes.
- ✓ In mammals, sex determination is associated with chromosomal differences between the two sexes, typically XX females and XY males. 23 pairs of human chromosomes include 22 pairs of autosomes (44A) and one pair of sex chromosomes (XX or XY).

- ✓ Females are homogametic producing only one type of gametes (egg), each containing one X chromosome while the males are heterogametic producing two types of sperms with X and Y chromosomes.
- ✓ An independently evolved XX: XY system of sex chromosomes also exist in *Drosophila*



21.**Barr body**.

- ✓ In 1949, Barr and Bertram first observed a condensed body in the nerve cells of female cat which was absent in the male.
- ✓ This condensed body was called sex chromatin by them and was later referred as **Barr body**.

22.**Kin Selection**

- ✓ All other females which are diploid having developed from fertilized eggs help to raise the queen's eggs and so contribute to the queen's reproductive success and indirectly to their own, a phenomenon known as **Kin Selection**.
- ✓ The queen constructs their social environment by releasing a hormone that suppresses fertility of the workers.

23.haplodiploidy mechanism

- ✓ In hymenopteran insects such as honeybees, ants and wasps a mechanism of sex determination called haplodiploidy mechanism of sex determination is common

24.haplodiplody

- ✓ Fertilized eggs develop into females (Queen or Worker) and unfertilized eggs develop into males (drones) by parthenogenesis.
- ✓ It means that the males have half the number of chromosomes (haploid) and the females have double the number (diploid), hence the name haplodiplody for this system of sex determination.

25. **Colour blindness**

- ❖ In human beings a dominant X – linked gene is necessary for the formation of colour sensitive cells, the cones.
- ❖ The recessive form of this gene is incapable of producing colour sensitive cone cells. Homozygous recessive females (XcXc) and hemizygous recessive males (XcY) are unable to distinguish red and green colour.
- ❖ The inheritance of colour blindness can be studied in the following two types of marriages.

26. **Karyotyping**

- ❖ Karyotyping is a technique through which a complete set of chromosomes is separated from a cell and the chromosomes are arranged in pairs.
- ❖ An idiogram refers to a diagrammatic representation of chromosomes.

27.**karyotype**

- ❖ The individual chromosomes are cut from the photograph and are arranged in an orderly fashion in homologous pairs.
- ❖ This arrangement is called a **karyotype**.

28.**Applications of Karyotyping:**

- ❖ It helps in gender identification.
- ❖ It is used to detect the chromosomal aberrations like deletion, duplication, translocation, nondisjunction of chromosomes.
- ❖ It helps to identify the abnormalities of chromosomes like aneuploidy.
- ❖ It is also used in predicting the evolutionary relationships between species.
- ❖ Genetic diseases in human beings can be detected by this technique.

29.**Human Karyotype**

Depending upon the position of the centromere and relative length of two arms, human chromosomes are of three types:

Metacentric, sub metacentric and acrocentric. The photograph of chromosomes are arranged in the order of descending length in groups from A to G

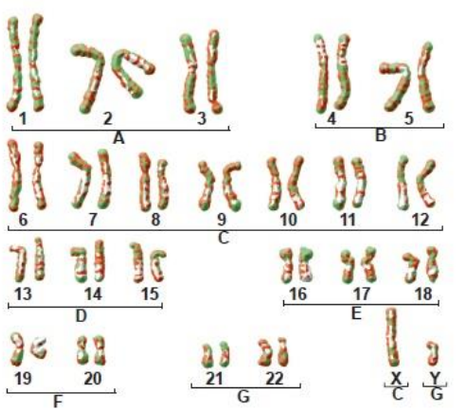


Fig. 4.9 - Human karyotype (male)

30.**Pedigree Analysis**

- ❖ Pedigree is a “family tree”, drawn with standard genetic symbols, showing the inheritance pathway for specific phenotypic characters
- ❖ Pedigree analysis is the study of traits as they have appeared in a given family line for several past generations

31.**Thalassemia**

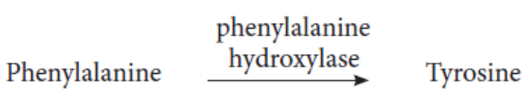
- ❖ Thalassemia is an autosomal recessive disorder. It is caused by gene mutation resulting in excessive destruction of RBC’s due to the formation of abnormal haemoglobin molecules.

- ❖ Normally haemoglobin is composed of four polypeptide chains, two **alpha** and two **beta** globin chains.
- ❖ Thalassemia patients have defects in either the alpha or beta globin chain causing the production of abnormal haemoglobin molecules resulting in anaemia.

- Thalassemia is classified into alpha and beta based on which chain of haemoglobin molecule is affected.
- It is controlled by two closely linked genes HBA1 and HBA2 on chromosome 16. Mutation or deletion of one or more of the four alpha gene alleles causes **Alpha Thalassemia**. In **Beta Thalassemia,** production of beta globin chain is affected.
  - ❖ It is controlled by a single gene (HBB) on chromosome 11. It is the most common type of Thalassemia and is also known as Cooley's anaemia.
  - ❖ In this disorder the alpha chain production is increased and damages the membranes of RBC.

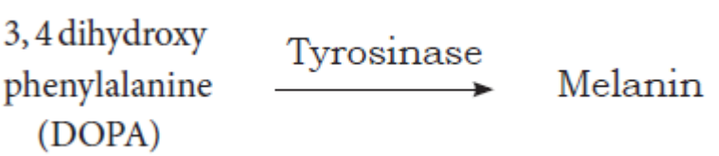
32.**Phenylketonuria**

- ❖ It is an inborn error of **Phenylalanine** metabolism caused due to a pair of autosomal recessive genes. It is caused due to mutation in the gene PAH (phenylalanine hydroxylase gene) located on chromosome 12 for the hepatic enzyme "phenylalanine hydroxylase" This enzyme is essential for the conversion of phenylalanine to tyrosine.
- ❖ Affected individual lacks this enzyme, so phenylalanine accumulates and gets converted to phenylpyruvic acid and other derivatives.
- ❖ It is characterized by severe mental retardation, light pigmentation of skin and hair. Phenylpyruvic acid is excreted in the urine.



33.**Albinism**

- ❖ Albinism is an inborn error of metabolism, caused due to an autosomal recessive gene. Melanin pigment is responsible for skin colour.
- ❖ Absence of melanin results in a condition called albinism. A person with the recessive allele lacks the tyrosinase enzyme system, which is required for the conversion of dihydroxyphenyl alanine (DOPA) into melanin pigment inside the melanocytes.
- ❖ In an albino, melanocytes are present in normal numbers in their skin, hair, iris, etc., but lack melanin pigment.



34.**Huntington's chorea**

- ❖ It is inherited as an autosomal dominant lethal gene in man.
- ❖ It is characterized by involuntary jerking of the body and progressive degeneration of the nervous system,

- ❖ accompanied by gradual mental and physical deterioration. The patients with this disease usually die between the age of 35 and 40.

35. **Chromosomal Abnormalities**

- ❖ Each human diploid (2n) body cell has 46 chromosomes (23 pairs). Chromosomal disorders are caused by errors in the number or structure of chromosomes.
- ❖ Chromosomal anomalies usually occur when there is an error in cell division. Failure of chromatids to segregate during cell division resulting in the gain or loss of one or more chromosomes is called aneuploidy.
- ❖ It is caused by non-disjunction of chromosomes. Group of signs and symptoms that occur together and characterize a particular abnormality is called a syndrome. In humans, Down's syndrome, Turner's syndrome, Klinefelter's syndrome, Patau's syndrome are some of the examples of chromosomal disorders.

36. Down's Syndrome/Trisomy – 21

- ❖ Trisomic condition of chromosome - 21 results in Down's syndrome.
- ❖ It is characterized by severe mental retardation, defective development of the central nervous system, increased separation between the eyes, flattened nose, ears are malformed, mouth is constantly open and the tongue protrudes.

37. Patau's Syndrome/Trisomy-13

- ❖ Trisomic condition of chromosome 13 results in Patau's syndrome. Meiotic non disjunction is thought to be the cause for this chromosomal abnormality.
- ❖ It is characterized by multiple and severe body malformations as well as profound mental deficiency.

Small head with small eyes, cleft palate, malformation of the brain and internal organs are some of the symptoms of this syndrome.

38. Allosomal abnormalities in human beings

- ❖ Mitotic or meiotic non-disjunction of sex chromosomes causes allosomal abnormalities.
- ❖ Several sex chromosomal abnormalities have been detected.
- ❖ Eg. Klinefelter's syndrome and Turner's syndrome.

39. Klinefelter's Syndrome (XXY Males)

- ❖ This genetic disorder is due to the presence of an additional copy of the X chromosome resulting in a karyotype of 47,XXY.
- ❖ Persons with this syndrome have 47 chromosomes (44AA+XXY).
- ❖ They are usually sterile males, tall, obese, with long limbs, high pitched voice, under developed genitalia and have feeble breast (gynaecomastia) development

40. Turner's Syndrome (XO Females)

- ❖ This genetic disorder is due to the loss of a X chromosome resulting in a karyotype of 45,X.
- ❖ Persons with this syndrome have 45 chromosomes (44 autosomes and one X chromosome) (44AA+XO) and are sterile females.
- ❖ Low stature, webbed neck, under developed breast, rudimentary gonads lack of menstrual cycle during puberty, are the main symptoms of this syndrome.

UNIT II 5. MOLECULAR GENETICS

1. **One gene-one enzyme hypothesis**

✓ The experiments of **George Beadle and Edward Tatum** in the early 1940's on *Neurospora crassa* (the red bread mould) led them to propose one gene-one enzyme hypothesis, which states that one gene controls the production of one enzyme.

2. **One gene-one polypeptide hypothesis**
   - ✓ It was observed that an enzyme may be composed of more than one polypeptide chain and a gene can code for only one polypeptide chain.
   - ✓ Thus one gene-one polypeptide hypothesis states that one gene controls the production of only one polypeptide chain of an enzyme molecule.

3. **Gene as the functional unit of inheritance**

following properties:

✓ Number of genes in each organism is more than the number of chromosomes; hence several genes are located on the same chromosome.

✓ The genes are arranged in a single linear order like beads on a string.

✓ Each gene occupies a specific position called locus.

✓ Genes may exist in several alternate forms called alleles.

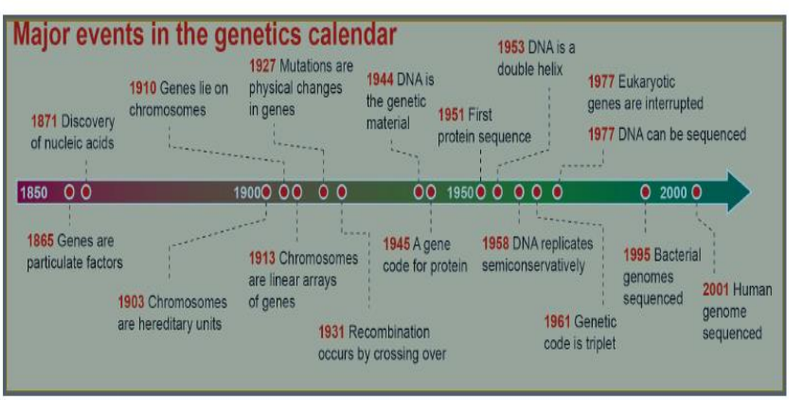
✓ Genes may undergo sudden change in positions and composition called mutations.

✓ Genes are capable of self-duplication producing their own copies.

4. **chromosomes**
   - ✓ As early as 1848, Wilhelm Hofmeister, a German botanist, had observed that cell nuclei organize themselves into small, rod like bodies during mitosis called **chromosomes**

5. **nuclein**

In 1869, Friedrich Miescher, a Swiss physician, isolated a substance from the cell nuclei and called it as **nuclein**



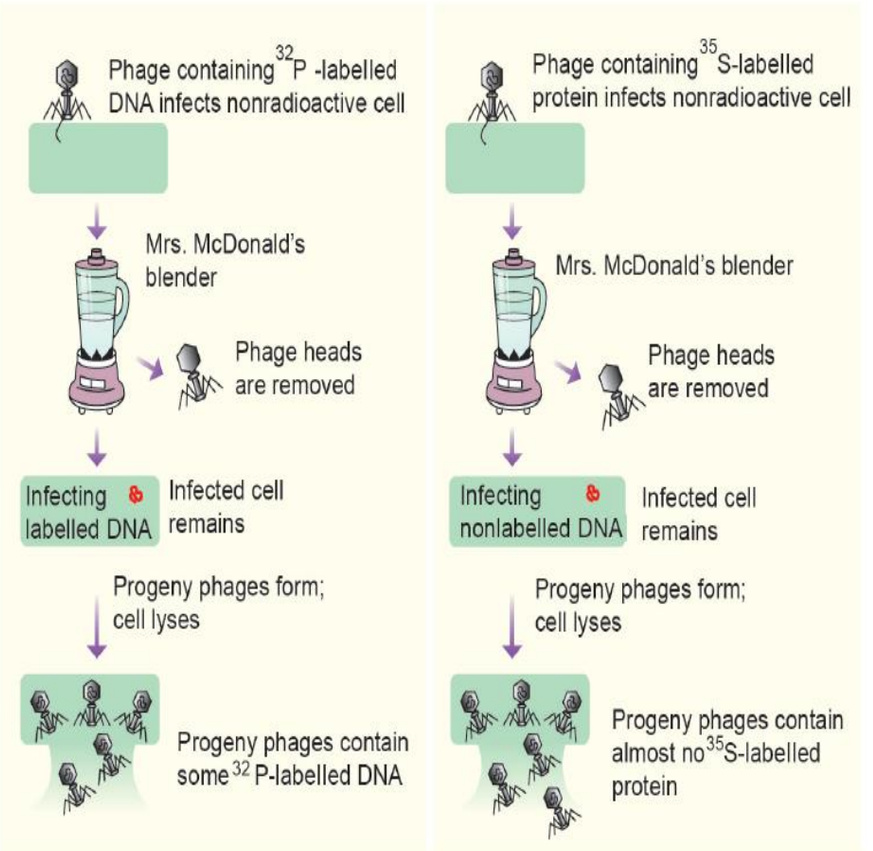


Fig. 5.2 The Hershey-Chase (blender) experiment

Nitrogenous bases

- ✓ The bases are nitrogen containing molecules having the chemical properties of a base (a substance that accepts H+ ion or proton in solution).
- ✓ DNA and RNA both have four bases (two purines and two pyrimidines) in their nucleotide chain. Two of the bases, Adenine (A) and Guanine (G) have double carbon–nitrogen ring structures and are called purines.
- ✓ The bases, Thymine (T), Cytosine (C) and Uracil (U) have single ring structure and these are called pyrimidines.
- ✓ Thymine is unique for DNA, while Uracil is unique for RNA.

ribozyme. There are several biochemical reactions in living systems that are catalysed by RNA. This catalytic RNA is known as **ribozyme.**

Properties of genetic material (DNA versus RNA)

- ❖ **Self Replication:** It should be able to replicate. According to the rule of base pairing and complementarity, both nuclecacids (DNA and RNA) have the ability to direct duplications. Proteins fail to fulfill this criteria

Stability:

- ❖ It should be stable structurally and chemically.
- ❖ The genetic material should be stable enough not to change with different stages of life cycle, age or with change in physiology of the organism.
- ❖ Stability as one of property of genetic material was clearly evident in Griffith's transforming principle.

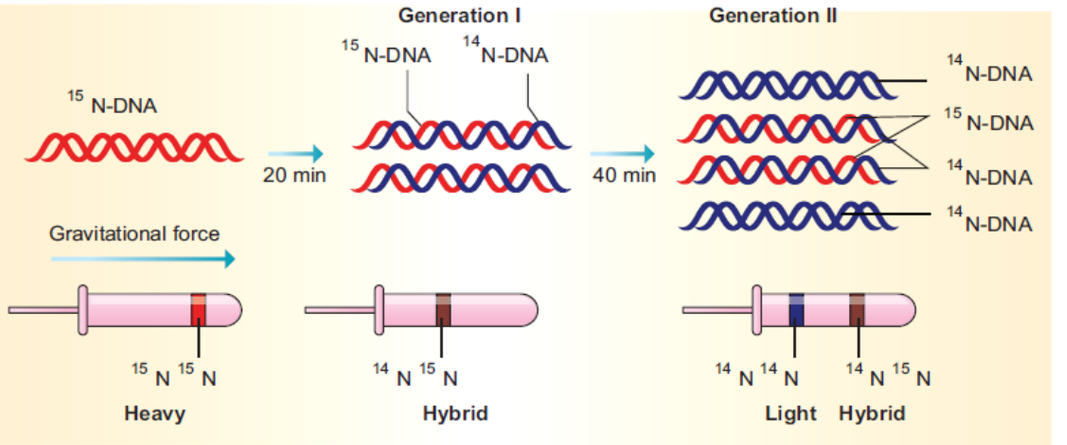
- Heat which killed the bacteria did not destroy some of the properties of genetic material. In DNA the two strands being complementary, if separated (denatured) by heating can come together (renaturation) when appropriate condition is provided.
- **Information storage:** It should be able to express itself in the form of '**Mendelian characters**'. RNA can directly code for protein synthesis and can easily express the characters.

- DNA, however depends on RNA for synthesis of proteins.
- Both DNA and RNA can act as a genetic material, but DNA being more stable stores the genetic information and RNA transfers the genetic information.
- **Variation through mutation:** It should be able to mutate. Both DNA and RNA are able to mutate. RNA being unstable, mutates at a faster rate.
  - Thus viruses having RNA genome with shorter life span can mutate and evolve faster.**DNA Replication**
- Replication of DNA takes place during the S phase of cell cycle.
- During replication, each DNA molecule gives rise to two DNA strands, identical to each other as well as to the parent strand. Three hypotheses of DNA replication have been proposed
- . They are conservative replication, dispersive replication, and semi-conservative replication.
- In conservative replication, the original double helix serves as a template.
- The original molecule is preserved intact and an entirely new double stranded molecule is synthesized
- . In dispersive replication, the original molecule is broken into fragments and each fragment serves as a template for the synthesis of complementary fragments. Finally two new molecules are formed which consist of both old and new fragments.
- Semi-conservative replication was proposed by Watson and Crick in 1953. This mechanism of replication is based on the DNA model.
- They suggested that the two polynucleotide strands of DNA molecule unwind and start separating at one end.
- During this process, covalent hydrogen bonds are broken.
- The separated single strand then acts as template for the synthesis of a new strand. Subsequently, each daughter double helix carries one polynucleotide strand from the parent molecule that acts as a template and the other strand is newly synthesised and complementary to the parent strand.

Experimental proof of DNA replication

- The mode of DNA replication was determined in 1958 by Meselson and Stahl. They designed an experiment to distinguish between semi conservative, conservative and dispersive replications.
- In their experiment, they grew two cultures of *E.coli* for many generations in separate media.
- The 'heavy' culture was grown in a medium in which the nitrogen source (NH4Cl) contained the heavy isotope 15N and the 'light' culture was grown in a medium in which the nitrogen source contained light isotope 14N for many generations.
- At the end of growth, they observed that the bacterial DNA in the heavy culture contained only 15N and in the light culture only 14N.
- The heavy DNA could be distinguished from light DNA (15N from 14N) with a technique called **Cesium Chloride (CsCl) density gradient centrifugation**.
- In this process, heavy and light DNA extracted from cells in the two cultures settled into two distinct and separate bands (hybrid DNA)
- The heavy culture (15N) was then transferred into a medium that had only NH4Cl, and took samples at various definite time intervals (20 minutes duration).
- After the first replication, they extracted DNA and subjected it to density gradient centrifugation.

- The DNA settled into a band that was intermediate in position between the previously determined heavy and light bands.
- After the second replication (40 minutes duration), they again extracted DNA samples, and this time found the DNA settling into two bands, one at the light band position and one at intermediate position
- . These results confirm Watson and Crick's semi conservative replication hypothesis.



DNA polymerase.

- As they move away in both directions, newly synthesized complementary nucleotides are paired with the existing nucleotides on the parent strand and covalently bonded together by **DNA polymerase**.
- Formation of new strand requires a primer (a short stretch of RNA)for initiation.

replication fork.

- At the point of origin of repliction, the helicases and topoisomerases (DNA gyrase) unwind and pull apart the strands, forming a Y-Shaped structure called the **replication fork**.
- **Transcription**
  - Francis Crick proposed the **Central dogma** in molecular biology which states that genetic information flows as follows:
  - The process of copying genetic information from one strand of DNA into RNA is termed **transcription**. This process takes place in presence of DNA dependent RNA polymerase.
  - In some retroviruses that contain RNA as the genetic material (e.g, HIV), the flow of

Application of DNA finger printing

Forensic analysis - It can be used in the identification of a person involved in criminal activities, for settling paternity or maternity disputes, and in determining relationships for immigration purposes.

Pedigree analysis – inheritance pattern of genes through generations and for detecting inherited diseases.

Conservation of wild life – protection of endangered species. By maintaining DNA records for identification of tissues of the dead endangered organisms.

Anthropological studies–It is useful in determining the origin and migration of human populations and genetic diversities.

UNIT – II 6. Evolution

- **Origin of life – Evolution oflife forms**
- **Theory of special creation** states that life was created by a supernatural power, respectfully referred to as "God".
- According to Hinduism, Lord Brahma created the Earth. Christianity, Islam and most religions believe that God created the universe, the plants and the animals.
- According to **the theory of spontaneous generation** or Abiogenesis, living organisms originated from non-living materials and occurred through stepwise chemical and molecular evolution over millions of years.
- Thomas Huxley coined the term abiogenesis.
- **Big bang theory** explains the origin of universe as a singular huge explosion in physical terms.
- The primitive earth had no proper atmosphere, but consisted of ammonia, methane, hydrogen and water vapour.
- The climate of the earth was extremely high. UV rays from the sun split up water molecules into hydrogen and oxygen.
- Gradually the temperature cooled and the water vapour condensed to form rain. Rain water filled all the depressions to form water bodies.
- Ammonia and methane in the atmosphere combined with oxygen to form carbon-dioxide and other gases.
- According to the **theory of biogenesis,** life arose from pre-existing life. The term biogenesis also refers to the biochemical process of production of living organisms. This term was coined by Henry Bastian.
- According to the **theory of chemical evolution,** primitive organisms in the primordial environment of the earth evolved spontaneously from inorganic substances and physical forces such as lightning, UV radiations, volcanic activities, etc., Oparin (1924) suggested

- that the organic compounds could have undergone a series of reactions leading to more complex molecules.
- He proposed that the molecules formed colloidal aggregates or 'coacervates' in an aqueous environment. The coacervates were able to absorb and assimilate organic compounds from the environment.
- Haldane (1929) proposed that the primordial sea served as a vast chemical laboratory powered by solar energy.
- The atmosphere was oxygen free and the combination of CO_2, NH_3 and UV radiations gave rise to organic compounds.
- The sea became a 'hot' dilute soup containing large populations of organic monomers and polymers.
- They envisaged that groups of monomers and polymers acquired lipid membranes and further developed into the first living cell.
- Haldane coined the term prebiotic soup and this became the powerful symbol of the Oparin-Haldane view on the origin of life (1924-1929).
- Oparin and Haldane independently suggested that if the primitive atmosphere was reducing and if there was appropriate supply of energy such as lightning or UV light then a wide range of organic compounds can be synthesized.

Table 6.1 Geological Time Scale

ERA	YEARS IN MILLION	PERIOD	EPOCH	FAUNA	FLORA
Cenozoic	1	Quaternary	Recent (Holocene)	Age of Mammals	Angiosperms Monocotyledons
	6		Pleistocene	Age of Human beings	Age of Angiosperms - Dicotyledons
	15	Tertiary	Pliocene	Human evolution	
	10		Miocene	Mammals and birds	
	20		Oligocene		
	100		Eocene		
			Paleocene		
Mesozoic	125	Cretaceous		(Golden age of Reptiles) Rise of Dinosaurs	Sphenopsides, Ginkgos, Gnetales, (Dicotyledons)
	150	Jurassic			Herbaceous lycopods, Ferns, Conifers, Cycads
	180	Triassic			
Paleozoic	205	Permian		Mammal like reptiles	Arborescent lycopods
	230	Carboniferous	Pennsylvanian	Earliest Amphibians and abundant Echinoderms	Seed ferns and Bryophytes
	255		Mississippian	Earliest reptiles	
	315	Devonian		Age of fishes	Progymnosperms
	350	Silurian		Earliest fishes and land invertebrates	Zosterophyllum
	430	Ordovician		Dominance of invertebrates	Appearance of first land plants
	510	Cambrian		Fossil invertebrates	Origin of algae
Precambrian	3000	Upper		Multicellular organisms	
		Middle		Appearance of eukaryotes	
		Lower			Planktons prokaryotes

Experimental approach to the origin of life

- **Urey and Miller (1953)**, paved way for understanding the possible synthesis of organic compounds that led to the appearance of living organisms is depicted in the In their experiment, a mixture of gases was allowed to circulate over electric discharge from an tungsten electrode.
- A small flask was kept boiling and the steam emanating from it was made to mix with the mixture of gases (ammonia, methane and hydrogen) in the large chamber that was connected to the boiling water. The steam condensed to form water.

Atavistic organs

- Sudden appearance of vestigial organs in highly evolved organisms is called atavistic organs. Example, presence of tail in a human baby is an atavistic organ.

theory of recapitulation

- **theory of recapitulation"** which states that the life history of an individual (ontogeny) briefly repeats or recapitulates the evolutionary history of the race (phylogeny).
- In other words **"Ontogeny recapitulates Phylogeny".** The embryonic stages of a higher animal resemble the adult stage of its ancestors.
- Appearance of pharyngeal gill slits, yolk sac and the appearance of tail in human embryos are some of the examples

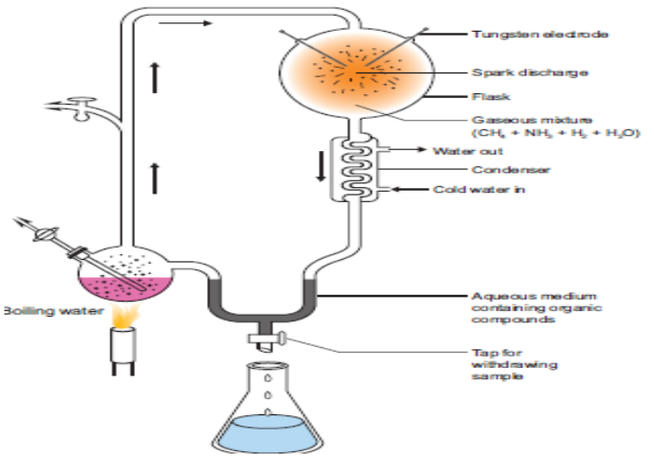


Fig. 6.1 Diagrammatic representation of Urey-Miller's experiment

- which ran down the 'U' tube. Experiment was conducted continuously for a week and the liquid was analysed. Glycine, alanine, beta alanine and aspartic acid were identified.
- Thus Miller's experiments had an insight as to the possibility of abiogenetic synthesis of large amount of variety of organic compounds in nature from a mixture of sample gases in which the only source of carbon was methane.
- Later in similar experiments, formation of all types of amino acids, and nitrogen bases were noticed.

Evidences forbiological evolution

Paleontological evidences

- Paleontology is the study of prehistoric life through fossils. Fossils are described as the true witnesses of evolution or documents of various geological strata of evolution.

- Fossilization is the process by which plant and animal remains are preserved in sedimentary rocks. They fall under three main categories.

i) **Actual remains** – The original hard parts such as bones, teeth or shells are preserved as such in the earth's atmosphere. This is the most common method of fossilization.

ii) When marine animals die, their hard parts such as bones, shells, etc., are covered with sediments and are protected from further deterioration.

iii) They get preserved as such as they are preserved in vast ocean; the salinity in them prevents decay.

iv) The sediments become hardened to form definite layers or strata. For example, Woolly Mammoth that lived 22 thousand years ago were preserved in the frozen coast of Siberia as such. Several human beings and animals living in the ancient city of Pompeii were preserved intact by volcanic ash which gushed out from Mount Vesuvius.

- original portion of their body may be replaced molecule for molecule by minerals and the original substance being lost through disintegration.
- This method of fossilization is called petrifaction. The principle minerals involved in this type fossilization are iron pyrites, silica, calcium carbonate and bicarbonates of calcium and magnesium.

iii) Natural moulds and casts – Even after disintegration, the body of an animal might leave indelible impression on the soft mud which later becomes hardened into stones. Such impressions are called moulds. The cavities of the moulds may get filled up
by hard minerals and get fossilized, which are called casts. Hardened faecal matter termed as coprolites occur as tiny pellets. Analysis of the coprolites enables us to understand the nature of diet the pre-historic animals thrived on.

Evidences from comparative anatomy

- Similarities in structure between groups of organisms are accepted as indicators of relationship. For example, a comparative study of the forelimbs of different vertebrates exhibits a fundamental plan of similarity in structure.
- These relationships can be studied under homologous organs, analogous organs, vestigial organs, connecting links and atavistic organs.

Homologous structures

- In vertebrates, comparative anatomical studies reveal a basic plan in various structures such as fore limbs and hind limbs.
- Fore limbs of vertebrates exhibit anatomical similarity with each other and is made of similar bones such as humerus, radius, ulna, carpals, metacarpals and phalanges.
- Structures which are similar in origin but perform different functions are called homologous structures that brings about **divergent evolution** Similarly the thorn of *Bougainvillea* and the tendrils of *Curcurbita* and *Pisum sativum* represent homology.
- The thorn in former is used as a defence mechanism from grazing animals and the tendrils of latter is used as a support for climbing.

Analogous structures

- Organisms having different structural patterns but similar function are termed as analogous structures. For example, the wings of birds and insects are different structurally but perform the same function of flight that brings about **convergent evolution** Other examples of analogous organs include the eyes of the Octopus and of
- mammals and the flippers of Penguins and Dolphins.
- Root modification in sweet potato and stem modification in potato are considered as analogous organs. Both of these plants have a common function of storage of food.

Theories of biological evolution

Lamarck's theory

- **Jean Baptiste de Lamarck,** was the first to postulate the theory of evolution in his famous book '**Philosophie Zoologique**' in the year **1809**.
- The two principles of Lamarckian theory are:
- **i. The theory of use and disuse** - Organs that are used often will increase in size and those that are not used will degenerate.
- Neck in giraffe is an example of use and absence of limbs in snakes is an example for disuse theory.
- **ii. The theory of inheritance of acquired characters** - Characters that are developed during the life time of an organism are called acquired characters and these are then inherited.

The main objection to Lamarckism

- Lamarck's "Theory of Acquired characters" was disproved by **August Weismann** who conducted experiments on mice for twenty generations by cutting their tails and breeding them.
- All mice born were with tail. Weismann proved that change in the somatoplasm will not be transferred to the next generation but changes in the germplasm will be inherited

Neo-Lamarckism

- The followers of Lamarck (Neo-Lamarckists) like **Cope, Osborn, Packard** and **Spencer** tried to explain Lamarck's theory on a more scientific basis.
- They considered that adaptations are universal. Organisms acquire new structures due to their adaptations to the changed environmental conditions.
- They argued that external conditions stimulate the somatic cells to produce certain 'secretions' which reach the sex cells through the blood and bring about variations in the offspring.

Darwin's theory of Natural Selection

- **Charles Darwin** explained the theory of evolution in his book **'The Origin of Species by Natural Selection'.**
- During his journey around the Earth, he made extensive observations of plants and animals. He noted a huge variety and remarkable similarities among organisms and their adaptive features to cope up to their environment.
- He proved that fittest organisms can survive and leave more progenies than the unfit ones through natural selection.
- Darwin's theory was based on several facts, observations and influences.

Over production (or) prodigality of production

- All living organisms increase their population in larger number. For example, Salmon fish produces about 28 million eggs during breeding season and if all of them hatch, the seas would be filled with salmon in few generations.
- Elephant, the slowest reeder that can produce six young ones in its life time can produce 6 million descendants at the end of 750 years in the absence of any check.

Struggle for existence

- Organisms struggle for food, space and mate. As these become a limiting factor, competition exists among the members of the population. Darwin denoted struggle for existence in three ways –
- Intra specific struggle between the same species for food, space and mate.
- Inter specific struggle with different species for food and space.
- Struggle with the environment to cope with the climatic variations, flood, earthquakes, drought, etc.,

1. **Universal occurrence of variations**
   - No two individuals are alike. There are variations even in identical twins. Even the children born of the same parents differ in colour, height, behavior, etc., The useful variations found in an organism help them to overcome struggle and such variations are passed on to the next generation.
1. **Origin of species by Natural Selection**
   - According to Darwin, nature is the most powerful selective force. He compared origin of species by natural selection to a small isolated group.
   - Darwin believed that the struggle for existence resulted in the survival of the fittest. Such organisms become better adapted to the changed environment.

Objections to Darwinism

- Some objections raised against Darwinism were –
- Darwin failed to explain the mechanism of variation.
- Darwinism explains the survival of the fittest but not the arrival of the fittest.
- He focused on small fluctuating variations that are mostly non-heritable.
- He did not distinguish between somatic and germinal variations.
- He could not explain the occurrence of vestigial organs, over specialization of some organs like large tusks in extinct mammoths, oversized antlers in the extinct Irish deer, etc.,
- Neo Darwinism is the interpretation of Darwinian evolution through Natural Selection as it has been modified since it was proposed.

- New facts and discoveries about evolution have led to modifications of Darwinism and is supported by **Wallace, Heinrich, Haeckel, Weismann** and **Mendel**.
- This theory emphasizes the change in the frequency of genes in population arises due to mutation, variation, isolation and Natural selection.

Mutation theory

- **Hugo de Vries** put forth the Mutation theory. Mutations are sudden random changes that occur in an organism that is not heritable.

- ❖ De Vries carried out his experiments in the Evening Primrose plant (*Oenothera lamarckiana*) and observed variations in them due to mutation.
- ❖ According to de Vries, sudden and large variations were responsible for the origin of new species whereas Lamarck and Darwin believed in gradual accumulation of all variations as the causative factors in the origin of new species.

Salient features of Mutation Theory

- ❖ Mutations or discontinuous variation are transmitted to other generations.
- ❖ In naturally breeding populations, mutations occur from time to time.
- ❖ There are no intermediate forms, as they are fully fledged.
- ❖ They are strictly subjected to natural selection.

Modern synthetic theory

❖ **Sewell Wright, Fisher, Mayer, Huxley, Dobzhansky, Simpson and Haeckel** explained Natural Selection in the light of Post-Darwinian discoveries.

❖ According to this theory gene mutations, chromosomal mutations, genetic recombinations, natural selection and reproductive isolation are the five basic factors involved in the process of organic evolution.

❖ **i. Gene mutation** refers to the changes in the structure of the gene. It is also called gene/ point mutation. It alters the phenotype of an organism and produces variations in their offspring.

❖ **ii. Chromosomal mutation** refers to the changes in the structure of chromosomes due to deletion, addition, duplication, inversion or translocation. This too alters the phenotype of an organism and produces variations in their offspring.

❖ **iii. Genetic recombination** is due to crossing over of genes during meiosis. This brings about genetic variations in the individuals of the same species and leads to heritable variations.

❖ **iv. Natural selection** does not produce any genetic variations but once such variations occur it favours some genetic changes while rejecting others (driving force of evolution).

❖ **v. Reproductive isolation** helps in preventing interbreeding between related organisms.

Adaptive Radiation

- ➢ The evolutionary process which produces new species diverged from a single ancestral form becomes adapted to newly invaded habitats is called adaptive radiation.
- ➢ Adaptive radiations are best exemplified in closely related groups that have evolved in relatively short time.
- ➢ Darwin's finches and Australian marsupials are best examples for adaptive radiation.
- ➢ When more than one adaptive radiation occurs in an isolated geographical area, having the same structural and functional similarity it is due to convergent evolution.
- ➢ Their common ancestor arrived on the Galapagos about 2 million years ago. During that time, Darwin's finches have evolved into 14 recognized species differing in body size, beak shape and feeding behavior.
- ➢ Changes in the size and form of the beak have enabled
- ➢ different species to utilize different food resources such as insects, seeds, nectar from cactus flowers and blood from iguanas, all driven by Natural selection.
- ➢ represents some of the finches observed by Darwin. Genetic variation in the ALX1 gene in the DNA of Darwin finches is associated with variation in the beak shape.
- ➢ ild mutation in the ALX1 gene leads to phenotypic change in the shape of the beak of the Darwin finches.

Natural selection

- ❖ It occurs when one allele (or combination of alleles of differences) makes an organism more or less fit to survive and reproduce in a given environment.
- ❖ If an allele reduces fitness, its frequencies tend to drop from one generation to the next.
- ❖ The evolutionary path of a given gene i.e., how its allele's change in frequency in the population across generation, may result from several evolutionary mechanisms acting at once.

- ❖ For example, one gene's allele frequencies might be modified by both gene flow and genetic drift, for another gene, mutation may produce a new allele, that is favoured by natural selection

Selection

- There are mainly three types of natural selection
- **i. Stabilising Selection (centipetal selection):** This type of selection operates in a stable environment
- The organisms with average phenotypes survive whereas the extreme individuals from both the ends are eliminated.
- There is no speciation but the phenotypic stability is maintained within the population over generation.
- For example, measurements of sparrows that survived the storm clustered around the mean, and the sparrows that failed to survive the storm clustered around the extremes of the variation showing stabilizing selection.
- **ii. Directional Selection:** The environment which undergoes gradual change is subjected to directional selection **(Fig. 6. 7b).**This type of selection removes the individuals from one end towards the other end of phenotypic distribution. For example, size differences between male and female sparrows. Both male and female look alike externally but differ in body weight. Females show directional selection in relation to body weight.
- **iii. Disruptive Selection (centrifugal selection):** When homogenous environment changes into heterogenous environment this type of selection is operational **(Fig. 6.7c).** The organisms of both the extreme phenotypes are selected whereas individuals with average phenotype are eliminated. This results in splitting of the population into sub pulation/species.
- This is a rare form of selection but leads to formation of two or more different species. It is also called adaptive radiation. e.g. Darwin's finches-beak size in relation to seed size inhabiting Galapagos islands.
- Group selection and sexual selection are other types of selection. The two major group selections are Altrusim and Kin selection.

Hardy - Weinberg Principle

q2= frequency of aa

p = 0.3, q = 0.7 then,

p2 = (0.3)2 = 0.09 = 9 % AA

2pq = 2(0.3) (0.7) = 0.42 = 42 % Aa

q2 = (0.7)2 0.49 = 49 % aa

Hardy Weinberg's assumptions include

- **No mutation** – No new alleles are generated by mutation nor the genes get duplicated or deleted.
- **Random mating** – Every organism gets a chance to mate and the mating is random with each other with no preferences for a particular genotype.
- **No gene flow -** Neither individuals nor their gametes enter (immigration) or exit (emigration) the population.
- **Very large population size -** The population should be infinite in size.
- **No natural selection**- All alleles are fit to survive and reproduce.
- If any one of these assumptions were not met, the population will not be in Hardy- Weinberg equilibrium. Only if the allele frequencies changes from one generation to the other, evolution will take place.

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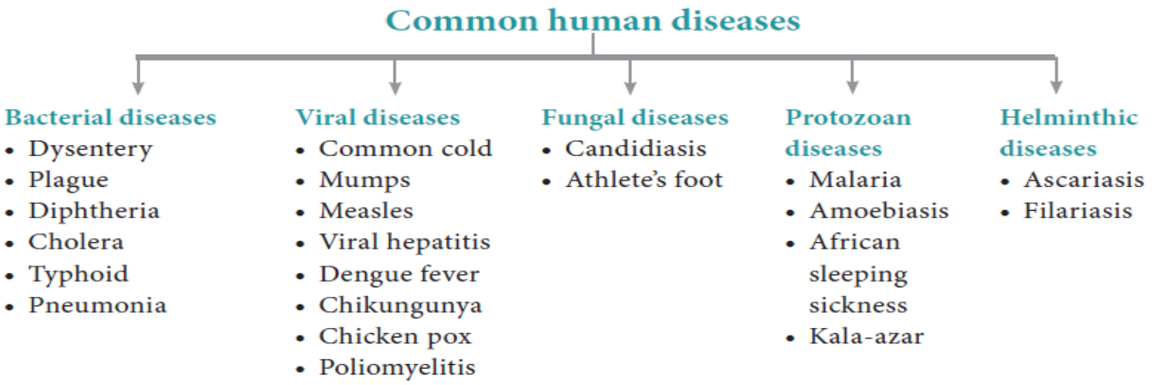
7. Human Health and Diseases

1. **communicable diseases**

- Diseases which are transmitted from one person to another are called infectious diseases or **communicable diseases**. Such disease causing organisms are called **pathogens** and are transmitted through air, water, food, physical contact and vectors.
- Th e disease causing pathogen may be virus, bacteria, fungi, protozoan parasites, helminthic parasites, etc.,



2. **NON COMMUNICABLE DISEASES**
   - ❖ **Non-infectious diseases** are not transmitted from an infected person to a healthy person.
   - ❖ In origin they may be genetic (cystic fibrosis), nutritional (vitamin deficiency diseases) and degenerative (arthritis, heart attack, stroke).
   - ❖ Among non - infectious diseases, cancer is one of the major causes of death.

3. **pathogenic bacteria**

   Though the number of bacterial species is very high, only a few bacteria are associated with human diseases and are called **pathogenic bacteria**. Such pathogens may emit toxins and affected the body.

Table 7.1. Bacterial diseases in human beings

S. No	Diseases	Causative agent	Site of infection	Mode of transmission	Symptoms
1	Shigellosis (Bacillary dysentery)	*Shigella sp.*	Intestine	Food and water contaminated by faeces / faecal oral route	Abdominal pain, dehydration, blood and mucus in the stools
2	Bubonic plague (Black death)	*Yersinia pestis*	Lymph nodes	Rat flea vector- *Xenopsylla cheopis*	Fever, headache, and swollen lymph nodes
3	Diphtheria	*Corynebacterium diphtheriae*	Larynx, skin, nasal and genital passage	Droplet infection	Fever, sore throat, hoarseness and difficulty in breathing
4	Cholera	*Vibrio cholerae*	Intestine	Contaminated food and water/ faecal oral route	Severe diarrhoea and dehydration
5	Tetanus (Lock jaw)	*Clostridium tetani*	Spasm of muscles	Through wound infection	Rigidity of jaw muscle, increased heart beat rate and spasm of the muscles of the jaw and face
6	Typhoid (Enteric fever)	*Salmonella typhi*	Intestine	Through contaminated food and water	Headache, abdominal discomfort, fever and diarrhoea
7	Pneumonia	*Streptococcus pneumoniae*	Lungs	Droplet infection	Fever, cough, painful breathing and brown sputum
8	Tuberculosis	*Mycobacterium tuberculosis*	Lungs	Droplet infection	Thick mucopurulant nasal discharge

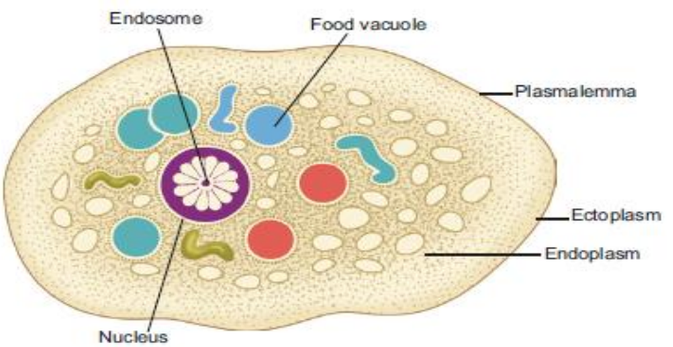
- **Common cold**
- The new viruses break out of the cell, killing it and invade other cells in the body, causing
  - diseases in human beings. *Rhino viruses* cause one of the most infectious human ailment called the "**Common cold**".

4. Viral diseases are generally grouped into four types on the basis of the symptoms produced in the body organs.

- Pneumotropic diseases (respiratory tract infected by influenza)
- Dermotropic diseases (skin and subcutaneous tissues affected by chicken pox and measles)
- Viscerotropic diseases (blood and visceral organs affected by yellow fever and dengue fever)
- Neurotropic diseases (central nervous system affected by rabies and polio).

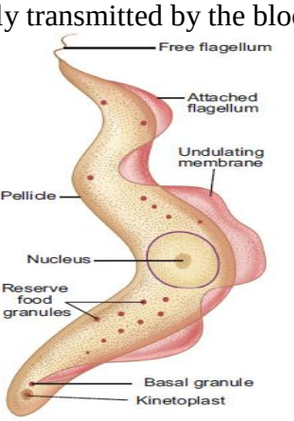
5. **Amoebiasis**

- **Amoebiasis** also called amoebic dysentery or amoebic colitis is caused by *Entamoeba histolytica*, which lives in the human large intestine and feeds on food particles and bacteria
- Infective stage of this parasite is the **trophozoite**, which penetrates
- the walls of the host intestine (colon) and secretes histolytic enzymes causing ulceration, bleeding, abdominal pain and stools with excess mucus.
- Symptoms of amoebiasis can range from diarrhoea to dysentery with blood and mucus in the stool.
- **House flies (***Musca domestica***)** acts as a carrier for transmitting the parasite from contaminated faeces and water.



6. **African sleeping sickness**

African sleeping sickness is caused by *Trypanosoma species.* *Trypanosoma* is generally transmitted by the blood sucking **Tsetse** flies. ree species of *Trypanosoma* cause sleeping sickness in man.



1. *T. gambiense* is transmitted by *Glossina palpalis* **(Tsetse fly)** and causes Gambian or Central African sleeping sickness **(Fig. 7.2).**

2. *T. rhodesiense* is transmitted by *Glossina morsitans* causing **Rhodesian or East African sleeping sickness.**

3. *T. cruzi* is transmitted by a bug called *Triatoma megista* and causes **Chagas disease or American trypanosomiasis.**

7. **Kala – azar**

- **Kala – azar** or visceral leishmaniasis is caused by *Leishmania donovani,* which is transmitted by the vector *Phlebotomus* **(sand fly)**. Infection may occur in the endothelial cells, bone marrow, liver, lymph glands and blood vessels of the spleen.
- Symptoms of Kala azar are weight loss, anaemia, fever, enlargement of spleen and liver.

8. TYPES OF MALARIA

- **Malaria** is caused by different types of *Plasmodium* species such as *P. vivax, P. ovale, P. malariae and P. falciparum*
- *Plasmodium* lives in the RBC of human in its mature condition it is called as **trophozoite**. It is transmited from one person to another by the bite of the infected female *Anopheles* mosquito

9. three phases OF MALAIA

- The life cycle of *Plasmodium* involves three phases namely **schizogony, gamogony** and **sporogony**

10. Prevention

- It is possible to break the transmission cycle by killing the insect vector.
- Mosquito's lay their eggs in water. Larvae hatch and develop in water but breathe air by moving to the surface.
- Oil can be sprayed over the water surface, to make it impossible for mosquito larvae and pupae to breathe.

11.

TYPES AND INCUBATION PERIOD MALARIA

Sl No	Types of Malaria	Causative agent	Duration of Erythrocytic cycle
1	Tertian, benign tertian or vivax malaria	*P. vivax*	48 hours
2	Quartan malaria	*P. malariae*	72 hours
3	Mild tertian malaria	*P. ovale*	48 hours
4	Malignant tertian or quotidian malaria	*P. falciparum*	36 – 48 hours

12. **Malaria vaccine**

- **Malaria vaccine** is used to prevent malaria. The only approved vaccine as of 2015 is RTS,S(Mosquirix).
- It requires four injections and has relatively low efficacy (26–50%).
  - Due to this low efficacy, WHO does not recommend the use of RTS,S vaccine in babies between 6 and 12 weeks of age.

1. **sporozoites**

The oocyte undergoes meiosis by a process called **sporogony** to form **sporozoites**

2. ookinete.In the mosquito's gut, the infected erythrocytes lyse and male and female gametes fertilize to f orm a diploid zygote called **ookinete**.

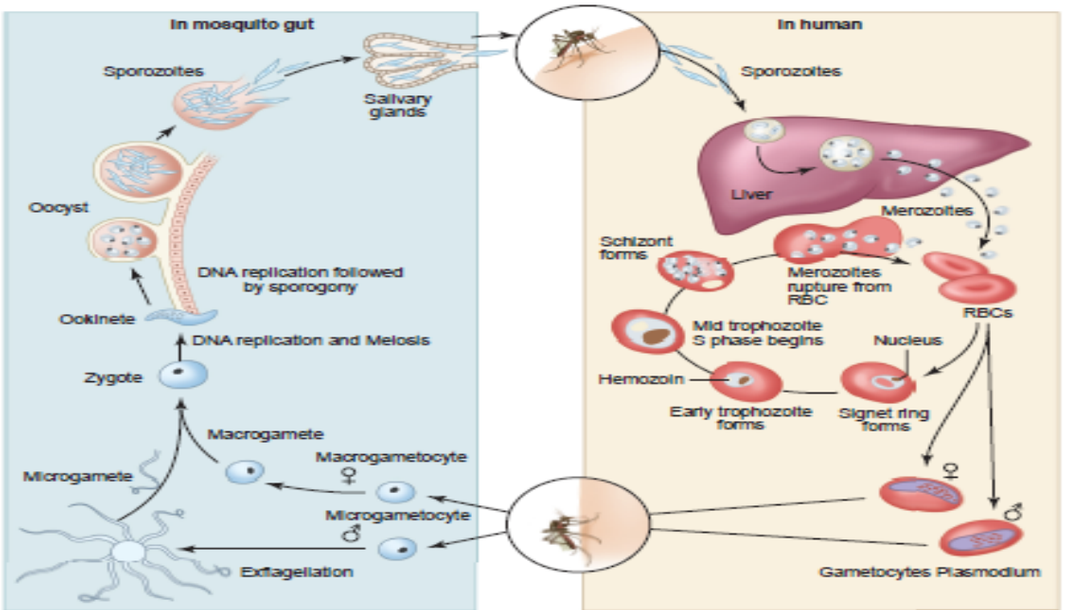


Fig. 7.3 Life cycle of *Plasmodium*

4. Fungal diseases

- Fungi was recognized as a causative agent of human diseases much earlier than bacteria. Dermatomycosis is a cutaneous infection caused by fungi belonging to the genera *Trichophyton*, *Microsporum* and *Epidermophyton*.
- Ringworm is one of the most common fungal disease in humans
- Appearance of dry, scaly lesions on the skin, nails and scalp are the main symptoms of the disease. Heat and moisture help these fungi
- to grow and makes them to thrive in skin folds such as those in the groin or between the toes.
- Ringworms of the feet is known as **Athlete's foot** caused by *Tinea pedis* Ringworms are generally acquired from soil or by using clothes, towels and comb used by infected persons.

4. Helminthic diseases

- Helminthes are mostly endoparasitic in the gut and blood of human beings and cause diseases called **helminthiasis.** The two most prevalent helminthic diseases are Ascariasis and Filariasis.
- *Ascaris* is a monogenic parasite and exhibits sexual dimorphism.
- **Ascariasis** is a disease caused by the intestinal endoparasite *Ascaris lumbricoides* commonly called the **round worms**
  - of the disease are abdominal pain, vomiting, headache, anaemia, irritability and diarrhoea.
  - A heavy infection can cause nutritional deficiency and severe abdominal pain and causes stunted growth in children.
  - It may also cause enteritis, hepatitis and bronchitis. **Filariasis** is caused by *Wuchereria bancroft i,* commonly called **fi larial worm.**
  - It is found in the **lymph vessels** and **lymph nodes** of man
  - *Wuchereria bancroft i* is sexually dimorphic, viviparous and digenic.
  - The life cycle is completed in two hosts, man and the female *Culex* mosquito Th e female filarial worm gives rise to **juveniles** called **microfi lariae larvae**.
  - In the lymph glands, the juveniles develop into adults.

- ❖ The accumulation of the worms block the lymphatic system resulting in inflammation of the lymph nodes.
- ❖ It is transmitted through ingestion of embryonated eggs through contaminated food and water.
- ❖ Children playing in contaminated soils are also prone to have a chance of transfer of eggs from hand to mouth.
- ❖ The symptoms In some cases, the obstruction of lymph vessels causes elephantiasis or fi lariasis of the **limbs**, **scrotum** and **mammary glands.**

5. drug abuse.

- ❖ The intake of certain drugs for a purpose other than their normal clinical use in an amount and frequency that impair one's physical, physiological and psychological functions is called **drug abuse**.

6**. The drugs which are commonly abused**

The drugs which are commonly abused include **opioids, cannabinoids, coca-alkaloids, barbiturates, amphetamines and LSD**.

Table 7.4 classification of drugs

Group	Drugs	Effects
Stimulants	Amphetamines, cocaine, nicotine and tobacco	Accelerates the activity of the brain
Depressants	Alcohol, Barbiturates, Tranquilizers	Slows down the activity of the brain
Narcotic/ Analgesics	Opium, Morphine	Act as depressants on the Central Nervous System
Cannabis	Bhang (Marijuana), Ganja, Charas	Affects the cardiovascular system
Hallucinogens	Lysergic acid diethylamide (LSD), Phencyclidine	Distorts the way one sees, hears and feels

7.

8. Liver cirrhosis

- ➢ Over time fat accumulation and high levels of alcohol destroy the liver cells and a scar tissue grows in the place of dead cells. This scarring of the liver is called **"Liver cirrhosis**".
- ➢ 9. **Korsakoff syndrome** Excessive alcohol use weakens the heart muscle, causing scar tissue to build up in the cardiac muscle fibers.
- ➢ As a result, heavy drinkers have an increased risk of high blood pressure, stroke, coronary artery disease and heart attack.
- ➢ **Korsakoff syndrome,** a chronic memory disorder is most commonly caused by alcohol misuse.

10. **Prevention and control**

1. Effectively dealing with peer pressure

2. Seeking help from parents and peers

3. Education and counselling

4. Looking for danger signs
5. Seeking professional and medical assistance

11. Alcoholism

Alcoholism is the inability to control drinking due to physical and emotional dependence on alcohol. Treatment involves counseling by a healthcare professional. Detoxification programme in a hospital or medical facility is an option for those who need additional assistance. Medications are available to reduce the desire to drink and smoke.

12. Alcoholic Anonymous

Alcoholic anonymous was started in 1935 by a businessman and a doctor who had been a "hopeless drunk" for many years.

After the men helped each other to stop drinking and to stay sober, they then founded the alcoholic anonymous to help other alcoholics. Since that time alcoholic anonymous has spread throughout the world.

13. Life style modifications

- Avoid eating junk food and foods that have preservatives and colouring agents.
- Physical exercises such as brisk walking and yoga can be done regularly.
- Following medical advice, if any health problems in addition to life style disorders.
- To avoid smoking drugs and drinking alcohol.
- To follow a healthy balanced diet rich in vitamins and proteins.
- 7 – 8 hours of sleep every day is required.

14. Helminthic diseases

- Helminthes are mostly endoparasitic in the gut and blood of human beings and cause diseases called **helminthiasis.**
- The two most prevalent helminthic diseases are Ascariasis and Filariasis

15. **Filariasis**

- **Filariasis** is caused by *Wuchereria bancroft i*, commonly called **fi larial worm.**
- It is found in the **lymph vessels** and **lymph nodes** of man**)**.
- *Wuchereria bancroft i* is sexually dimorphic, viviparous and digenic. Th e life cycle is completed in two hosts, man and the female *Culex* mosquito
- . Th e female fi larial worm gives rise to **juveniles** called **microfi lariae larvae**.
- In the lymph glands, the juveniles develop into adults. Th e accumulation of the worms block the lymphatic system resulting in infl ammation of the lymph nodes.
- In some cases, the obstruction of lymph vessels causes elephantiasis or fi lariasis of the **limbs**, **scrotum** and **mammary glands**

16. **immunity**

- The overall ability of body to fight against the disease causing pathogen is called **immunity**.
- It is also called disease resistance and the lack of immunity is known as **susceptibility**. Immunity is highly specific.

Table 7.4 Innate immunity- types and mechanisms

Type of innate immunity	Mechanism
1. Anatomical barriers	
Skin	Prevents the entry of microbes. Its acidic environment (pH 3-5) retards the growth of microbes.
Mucus membrane	Mucus entraps foreign microorganisms and competes with microbes for attachment.
2. Physiological barriers	
Temperature	Normal body temperature inhibits the growth of pathogens. Fever also inhibits the growth of pathogens.
Low pH	Acidity of gastric secretions (HCl) kills most ingested microbes.
Chemical mediators	Lysozyme acts as antibacterial agent and cleaves the bacterial cell wall. Interferons induce antiviral state in the uninfected cells. Complementary substances produced from leucocytes lyse the pathogenic microbes or facilitate phagocytosis.
3. Phagocytic barriers	Specialized cells (Monocytes, neutrophils, tissue macrophages) phagocytose, and digest whole microorganisms.
4. Inflammatory barriers	Tissue damage and infection induce leakage of vascular fluid, containing chemotactic signals like serotonin, histamine and prostaglandins. They influx the phagocytic cells into the affected area. This phenomenon is called diapedesis.

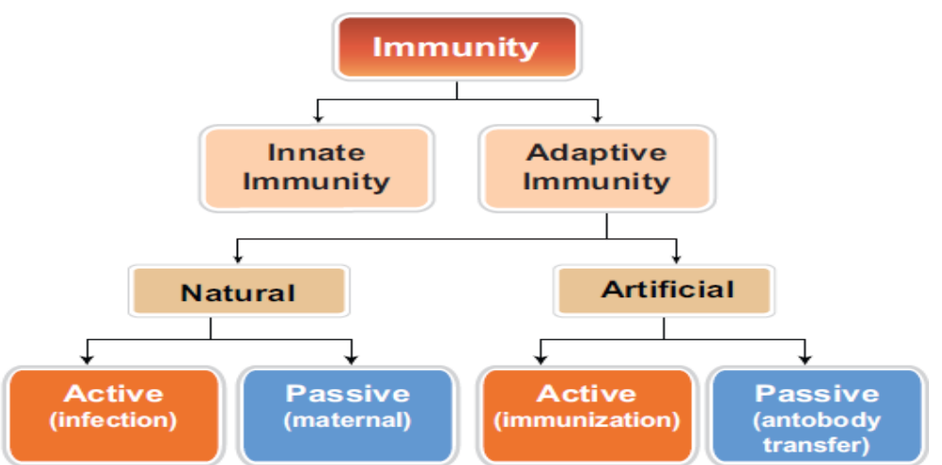


Fig. 7.9 Immune system

18.

- Acquired immunity has two components – **cell mediated immunity (CMI) and antibody mediated immunity or humoral immunity.**
- **Cell mediated immunity**
- When pathogens are destroyed by cells without producing antibodies, then it is known as cell mediated immune response or cell mediated immunity.
- This is brought about by T cells, macrophages and natural killer cells.
- **Antibody mediated immunity or humoral immunity**

- When pathogens are destroyed by the production of antibodies, then it is known as antibody mediated or humoral immunity.
- This is brought about by B cells with the help of antigen presenting cells and T helper cells.

- Antibody production is the characteristic feature of **vertebrates** only.

Table 7.5 Differences between active and passive immunity

Sl.No	Active Immunity	Passive Immunity
1	Active immunity is produced actively by host's immune system.	Passive immunity is received passively and there is no active host participation.
2	It is produced due to contact with pathogen or by its antigen.	It is produced due to antibodies obtained from outside.
3	It is durable and effective in protection.	It is transient and less effective.
4	Immunological memory is present.	No memory.
5	Booster effect on subsequent dose is possible.	Subsequent dose is less effective.
6	Immunity is effective only after a short period.	Immunity develops immediately.

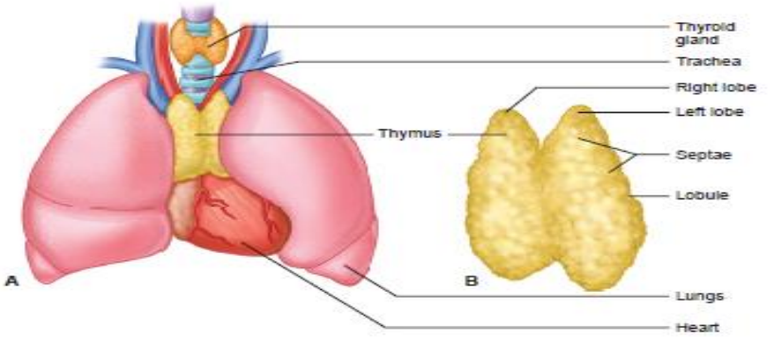
Table 7.6 Differences between primary and secondary immune responses

Sl.No	Primary Immune Response	Secondary Immune Response
1	It occurs as a result of primary contact with an antigen.	It occurs as a result of second and subsequent contacts with the same antigen.
2	Antibody level reaches peak in 7 to 10 days.	Antibody level reaches peak in 3 to 5 days.
3	Prolonged period is required to establish immunity.	It establishes immunity in a short time.
4	There is rapid decline in antibody level.	Antibody level remains high for longer period.
5	It appears mainly in the lymph nodes and spleen.	It appears mainly in the bone marrow, followed by the spleen and lymph nodes.

21. Thymus

- The thymus is a flat and bilobed organ located behind the sternun, above the heart.
- Each lobe of the thymus contains numerous lobules, separated from each other by connective tissue called septa.
- Each lobule is differentiated into two compartments, the outer compartment or **outer cortex,** is densely packed with immature T cells called thymocytes, whereas the inner compartment or medulla is sparsely populated with thymocytes.

- One of its main secretions is the hormone **thymosin**. It stimulates the T cell to become mature and **immunocompetent**. By the early teens, the thymus begins to atrophy and is replaced by adipose tissue**).**
- Thus thymus is **most active** during the **neonatal and pre-adolescent periods**.

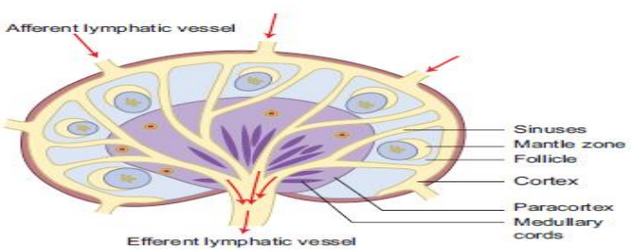


22. Bone marrow

- Bone marrow is a lymphoid tissue found within the spongy portion of the bone. Bone marrow contains stem cells known as haematopoietic cells.
- These cells have the potential to multiply through cell division and either remain as stem cells or differentiate and mature into different kinds of blood cells.

23.Lymph node

- Lymph node is a small bean-shaped structure and is part of the body's immune system. It is the **first one to encounter** the antigen that enters the tissue spaces.
- Lymph nodes filter and trap substances that travel through the lymphatic fluid.
- They are packed tightly with white blood cells, namely lymphocytes and macrophages. There are hundreds of lymph nodes found throughout the body.
- They are connected to one another by lymph vessels.
- **Lymph** is a clear, transparent, colourless, mobile and extracellular fluid connective tissue.As the lymph percolates through the lymph node, the particulate antigen brought in by the lymph will be **trapped** by the phagocytic cells, follicular and interdigitating dendritic cells.



24. **Peyer's patches**

- **Peyer's patches** are oval-shaped areas of thickened tissue that are embedded in the mucus-secreting lining of the small intestine of humans and other vertebrate animals.
- Peyer's patches contain a variety of immune cells, including macrophages, dendritic cells, T cells, and B cells.
- **Peyer's patches** are oval-shaped areas of thickened tissue that are embedded in the mucus-secreting lining of the small intestine of humans and other vertebrate animals. Peyer's patches contain a variety of immune cells, including macrophages, dendritic cells, T cells, and B cells.

25. **Spleen**

- **Spleen** is a secondary lymphoid organ located in the upper part of the abdominal cavity close to the diaphragm.
- Spleen contains B and T cells. It brings humoral and cell mediated immunity.

26. MALT

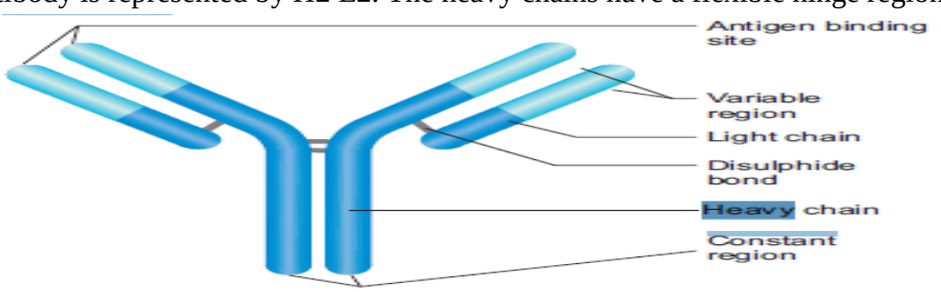
- **MALT** is populated by lymphocytes such as T and B cells, as well as plasma cells and macrophages, each of which is well situated to encounter antigens passing through the mucosal epithelium.

27. (BALT)

- Bronchus Associated Lymphoid Tissues **(BALT)** also a component of MALT is made of lymphoid tissue (tonsils, lymph nodes, lymph follicles) is found in the respiratory mucosae from the nasal cavities to the lungs.

28. Types Ig

- They are **IgG** (gamma), **IgM** (mu), **IgA** (alpha), **IgD** (delta) and **IgE** (epsilon).
- In the 1950s, experiments by **Porter and Edelman** revealed the basic structure of the immunoglobulin.
- An antibody molecule is **Y** shaped structure that comprises of four polypeptide chains, two identical light chains **(L)** of molecular weight 25,000 Da (approximately 214 amino acids) and two identical heavy chains **(H)** of molecular weight 50,000 Da (approximately 450 amino acids).
- The polypeptide chains are linked together by di-sulphide (S-S) bonds.
- One light chain is attached to each heavy chain and two heavy chains are attached to each other to form a Y shaped
- structure. Hence, an antibody is represented by H2 L2. The heavy chains have a flexible hinge region at their approximate middles.



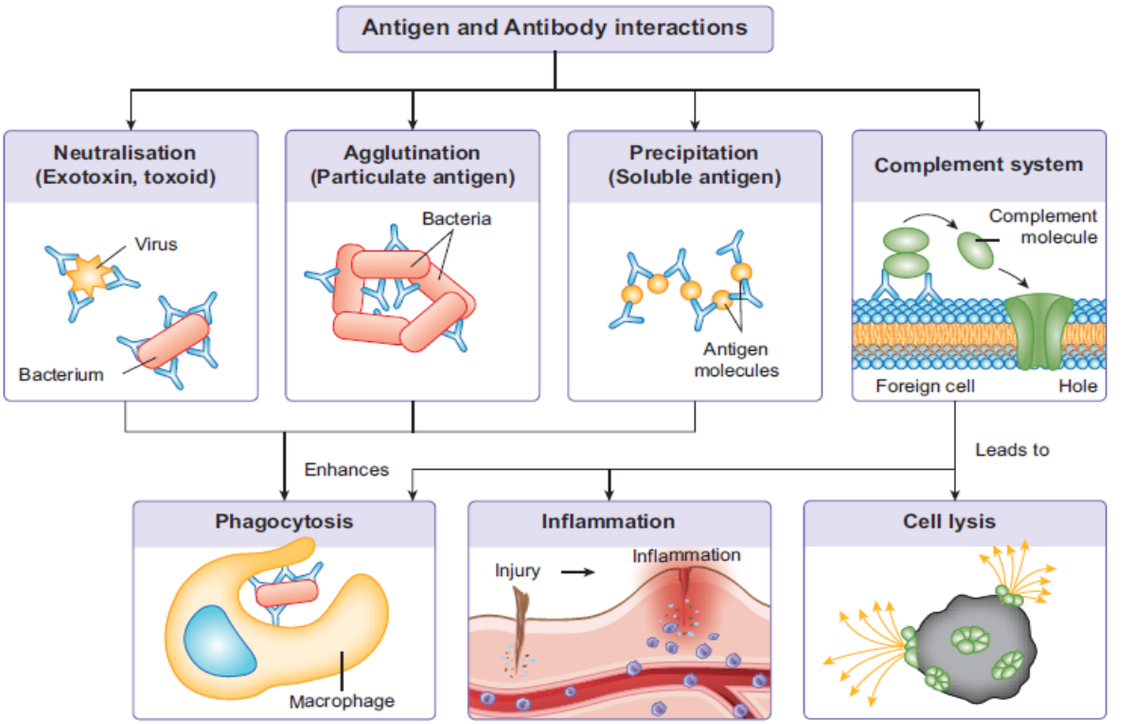


Fig. 7.16 Antigen and antibody reaction

29. allergy

- Some of the individuals are very sensitive to some particles present in the environment. The exaggerated response of the immune system to certain antigens present in the environment is called **allergy (allo-altered, erg-reaction)**.
- The substances to which such an immune response is produced are called **allergens**

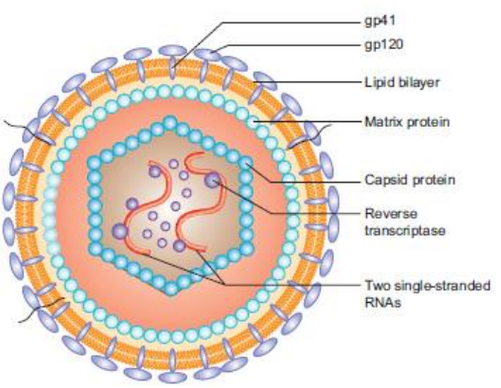


Fig. 7.18 Structure of HIV

30. Scope of Immunology

- The younger graduates in this field can find number of employment opportunities in Government as well as private hospitals.

- The scope of the immunology is immunotherapy, microbial immunology, clinical immunology, cellularimmunology, allergy and immunology, translational immunology, transplantation immunology, neuro-inflammatory disorders, tumour immunology, vaccine immunology, inflammatory disorders, ocular immunology and inflammation.

Table 7.8 Differences between normal cell and cancer cell

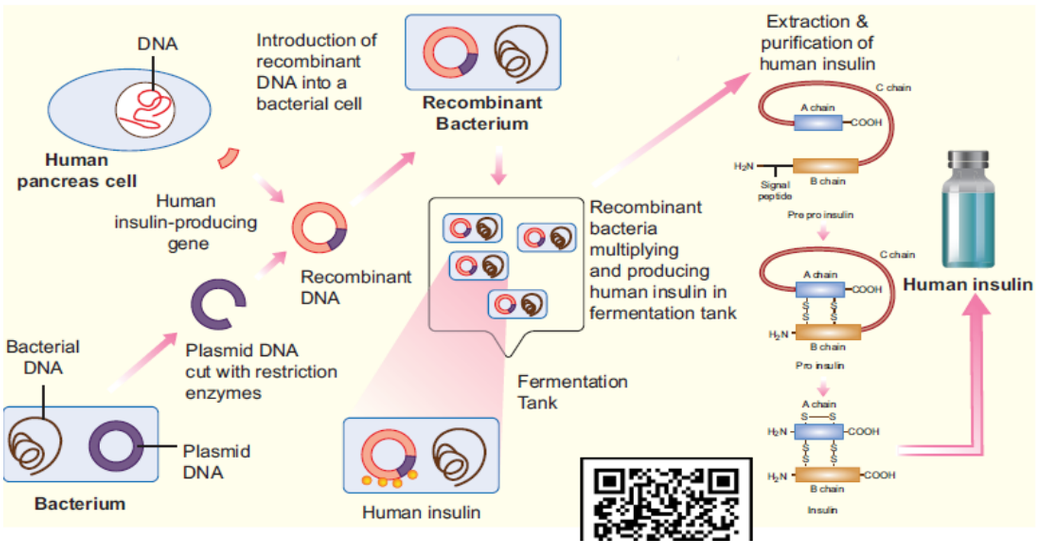
Normal Cells	Cancer cells
Small, uniformly shaped nuclei Relatively large cytoplasmic volume	Large, variable shaped nuclei Relatively small cytoplasmic volume
Conformity in cell size and shape Cells arranged into discrete tissues	Variation in cell size and shape Disorganised arrangement of cells
May possess differentiated cell structures Normal presentation of cell surface markers	Loss of normal specialised features Elevated expression of certain cell markers
Lower levels of dividing cells Cell tissues clearly demarcated	Large number of dividing cells Poorly defined tumor boundaries

9. APPLICATION OF BIOTECHNOLOGY

1. Recombinant Human Insulin

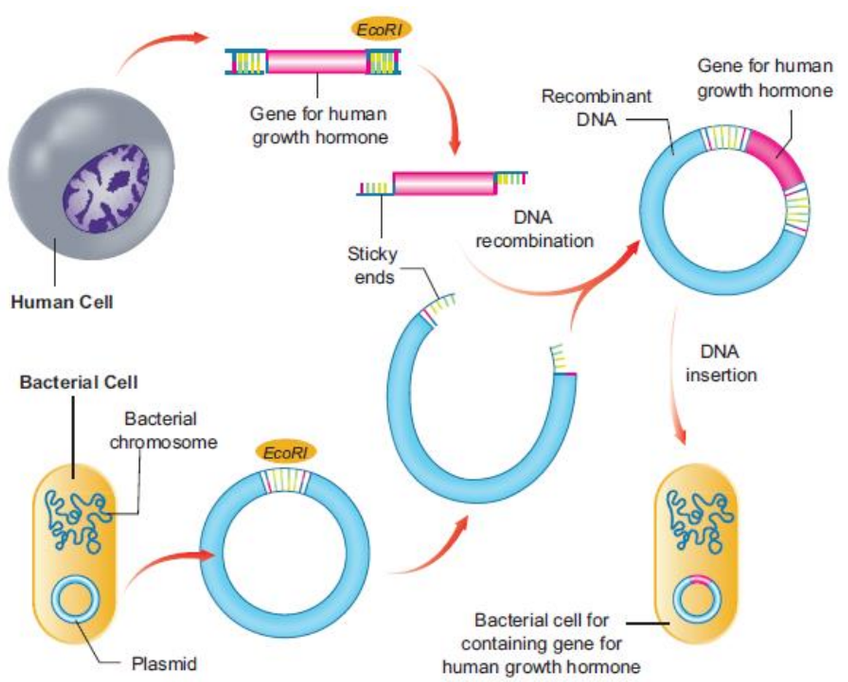
- The Human insulin is synthesized by the β cells of Islets of Langerhans in the pancreas.
- It is formed of 51 aminoacids which are arranged in two polypeptide chains, A and B. The polypeptide chain A has 21 amino acids while the polypeptide chain B has 30 amino acids.
- Both A and B chains are attached together by disulphide bonds. Insulin controls the levels of glucose in blood. It facilitates the cellular uptake and utilization of glucose for the release of energy.

- Deficiency of insulin leads to diabetes mellitus which is characterized by increased blood glucose concentration and a complex of symptoms which may lead to death, if untreated.
- A continuous program of insulin dependence is required to treat this deficiency.
- This technique involved the insertion of human insulin gene on the plasmids of *E.coli*.
- The polypeptide chains are synthesized as a precursor called pre-pro insulin, which contains A and B segments linked by a third chain (C) and preceded by a leader sequence.
- The leader sequence is removed after translation and the C chain is excised, leaving the A and B polypeptide chains
- Insulin was the first ever pharmaceutical product of recombinant DNA technology administered to humans.
- The approval to use recombinant insulin for diabetes mellitus was given in 1982. In 1986 human insulin was marketed under the trade name Humulin.



2. Human Growth Hormone (hGH)

- At about the same time when recombinant insulin was first made in *E. coli*, other research groups worked on human growth hormones somatostatin and somatotropin.
- These are peptide hormones secreted by the pituitary gland that helps in the growth and development by increasing the uptake of amino acids and promoting protein synthesis. Deficiency of human growth hormone causes dwarfism, which could be treated by injecting hGH extracted from the human pituitary glands.
- Using recombinant DNA technology hGH can be produced.
- The gene for hGH is isolated from the human pituitary gland cells. The isolated gene is inserted into a plasmid vector and then is transferred into *E. coli.*
- The recombinant *E. coli* then starts producing human growth hormone.The recombinant E. coli are isolated from the culture and mass production of hGH is carried out by fermentation technology.
- A recombinant form of human growth hormone called somatropin is used as a drug to treat growth disorders in children.



3. Human Blood-Clotting **Factor VIII**

- You would have studied in your earlier class that many factors are required for normal blood clotting process and the factor VIII is one of them.
- The genes for the formation of factor VIII is located in the X chromosome.
- A genetic defect in the synthesis of factor VIII results in Haemophilia A, a sex-linked disease characterized by prolonged clotting time and internal bleeding factor VIII isolated from blood of normal human being was used in the treatment of Haemophilia A. Requirement of large quantities of blood for this purpose and the risk of transmission of infectious diseases like AIDS is a disadvantage.
- Recombinant DNA technology was used to produce Recombinant Factor VIII in the Chinese Hamster ovary and in the baby Hamster kidney cells.
- More recently a cell line of human origin has been used for the first time to produce human blood clotting factor VIII.

Interferons

- Interferons are proteinaceous, antiviral, species specific substances produced by mammalian cells when infected with viruses.
- Interferons were discovered by Alick Isaacs and Jean Lindemann in 1957. Based on the structure of interferons they are classified as α, β and γ interferons.
- They stimulate the cellular DNA to produce antiviral enzymes which inhibit viral replication and protect the cells.
- Similar to factor VIII , interferons could be isolated from blood, but the amount of blood required for isolation of interferons is enormous and not practical.
- To overcome this issue interferons could be produced by rDNA technology.
- The yeast *Saccharomyces cerevisiae* is more suitable for production of recombinant interferons than *E.coli*, since *E.coli* does not possess the machinery for glycosylation of proteins.
- Interferons are used for the treatment of various diseases like cancer, AIDS, multiple sclerosis, hepatitis C and herpes zoster.
- In spite of the therapeutic applications interferons are not within the reach of the common man due to high cost for its production.

4. Attenuated recombinant vaccines

- This includes genetically modified pathogenic organisms (bacteria or viruses) that are made nonpathogenic and are used as vaccines.
- It is now possible to genetically engineer the organisms (bacteria or viruses) and use them as live vaccines and such vaccines are referred to as attenuated recombinant vaccines.

Fig. 9.4 Process of gene therapy

Table 9.1 Diffentiation between somatic cell gene therapy and germ line gene therapy

SOMATIC CELL GENE THERAPY	GERM LINE GENE THERAPY
Therapeutic genes transferred into the somatic cells.	Therapeutic genes transferred into the germ cells.
Introduction of genes into bone marrow cells, blood cells, skin cells etc.,	Genes introduced into eggs and sperms.
Will not be inherited in later generations.	Heritable and passed on to later generations.

5. **Totipotency (Toti-total)** is the ability of a single cell to divide and produce all of the differentiated cells in an organism.

6. **Pluripotency (Pluri-several)** refers to a stem cell that has the potential to differentiate into any of the three germ layers-ectoderm, endoderm and mesoderm.
7. **Multipotency (multi-Many)** refers to the stem cells that can differentiate into various types of cells that are related. For example blood stem cells can differentiate into lymphocytes, monocytes , neutrophils etc.,
8. **Oligopotency (Oligo-Few)** refers to stem cells that can differentiate into few cell types. For example lymphoid or myeloid stem cells can differentiate into B and T cells but not RBC.
9. **Unipotency** (Uni- Single) refers to the ability of the stem cells to differentiate into only one cell type.

10. **PCR** (Polymerase Chain Reaction)

- The polymerase chain reaction (PCR) is an *invitro* amplification technique used for synthesising multiple identical copies (billions) of DNA of interest.
- The technique was developed by **Kary Mullis** (Nobel laureate, 1993) in the year 1983.

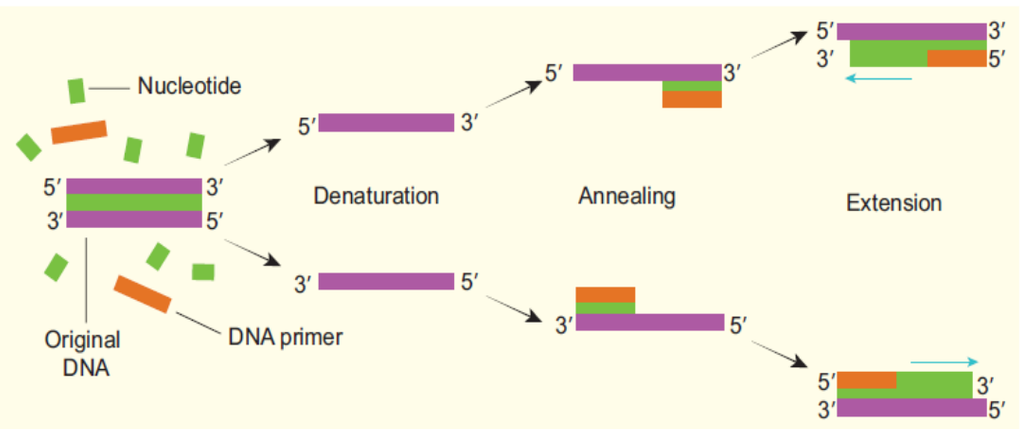


Fig. 9.7 Steps involved in PCR

11. denaturation

- The double stranded DNA of interest is denatured to separate into two individual strands by high temperature . This is called **denaturation**.
- Each strand is allowed to hybridize with a primer (renaturation or primer annealing). The primer template is used to synthesize DNA by using Taq – DNA polymerase.

12. Applications of PCR

- The differences in the genomes of two different organisms can be studied by PCR. PCR is very important in the study of evolutions, more specifically phylogenetics.
- As a technique which can amplify even minute quantities of DNA from any source, like hair, mummified tissues, bones or any fossilized materials.
    - PCR technique can also be used in the field of forensic medicine .
    - A single molecule of DNA from blood stains, hair, semen of an individual is adequate for amplification by PCR.
    - The amplified DNA is used to develop DNA fingerprint which is used as an important tool in forensic science.Thus, PCR is very useful for identification of criminals.
    - PCR is also used in amplification of specific DNA segment to be used in gene therapy.

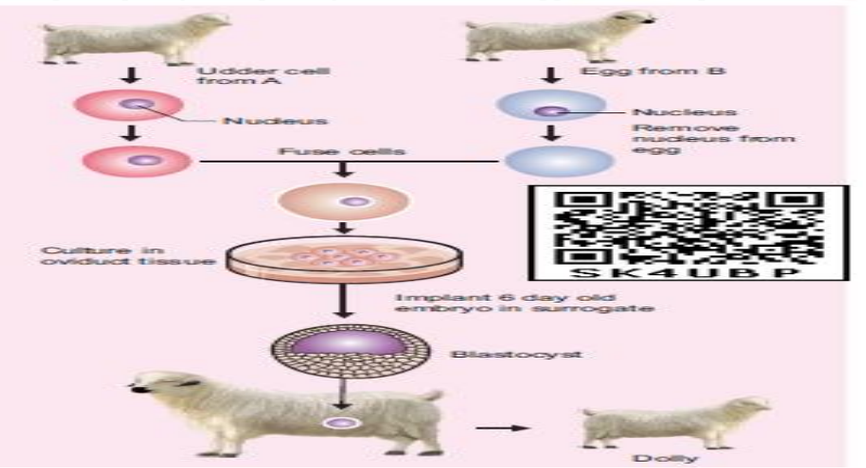
13. The various steps involved in the production of transgenic organisms are Identification and separation of desired gene.

- Selection of a vector (generally a virus) or direct transmission.
- Combining the desired gene with the vector.
- Introduction of transferred vector into cells, tissues, embryo or mature individual.

- Demonstration of integration and expression of foreign gene in transgenic tissue or animals. Transgenic animals such as mice, rat, rabbit, pig, cow, goat, sheep and fish have been produced

14. Uses Of Transgenesis

- Transgenesis is a powerful tool to study gene expression and developmental processes in higher organisms.
- Transgenesis helps in the improvement of genetic characters in animals.Transgenic animals serve as good models for understanding human diseases which help in the investigation of new treatments for diseases.Transgenic models exist for many human diseases such as cancer, Alzheimer's, cystic fibrosis, rheumatoid arthritis and sickle cell anemia.
- Transgenic animals are used to produce proteins which are important for medical and pharmaceutical applications
- Transgenic mice are used for testing the safety of vaccines.
- Transgenic animals are used for testing toxicity in animals that carry genes which make them sensitive to toxic substances than non-transgenic animals exposed to toxic substances and their effects are studied.
- Transgenesis is important for improving the quality and quantity of milk, meat, eggs and wool production in addition to testing drug resistance



Advantages and Disadvantages Of Cloning Animals

- Offers benefits for clinical trials and medical research. It can help in the production of proteins and drugs in the field of medicine.
- Aids stem cell research.
- Animal cloning could help to save endangered species.
- Animal and human activists see it as a threat to biodiversity saying that this alters evolution which will have an impact on populations and the ecosystem.
- The process is tedious and very expensive.
- It can cause animals to suffer.
- Reports show that animal surrogates were manifesting adverse outcomes and cloned animals were affected with disease and have high mortality rate.
- It might compromise human health through consumption of cloned animal meat.
- Cloned animals age faster than normal animals and are less healthy than the parent organism as discovered in Dolly
- Cloning can lead to occurrence of genetic disorders in animals.
- More than 90% of cloning attempts fail to produce a viable offspring.

15. Ethical Issues

- Biotechnology has given to the society cheap drugs, better friuts and vegetables, pest resistant crops, indigenious cure to diseases and lot of controversy.
- This is mainly because the major part of the modern biotechnology deals with genetic manipulations.
- People fear that these genetic manipulations may lead to unknown consequences. The major apprehension of recombinant DNA technology is that unique microorganisms either inadvertently or deliberately for the purpose of war may be developed that could cause epidemics or environmental catastrophies.
- Although many are concerned about the possible risk of genetic engineering, the risks are in fact slight and the potential benefits are substantial.

CHAPTER 10

Organisms and Population

- **van't Hoff's rule**
- van't Hoff proposed that, with the increase of every 10ºC, the rate of metabolic activity doubles or the reaction rate is halved with the decrease of 10ºC.
- This rule is referred as the van't Hoff's rule. The effect of temperature on the rate of reaction is expressed in terms of temperature coefficient or Q_{10} value.
- The Q_{10} values are estimated taking the ratio between the rate of reaction at XºC and rate of reaction at (X-10ºC).
- In the living system the Q_{10} value is about 2.0. If the Q_{10} value is 2.0, it means 10ºC increase and the rate of metabolism doubles.

1. ecology'

2. the word '**ecology**' is derived from the Greek term '*oikos*', meaning 'house' and *logos*, meaning 'study'.
3. Thus, the study of the environmental 'house' includes all the organisms in it and all the functional processes that make the house habitable.
   2. '**ecological equivalents**
4. Groups of species with comparable role and niche dimensions within a community are termed 'guilds'. Species that occupy the same niche in different geographical regions, are termed 'ecological equivalents'

3. Bergmann's rule

- In certain environments, the size and colouration of animals are influenced by temperature.
- Birds and mammals attain greater body size in colder regions than warmer regions (**Bergmann's rule**).

5. **Allen's rule**
   Warm blooded animals, living in colder climates, tend to have shorter limbs, ears and other appendages when compared to the members of the same species in warmer climates (**Allen's rule**)
6. **Phototaxis:** The movement of organism in response to light, either towards the source of light as in Moths (positive phototaxis) or away from light (Euglena, Volvox, earthworm (negative phototaxis)
7. **Phototropism:** The growth or orientation of an organism in response to light, either towards the source of light (positive phototropism) as seen in Sunflower, or a way from light (negative phototropism) as in case of the root of plants.
8. **Photokinesis:** A change in the speed of locomotion (or frequency of turning) in a motile organism or cell which is made in response to a change in light intensity is called Photokinesis. It involves undirected random movement in response to light.

9. Essential properties of water

- Water is one of the main agents in Pedogenesis (soil formation).
- It is the medium for several different ecosystems.
- It is present as moisture in the atmosphere and the outer layers of the lithosphere and is uneven in distribution on the earth.
- Water is heavier than air and imparts greater buoyancy to the aquatic medium. This enables organism to float at variable levels.
- Water has high heat capacity and latent heat, due to which it can withhold large amounts of heat. Thus, oceans and lakes tend to maintain a relatively constant temperature, and the biosphere is relatively thermostable.
- Water is physically unique because it is less dense as a solid (ice) than as a liquid.
- When water freezes (0^0C), it contracts. The maximum density of liquid water occurs at 4ºC. Below that, it expands markedly. This enables ice to float on the top of water bodies. Hence, only the surface of water bodies will freeze, while below the surface, water will be in liquid form, sustaining life.
- Water is considered as the Universal solvent. It is the main medium by which chemical constituents are transported from abiotic components to the living components of an ecosystem.
- Water has high surface tension. This allows pollen, dust, and even water striders to remain at the surface of a water body even though they are denser than the water.

Soil

- It is a mixture of organic matter, minerals, gases, liquids and organisms that together support life. The soil zone is known as **Pedosphere**. Soil is formed from rocks which are the parent materials of soil, by weathering and is called embryonic soil (Pedogenesis).
- It has four major functions- medium for plant growth means for water storage and purification modifier of earth's atmosphere habitat for many organisms, which in turn modify the soil Soil is formed of many horizontal layers called as Soil Profile.

Properties of Soil

1. **Texture of soil** – The texture of soil is determined by the size of the soil particles. The types of soil include sand, silt and clay on the basis of their size differences.
2. **Porosity** – The space present between soil particles in a given volume of soil are called pore spaces. The percentage of soil volume occupied by pore space or by the interstitial spaces is called porosity of the soil.
3. **Permeability of soil**-The characteristic of soil that determines the movement of water through pore spaces is known as soil permeability. Soil permeability is directly dependent on the pore size. Water holding capacity of the soil is inversely dependent on soil porosity.
4. **Soil Temperature**-Soil gets its heat energy from solar radiation, decomposing organic matter, and heat from the interior of earth. Soil temperature effects the germination of seeds, growth of roots and biological activity of soil-inhabiting micro-and macro-organisms.
5. **Soil water-** In soil, water is not only important as a solvent and transporting agent, but also maintains soil texture, arrangement and compactness of soil particles, making soil habitable for plants and animals.

Acclimatization

Animals are known to modify their response to environmental changes (stress) in reasonably short time spans. This is known as **Acclimatization**

- **Wind** Wind is the natural movement of air of any velocity from a particular direction. The two main causes are differential heating between the equator and the poles and the rotation of the planet (Coriolis effect).
- Wind helps to transport pollen grains, seeds, and even flight of birds. While it is the source of wind energy, it also causes erosion. Wind speed is measured with an Anemometer.

Characters of a biome

- Location, Geographical position (Latitude, Longitude)
- Climate and physiochemical environment
- Predominant plant and animal life

Boundaries between biomes are not always sharply defined. Transition or transient zones are seen as in case of grassland and forest biomes biosphere.

- The aquatic biome is home to millions of aquatic organisms like fishes. The climate of coastal zones are influenced by aquatic bodies.

Aquatic biomes of earth

1. Freshwater (Lakes, ponds, rivers)
2. Brackish water (Estuaries / Wetlands)
3. Marine (Coral reefs, pelagic zones and abyssal zones)

TUNDRA BIOME

- This is the almost treeless plain in the northern parts of Asia, Europe and North America.
- Winters are long with little daylight, Summers are short, with long daylight hours.
- Precipitation is less than 250 mm per year. It is a zone of permafrost.
- Dwarf willows, birches, mosses, grasses, sedges are the flora here.
- Reindeer, arctic hare, musk ox, lemmings are important Tundra herbivores. Some important carnivores are the arctic fox, arctic wolf, bobcat and snowy owl. Polar bears live along coastal areas.

- Because of the severe winters, many of the animals are migratory. For example, the many shore birds and waterfowl such as ducks and geese, nest in the Tundra during the summer and migrate south for the winter.

GRASSLAND BIOME

- Grasslands occur in temperate and in the tropical regions.
- They have hot summers, cold winters, and irregular rainfall.
- Often they are characterized by high winds.
- The low irregular rainfall is the factor which makes the difference between a temperate deciduous forest and a temperate grassland.
- Herbivores like antelope, bison, wild horse, jack rabbit, ground squirrel and prairie dogs are abundant.
- Predators include coyotes, foxes, hawks and snakes.

- In India, fauna of grasslands includes Elephant, Gaur, Rhino, Antelope. Flora of grasslands include purple needle grass, wild oats, foxtail, ryegrass and buffalo grass

TAIGA BIOME

- The Taiga is 1300-1450 km wide zone south of the Tundra.
- This area has long and cold winters.
- Summer temperature ranges from 10º C to 21º C.
- Precipitation ranges about 380-1000 mm annually.
- The Taiga is a forest of coniferous trees such as spruce, fir and pine. This is a major source for the logging industry.
- Important migratory herbivores include moose, elk, deer and reindeer. Moose and reindeer migrate to the Taiga for winter and to the Tundra for summers.
- The common smaller mammals are herbivorous squirrels, snowshoe

Alpine biome

- The alpine zone (zone between timber line and snow zone) includes in the descending order, a sub-snow zone immediately below the snow zone, a meadow zone in the centre and a shrub zone which gradually merges into the timber zone.
- The snow zone of Himalayas lies over 5100m above mean sea level and alpine zone exists at a height of 3600m.
- From an ecological view point, the zone above the limits of tree growth (timber line) exhibits extreme environmental conditions which greatly influence the biota of this region.
- Alpine zone of Himalayas is characterized by sparseness of animal groups.
- Many invertebrates of alpine zone are predatory and occur in lakes, streams and ponds. Among fishes, amphibians and vertebrates are totally lacking and reptilian fauna is greatly impoverished.
- Flora of alpines includes alpine phacelia, bear grass, bristlecone pine, moss campion, polylepis forest, pygmy bitterroot, and wild potato.

Forest biomes

- Forest is a broad term used to describe areas where there are a large number of trees
- The forest biomes include a complex assemblage of different kinds of biotic communities. The major forest biomes are the Tropical forests and the Temperate forests.

Tropical forest

- They occur near the equator (between latitudes 23.5° at north and 23.5° at south).
- The major characteristic of tropical forests is their distinct seasons. Only two seasons are present (rainy and dry). Winter is absent. The length of daylight is about 12 hours and varies little.
- The average annual temperature ranges between 20° C and 25° C.

Precipitation is evenly distributed throughout the year with annual rainfall exceeding 2000 mm.

Soil is nutrient-poor and acidic.

- Decomposition is rapid and soils are subject to heavy leaching.
- Tree canopy is multilayered and continuous, allowing little light penetration.

- Flora is highly diverse: one square kilometre may contain as many as 100 different tree species. Trees are 25-35 m tall, with buttressed trunks and shallow roots, mostly evergreen, with large dark green leaves. Common vegetation are orchids, bromeliads, vines (lianas), ferns, mosses, and palms.
- They are characterized by the greatest diversity of fauna which includes birds, bats, small mammals, and insects.
- Based on the seasonal distribution of rainfall, the types of tropical forests are
- **Evergreen rainforest***:* no dry season.
- **Seasonal rainforest*:*** short dry period in a very wet tropical region.
- **Semi evergreen forest*:*** longer dry season (the upper tree storey consists of deciduous trees, while the lower storey is still evergreen).
- **Moist/dry deciduous forest (monsoon)*:*** the length of the dry season increases further as rainfall decreases (all trees are deciduous)

Temperate forest

- These forests occur in eastern North America, northeastern Asia and western and central Europe.
- Have well-defined seasons with a distinct winter. Moderate climate and a growing season of 140-200 days during 4-6 frost-free months distinguish temperate forests.
- Annual temperature varies from -30° C to 30° C.
- Precipitation (750-1500 mm) is distributed evenly throughout the year.
- Soil is fertile, enriched with decaying litter.
- Canopy is moderately dense and allows light to penetrate, resulting in well-developed and richly diversified understorey vegetation and stratification of animals.
- Flora is characterized by 3-4 tree species per km^2. Trees have broad leaves that are lost annually such as oak, hickory, beech, hemlock, maple, basswood, cottonwood, elm, willow, and spring-flowering herbs.
- Fauna consists of squirrels, rabbits, skunks, birds, deer, mountain lion, bobcat, timber wolf, fox, and black bear.
- Based on seasonal distribution of rainfall, the types of temperate forests are
- **Moist conifer and evergreen broad-leaved forests*:*** wet winters and dry summers.
- **Dry conifer forests*:*** dominate higher elevation zones; low precipitation.
- **Mediterranean forests*:*** precipitation is concentrated in winter (<1000 mm /year).
- **Temperate coniferous forests*:*** mild winters, high annual precipitation (> 2000 mm /year).
- **Temperate broad-leaved rainforests:** mild, frost-free winters, high precipitation (> 1500 mm/year), evenly distributed throughout the year.

Desert biomes

- Deserts cover about one fifth of the earth's surface and occur where rainfall is >500 mm/year.
- Rainfall is usually very low and/or concentrated in short bursts between long rainless periods. Evaporation rates regularly exceed rainfall rates.
- Soils are course-textured, shallow, rocky or gravely with good drainage and have no subsurface water. The finer dust and sand particles are blown elsewhere, leaving heavier pieces behind. Sand dunes are common.
- Mean annual temperatures range from 20-25° C. The extreme maximum ranges from 43.5 - 49° C. Minimum temperatures sometimes drop to -18° C. Based on the temperature range, deserts can be Hot deserts and Cold deserts.
- Hot deserts such as the Sahara of North Africa and the deserts of the southwestern U.S., Mexico, Australia and India (Thar desert) occur at low latitudes.
- **Hot deserts** have a considerable amount of specialized vegetation (xerophytes), *aloe*, *agave*, *Opuntia species*, *Euphorbia royleana* as well as specialized vertebrate and invertebrate animals.
- Soils often have abundant nutrients because they need only water to become very productive and have little or no organic matter.
- Only animals which can tap available water or capable of storing sufficient water and withstand the heat can survive in the desert. The animals include small nocturnal (active at night) carnivores. The dominant animals are burrowers and have cursorial, fossorial and saltatorial adaptations.
- The animals stay inactive in protected hideaways during the hot day and come out to forage at dusk, dawn or at night, when the desert is cooler.

- The dominant animals of warm deserts are reptiles and small mammals. The Indian Spiny-tailed lizard, the blackbuck, the white-footed fox are the common fauna of the Thar deserts. There are also insects, arachnids and birds

Cold deserts are characterized by cold winters with snowfall and high overall rainfall throughout the winter and occasionally over the summer.

- They occur in the Antarctic, Greenland and the Nearctic realm, parts of USA and in parts of western Asia and the Ladakh region in India.
- They have short, moist, and moderately warm summers with fairly long, cold winters. The mean winter temperature
- is between -2° C and 4° C and the mean summer temperature is between 21° C and 26° C.
- Winters receive quite a bit of snow. The mean annual precipitation ranges from 150- 250 mm.
- The soil is heavy, silty and salty.
- Widely distributed animals are jack rabbits, kangaroo rats, kangaroo mice, pocket mice, grasshopper mice, antelope and ground squirrels.

Responses To Abiotic Factors

- Every living organism responds to its environment. There are various ways by which organisms respond to abiotic conditions.
- Some organisms can maintain constant physiological and morphological conditions or undertake steps to overcome the environmental condition, which in itself is a response

The types of responses observed are

- **Regulate:** Some organisms are able to maintain homeostasis by physiological means which ensures constant body temperature, ionic / osmotic balance. Birds, mammals and a few lower vertebrate and invertebrate species are capable of such regulation.
- **Conform**: Most animals cannot maintain a constant internal environment. Their body temperature changes with the ambient temperature.
- In aquatic animals like fishes, the osmotic concentration of the body fluids changes with that of the ambient water osmotic concentration.
- Such animals are called **Conformers**. In case of extreme condition, the inhabitants relocate themselves as in migration.
- **Migrate:** Organisms tend to move away temporarily from a stressful habitat to a new, hospitable area and return when the stressful period is over.
- Birds migrate from Siberia to Vedanthangal in Tamilnadu to escape from the severe winter periods.
- **Suspend:** In certain conditions, if the organisms is unable to migrate, it may avoid the stress by becoming inactive. This is seen commonly in bears going into **hibernation** during winter. Some snails and fish go into **aestivation** to avoid summer related problems like heat and desiccation. Some lower animals suspend a certain phase of their life cycle, which is referred to as **diapause**

Adaptations of aquatic animals

1. The pectoral fins and dorsal fins act as stabilizers or balancers and the caudal fin helps in changing the direction as a rudder.
2. Arrangement of body muscles in the form of bundles (myotomes) help in locomotion.
3. Stream lined structure helps in the swift movement of the animals in water.
4. Respiration by gills making use of gases dissolved in water.
5. Presence of air-bladders filled with air for buoyancy.
6. Presence of lateral-line system. They function as rheoreceptors which is helpful in echolocating objects in water.
7. Integuments rich in mucous glands are protected by scales.
8. Maintain water and ionic balance in its body with excretory structures.

Adaptations of terrestrial animals

1. Earthworms, land Planarians secrete a mucus coating to maintain a moist situation for burrowing, coiling, respiration, etc.,
2. Arthropods have an external covering over the respiratory surfaces and well-developed tracheal systems.
3. In vertebrate skin, there are many cellular layers besides the well protected respiratory surfaces that help in preventing loss of water
4. Some animals obtain their water requirement from food as partial replacement of water lost through excretion.
5. Birds make nests and breed before the rainy season as there is availability of abundant food. But during drought birds rarely reproduce.
6. Camels are able to regulate water effectively for evaporative cooling through the skin and respiratory system and excrete highly concentrated urine, and can also withstand dehydration up to 25% of their body weight.

Table 10.1 Indices of density

S.No.	Indices of Density	Keys
1	Population density	It is usually expressed as the number of individuals per unit area or volume. Eg.100 trees per acre
2	Crude density	It is the size of a population in relation to the numbers per unit of total space. Eg.1000 fish in a pond.
3	Ecological density	It is the size of a population in relation to the numbers per unit of habitat space. (Available area or volume that can be colonized by a population). Eg. 1000 fish in the volume of water in the pond.
4	Relative abundance	These are time relative indices which can show the changes in number (increase and decrease) with respect to time. Number of birds of a species spotted per hour in an unit area over a specified time.

Population Dispersion

- Populations have a tendency to disperse or spread out in all directions, until some barriers are reached. This is observed by the migration of individuals into (Immigration) or out (Emigration) of the population area.

Migration

- Migration is a peculiar and unique kind of mass population movement from one place to another and back. To avoid the severe winter cold, Siberian cranes migrate from Siberia to Vedanthangal in Tamil Nadu and return back in spring. Some fishes are known to migrate from sea to fresh water (anadromous migration, Salmon) and some from fresh water to sea (catadromous migration, Eel).

Emigration

- Under natural conditions, emigration usually occurs when there is overcrowding. This is regarded as an adaptive behavior that regulates the population in a particular site and prevents over exploitation of the habitat. Further, it leads to occupation of new areas elsewhere.

Immigration

- It leads to a rise in population levels. If the population increases beyond the carrying capacity, it can result in increased mortality among the immigrants or decreased reproductive capacity of the individuals.

Population Age Distribution

The proportion of the age groups (pre- reproductive, reproductive and post reproductive) in a population is its age distribution attribute. This determines the reproductive status of the population at the given time and is an indicator of the future population size.

Usually a rapidly growing population will have larger proportion of young individuals. A stable population will have an even distribution of various age classes. A declining population tends to have a larger proportion of older individuals

Table 10.3 Analysis of two species population interactions

SN. NO.	TYPES OF INTERATION	SPECIES 1	SPECIES 2	GENERAL NATUE OF INTERACTION	EXAMPLES
1	Amensalism	–	0	The most powerful animal or large organisms inhibits the growth of other lower organisms	Cat and Rat
2	Mutualism	+	+	Interaction favorable to both and obligatory	Between crocodile and bird
3	Commensalism	+	0	Population 1, the commensal benefits, while 2 the host is not affected	Sucker fish on shark
4	Competition	–	–	Direct inhibition of each species by the other	Birds compete with squirrels for nuts and seeds.
5	Parasitism	+	–	Population 1, the parasite, generally smaller than 2, the host	*Ascaris* and tapeworm in human digestive tract.
6	Predation	+	–	Population 1, the predator, generally larger than 2, the prey	Lion predatory on deer

CHAPTER 11.

Biodiversity and its conservation

Concept of biodiversity

- The term biodiversity was introduced by Walter Rosen (1986). Biodiversity is the assemblage of different life forms. Each species is adapted to live in its specific environments.
- The changes in climatic conditions are reflected in the distribution and pattern of biodiversity on our planet.
- The number of species per unit area declines as we move from tropics towards the poles. The Tundra and Taiga of northern Canada, Alaska, northern Europe and Russia possess less than 12 species of trees.
- The temperate forests of the United states have 20-35 species of trees, while the tropical forests of Panama have over 110 species of trees in a relatively small area.

Levels of biodiversity

- Edward Wilson popularized the term 'Biodiversity' to describe diversity at all levels of biological organization from populations to biomes. There are three levels of biodiversity – Genetic diversity, Species diversity and Community/Ecosystem diversity
- **Genetic diversity** refers to the differences in genetic make-up (number and types of genes) between distinct species and to the genetic variation within a single species; also covers genetic variation between distinct populations of the same species.
- Genetic diversity can be measured using a variety of molecular techniques. India has more than 50,000 genetic variants of Paddy and 1000 variants of Mango.
- Variation of genes of a species increases with diversity in size and habitat. It results in the Alpha diversity: It is measured by counting the number of taxa (usually species) within a particular area, community or ecosystem.
- ii. Beta diversity: It is species diversity between two adjacent ecosystems and is obtaining by comparing the number of species unique to each of the ecosystem.

iii. Gamma diversity refers to the diversity of the habitats over the total landscape or geographical area.

The reasons for the richness of biodiversity in the Tropics are:

- Warm tropical regions between the tropic of Cancer and Capricorn on either side of equator possess congenial habitats for living organisms.
- Environmental conditions of the tropics are favourable not only for speciation but also for supporting both variety and number of organisms.
- The temperatures vary between 25° C to 35° C, a range in which most metabolic activities of living organisms occur with ease and efficiency.
- The average rainfall is often more than 200 mm per year.

Climate, seasons, temperature, humidity, photoperiods are more or less stable and encourage both variety and numbers.

Rich resource and nutrient availability.

- Tundra and the Polar ice caps. This variety (Biodiversity) is essential for the wellbeing of our planet and sustenance of life as a whole. The importance of biodiversity can be viewed and measured as

Ecosystem services b) Biological resources c) Social benefits of biodiversity

- The organization and functioning of ecosystems world over is effected and dependent on biodiversity and its richness. The major functional attributes are:
- continuity of nutrient cycles or biogeochemical cycles (N_2, C, H_2O, P, S cycles)

- soil formation, conditioning or maintenance of soil health (fertility) by soil microbial diversity along with the different trophic members
- increases ecosystem productivity and provide food resources
- act as water traps, filters, water flow regulators and water purifiers (forest cover and vegetation)
- climate stability (forests are essential for rainfall, temperature regulation, CO_2 absorption, which in turn regulate the density and type of vegetation)
- forest resource management and sustainable development
- maintaining balance between biotic components
- cleaning up of pollutants – microbes are the biggest degraders of molecules including many anthropogenic ones which are present in effluents, sewage, garbage and agro-chemicals
- ecological stability – the varieties and richness of species contribute to ecological stability and survival of species. Biodiverse regions are reservoirs of biological resources like food resources, gene pool, genetic resource, medicinal resources, bio-prospecting

- **Importance of biodiversity – Global and India**

- Biodiversity is the variety of life on earth. That is, it is the number of different species of flora and fauna including microorganisms.
- These organisms can inhabit different ecosystems with varying conditions like the Rainforests, Coral reefs, Grasslands, Deserts,
- to provide unique aesthetic value and hot spots for Ecotourism. Along with forest resources and wildlife it has commercial significance an indicator of the health of the ecosystem. Endemism is a crucial indicator of richness

Biogeographical regions of **India**

As per the international 'biome' type of classification based upon climate, fauna and flora and the soil conditions, India can be divided into ten different biogeographic zones, **(Fig.11.3)**namely:

1. **Trans Himalayan Region:** An extension of the Tibetan plateau, high-altitude cold desert in Ladakh (J&K) and Lauhala Spiti (H.P) comprising 5.7% of the country's landmass. The mountains of this region have the richest wild sheep and goat community in the world, renowned for its quality wool and wool products. Other fauna include Chiru and Black-rocked Crane.

2. **Himalayas:** The entire mountain chain running from north-western to north-eastern India, comprising a diverse range of biotic provinces and biomes and covers 7.2% of the country's landmass. The common fauna of the Himalayan ranges, are the wild sheep, mountain goats, shrew, snow leopard and panda, many of which are endangered.

3. 3. **Indian Desert:** The extremely arid area west of the Aravalli hill range, comprising both the salty desert of Gujarat and the sand desert of Rajasthan. It comprises 6.9% of the country's land-mass. Wild ass is endemic to this region. It is also the habitat for the Indian Bustard, camel, foxes and snakes, many of which are endangered.

4. 4. **Semi – Arid Zones:** This zone is between the desert and the Deccan plateau, including the Aravalli hill range covering 15.6% of the country's landmass. Fauna found here are nilghai, blackbuck, four horned antelopes, sambar, chital and spotted deer which are herbivores along with predators like Asiatic lion, tiger, leopard and jackal.

5. 5. **Western Ghats:** Western Ghats, are mountain ranges along the west coast of India, extending over almost 1,500km from Sat Pena in south Gujarat to the southernmost tip of Kerala. The annual rainfall is about 2000 mm. This zone has large populations of Nilgiri tahr (State animal of Tamil Nadu), Nilgiri Langur, tiger, leopard, and Indian elephant.The grizzled squirrel and lion tailed macaque are endemic to this region.

6. 6. **Deccan Peninsula:** This covers much of the southern and south-central plateau with a predominantly deciduous vegetation and 4.3% of the country's landmass. It is known for deciduous forests, thorn forests and pockets of semi ever green forests. Fauna found here are Chital, Sambhar, Nilghai, elephant, sloth

7. **Coastal Region:** Coastal region of India with sandy beaches, mud flats, coral reefs, mangroves constitutes 2.5% of the total geographical area. The coastline from Gujarat to Sundarbans is estimated to be

5423km long. Apart from this a total of 25 islets constitute the Lakshadweep, which are of coral origin and have a typical reef lagoon system, rich in biodiversity. The fauna includes native crabs, turtles and tunas

8. 10. **Andaman and Nicobar Islands:**The Andaman and Nicobar Islands in the Bay of Bengal have highly diverse set of biomes, constituting 0.3% of the total geographical area. They are centers of high endemism and contain some of India's finest evergreen forests and support a wide diversity of corals. Fauna includes Narcondam hornbills of the Andamans and the South Andaman Krait.

Causes of biodiversity loss

- The major causes for biodiversity decline are:
- Habitat loss, fragmentation and destruction (affects about 73% of all species)
- Pollution and pollutants (smog, pesticides, herbicides, oil slicks, GHGs)
- Climate change
- Introduction of alien/exotic species
- Over exploitation of resources (poaching, indiscriminate cutting of trees, over fishing, hunting, mining)
- Intensive agriculture and aquacultural practices
- Hybridization between native and non-native species and loss of native species
- Natural disasters (Tsunami, forest fire, earth quake, volcanoes)
- Industrialization, Urbanization, infrastructure development, Transport – Road and Shipping activity, communication towers, dam construction, unregulated tourism and monoculture are common area of specific threats
- Co-extinction

Extinction:

Natural extinction is a slow process of replacement of existing species with better adapted species due to changes in environmental conditions, evolutionary changes, predators and diseases. A small population can get extinct sooner than the large population due to inbreeding depression (less adaptivity and variation).

ii. Mass extinction: The earth has experienced quite a few mass extinctions due to environmental catastrophes. A mass extinction occurred about 225 million years ago during the Permian, where 90% of shallow water marine invertebrates disappeared.

iii. Anthropogenic extinctions These are abetted by human activities like hunting, habitat destruction, over exploitation,

urbanization and industrialization. Some examples of extinctions are Dodo of Mauritius and Steller's sea cow of Russia. Amphibians seem to be at higher risk of extinction because of habitat destruction.

Red Data Book

- Red Data book or Red list is a catalogue of taxa facing risk of extinction. IUCN – International Union of Conservation of Nature and Natural Resources, which is renamed as WCU – World Conservation Union (Morges Switzerland) maintains the Red Data book. The concept of Red list was mooted in 1963.
- The purpose of preparation of Red List are:
- To create awareness on the degree of threat to biodiversity
- Identification and documentation of species at high risk of extinction
- Provide global index on declining biodiversity
- Preparing conservation priorities and help in conservation of action
- Information on international agreements on conservation of biological diversity

Red list has eight categories of species i) Extinct ii) Extinct in wild iii) Critically Endangered iv) Endangered v) Vulnerable vi) Lower risk vii) Data deficiency viii) Not evaluated.

IUCN

- The International Union for Conservation of Nature (IUCN) is an organization working in the field of nature conservation and sustainable use of natural resources
- General strategies in conservation
- identify and protect all threatened species
- identify and conserve in protected areas the wild relatives of all the economically important organisms
- identify and protect critical habitats for feeding, breeding, nursing, resting of each species
- resting, feeding and breeding places of the organisms should be identified and protected
- Air, water and soil should be conserved on priority basis
- Wildlife Protection Act should be implemented
- There are two aspects of conservation strategies

***In-situ* conservation**

- **ii) *Ex-situ* conservation**

Act (WPA) 1972 (Table 11.1).

Table 11.1 National Parks in Tamil Nadu

National Parks in Tamil Nadu	Year of establishment	District(s)
Guindy NP	1976	Chennai
Gulf of Mannar Marine NP	1980	Ramanathpuram and Tuticorin
Indira Gandhi (Annamalai) NP	1989	Coimbatore
Mudumalai NP	1990	Nilgiris
Mukurthi NP	1990	Nilgiris

Table 11.2 Wild life sanctuaries in Tamil Nadu

Prominent WLS in Tamil Nadu	Year of establishment	Districts
Vedanthangal Lake Birds WLS	1936	Chengalpet
Mudumalai WLS	1942	Nilgiris
Point Calimere WLS	1967	Nagapattinam
Indira Gandhi (Annamalai) WLS	1976	Coimbatore
Mundanthurai WLS	1977	Tirunelveli

➢

Gene Banks:]Gene banks are a type of biorepository which preserve genetic materials. Seeds of different genetic strains of commercially important plants can be stored in long periods in seed banks, gametes of threatened species can be preserved in viable and fertile condition for long periods using cryopreservation techniques.

- However, it is not economically feasible to conserve all biological wealth and all the ecosystems. The number of species required to be saved from extinction far exceeds the conservati

Table 11.3 Difference between *Insitu* and *Exsitu* Conservation

Insitu Conservation	*Exsitu* Conservation
It is the on-site conservation or the conservation of genetic resources in natural populations of plant or animal species.	This is a conservation strategy which involves placing of threatened animals and plants in special care locations for their protection.
It is the process of protecting an endangered plant or animal species in its natural habitat, either by protecting or restoring the habitat itself, or by defending the species from predators.	It helps in recovering populations or preventing their extinction under simulated conditions that closely resemble their natural habitats.
National Parks, Biosphere Reserve, Wild Life Sanctuaries form *insitu* conservation strategies.	Zoological parks and Botanical gardens are common *exsitu* conservation programs.

on efforts.

12. Environmental Issues

- **Classification of Pollutants**
- **In terms of eco-system, pollutants can be classified into two basic groups – Non-degradable and degradable.** Based on the time taken to breakdown into their ingredients, degradable pollutants are classified as rapidly degradable (non-persistent) and slowly degradable (persistent).
- **Rapidly degradable or non-persistent pollutants:** These can be broken down by natural processes. Domestic sewage and vegetable waste are examples of such pollutants.
- **Slowly degradable or persistent pollutants:** These are pollutants that remain in the environment for many years in an unchanged condition and take decades or longer to degrade, as in the case of DDT.
- **Non-degradable pollutants**: These cannot be degraded by natural processes. Once they are released into the environment, they are difficult to be eliminated and continue to accumulate (biomagnification). Toxic elements like lead, mercury, cadmium, chromium and nickel are such common pollutants.

Effects of Air Pollution

- Affects all organisms as they depend on the atmosphere for respiration.
- Causes irritation in the throat, nose, lungs and eyes. It causes breathing problems and aggravates existing health conditions such as emphysema and asthma.
- Contaminated air reduces the body's defense mechanism and decreases the body's capacity to fight other infections in the respiratory system.
- Frequent exposure to polluted air increases the risk of cardiovascular diseases. Breathing air that is filled with fine particulate matter can induce hardening of the arteries, triggering cardiac arrhythmia or even a heart attack.
- People who exercise outdoors can sometimes be susceptible to adverse effects of air pollution because it involves deeper and faster breathing. Hence it is advisable to walk or jog in the mornings in places with ample tree cover.
- Gas leaks can be lethal or affect the quality of air in the affected area.
- CO in the atmosphere interferes with O_2 transport since haemoglopin has greater affinity for carbon monoxide. At low concentration it causes headache and blurred vision. In higher concentration, it can lead to coma and death.

Control of Air Pollution

- Certain measures help to remove pollutants, reduce their presence or prevent their entry into the atmosphere.
- Trees are the best remedy for urban particulate and gaseous pollution
- Forests act as carbon sinks and lungs of the planet
- Catalytic converters in vehicles help to reduce polluting gases drastically
- Diesel exhaust filters in automobiles cuts particulates
- Electrostatic precipitators reduce release of industrial pollutants.
- Cost effective air pollution treatment systems like indoor plants and high performance biofilters can improve indoor air quality.

Other notable effects of Air Pollution

- **Peroxyacetyl nitrate** (PAN) is a secondary pollutant present in photochemical smog. It is thermally unstable and decomposes into peroxyethanol radicals and nitrogen dioxide gas causing eye irritation

- **Global warming**: Increase in the concentrations of greenhouse gases such as CO_2, methane, nitrous oxide, CFCs, and ozone causes greenhouse effect, warming of the earth, resulting in sea level rise, submerging of islands and sea shores of various parts of the world.
- **Ozone depletion**: Thinning of the stratospheric ozone layer is known as ozone depletion. Such depletion causes the 'ozone hole', resulting in poor screening of the harmful UV rays and increase in incidences of skin cancer. Some of the common agents that deplete ozone are CFCs.
- **Acid rain**: Acid rain is a form of precipitation that contains acidic components, such as sulfuric acid or nitric acid. It damages trees, crops and harms marine animals (coral reefs) and induces corrosion.

Legal Protection

- The **Air** (Prevention and Control of Pollution) **Act** was enacted in 1981 and amended in 1987 for the prevention, control and abatement of Air pollution in India.
- Traffic Emissions Standards: The Government has decided to enforce Bharat Stage VI norms from 2020.
- The Green Bench and the National Green Tribunal (NGT) give judicial safeguard to environmental protection.
- Steps taken by the Central and the State governments in India:
- Road traffic rationing, encourage public transport, carpooling.
- Increase green cover alongside roads (planting avenue trees).
- Promoting Swachh Bharat Abhiyan
- Enactment and Enforcement of stricter environmental laws
- Maintenance of air standards by proper enforcement and monitoring
- Reducing carbon emissions
- Encourage use of renewable energy
- Limiting the sale of firecrackers and developing eco-friendly crackers
- Make Environmental Impact Assessment mandatory.

Effect of Water pollution on Ecosystems

- **Destruction of ecosystems:** Ecosystems, especially aquatic systems, can be severely affected or destroyed by water pollution.Water pollutants affect existing niches and habitats and the survival of organisms.
- Soil fertility is affected and the system becomes uninhabitable.
- **Disruption of food-chains:** Water pollution disrupts the natural food chains as well as food webs. Pollutants such as lead and cadmium are taken up by primary consumers where they can be lethal or get stored. Later, when these animals are consumed by secondary consumers, the food chain can get disrupted at any trophic level or result in enhanced concentration of these pollutants (biomagnification). Hot water from industries when released into the water bodies affects aquatic density and diversity

Effect of Water pollution on Organisms

- 1. Water pollution can be lethal to aquatic organisms and others that depend on these water bodies.
- Accidental oil spills from tanker ships can cause substantial environmental damage. Oil
- spreads on the water surface, prevents the entry of light and oxygen into the water.
- This increases BOD and COD, resulting in mass death of organisms and degradation of water quality. It also clogs fish gills and the feathers of aquatic birds.

2. Humans and other organisms can get affected by diseases such as hepatitis and typhoid by consuming contaminated water and food.
3. Excess of fluoride in drinking water causes fluorosis. In many poor nations, outbreak of water borne diseases and epidemics are a result of contaminated water and poor or absence of water treatment processes.

- 3. Water pollution can cause eutrophication due to nutrient enrichment. This causes algal blooms which affect the quality of water bodies. Red tides, if occur, can be lethal to aquatic organisms.

Control Measures

1. Right to clean water is a fundamental right under the Indian Constitution
1. Water (Prevention and Control of Pollution) Act, 1974, sections 17 to 40 prohibit the pollution of a stream or well by disposal of polluting matter.
2. The Central/State Pollution Control Boards have the power to advise the central/state government on various matters concerned with the prevention and control of pollution of water.
3. The Ministry of Environment, Forest and Climate Change (MoEFCC) is the nodal agency of the Central Government for the planning, promotion, co-ordination and for overseeing the implementation of India's environmental and forestry policies and programmes.

Prevention

Effect of Noise Pollution

- According to the USEPA (United States Environmental Protection Agency) there are direct links between noise and health. Heart disease, high blood pressure, stress related illness, sleep disruption, hearing loss (deafness), and productivity loss are the problems related to noise pollution.Increased stress and tension, nervousness, irritability, anxiety, depression and panic attacks.
  Peptic ulcer, severe head ache, memory loss.
- ate or control of pollutant(s) discharge at the point of generation.
- Wastewater can be pretreated by scientific methods before discharge to municipal treatment sources.
- Setting up of Sewage Treatment Plants (STP) and Effluent Treatment Plants (ETP).
- Regulate or restrict the use of synthetic fertilisers and pesticides.
- Public awareness and people's involvement is essential.
  Marine animals are affected by noise pollution from offshore activities and port activities.
  Fire crackers frighten animals. Birds are often affected by increased air traffic.

Control

- Planting trees in and around noise sources is an effective solution for noise pollution as plants are known to absorb noise and bring down sound levels.
- Regular servicing and tuning of automobile engines can effectively reduce noise pollution by vehicles and machinery.
- Workers should be provided with ear plugs and earmuffs at work sites that generate high noise levels.
- Lubrication of machinery and regular servicing minimizes noise levels.
- Regulations should be imposed to restrict the usage of loudspeakers in crowded areas and public places.

Agrochemicals

Chemicals which are used in agriculture for growth of plants and pest control are called agrochemicals or agrichemicals.

- Overuse of agrochemicals have been observed to generate residues that cause nutrient imbalance, and May kill beneficial bacteria and soil organisms.
- Can cause eutrophication in water bodies.
- Affect aquatic animals and their productivity.
- Pesticide containing water, even in trace quantities is unfit for human consumption.
- Particles (aerosols) and residues of these chemicals cause air pollution.
- Inhalation of contaminated air can cause respiratory problems.
- Consumption can lead to poisoning, side effects and after effects.
- Chemicals can cause skin rashes and irritation of eyes.
- Many of these chemicals are reported to be carcinogenic.
- They can trigger hormonal disorders and neurotoxicity.
- Beneficial insects and animals can be affected

Biomagnification

- Food chains are components of all ecosystems. Producers and consumers form trophic levels in a chain through which energy flow is carried out by the process of eating and being eaten.
- Usage, storage and transformation of food and biomolecules by metabolism are a normal process. Degradation or breakdown is an essential part of any food chain and hence all naturally occurring substances are degradable

Integrated Wastewater Management

Wastewater Treatment

- Wastewater or sewage originates from domestic waste waters, industrial wastes and
- animal wastes. Realizing the importance of clean potable water, the Government passed the Water (Prevention and Control of Pollution) Act in 1974, which made it mandatory to treat wastewater in treatment plants. The treatment can be carried out by three ways:
- Physical methods
- Chemical methods
- Biological methods

Physical methods of wastewater treatment

- Wastewaters containing insoluble substances or colloids are treated through processes such as flotation, sedimentation, filtration and centrifugal separation.

Chemical methods of Wastewater treatment

- Chemical methods of wastewater treatment include:
- Generation of insoluble solids.
- Produce an insoluble gas.
- Produce biologically degradable substances from a non-biodegradable substance.
- Oxidize or reduce to produce a non-objectionable substance.

Biological methods of Wastewater treatment

- (1) Bioremediation of wastewater includes the aerobic treatment (oxidation ponds, aeration lagoons) and anaerobic treatment (anaerobic bioreactors, anaerobic lagoons).

Table 12.1 Major sources of solid waste

Waste category	Source
Residential	Food wastes, plastics, paper, glass, leather, cardboard, metals, yard wastes, ashes, tires, batteries, old mattresses
Industrial	Packaging wastes, ashes, chemicals, cans, plastics, metal parts
Commercial	Thin and thick plastics, food wastes, metals, paper, glass, wood, cardboard materials
Institutional	Wood, paper, metals, cardboard materials, electronics
Construction and Demolition	Steel materials, concrete, wood, plastics, rubber, copper wires, dirt and glass.
Agriculture	Agricultural wastes, spoiled food, pesticide containers
Biomedical	Syringes, bandages, used gloves, catheter, urine bags, drugs, paper, plastics, food wastes, sanitary napkins and diapers, chemicals.
E-waste	Electronic items like used TVs, transistors, tape recorders, computer cabinets, mother boards, CDs, cassettes, mouse, wires, cords, switches., chargers.

Methods of disposal of radioactive wastes are

1. Limit generation - Limiting the generation of waste is the first and most important consideration in managing radioactive wastes.

2. Dilute and disperse - For wastes having low radioactivity, dilution and dispersion are adopted.
3. Delay and decay - Delay and decay is frequently an important strategy because much of the radioactivity in nuclear reactors and accelerators is very short lived.
4. Concentrate and confine process - Concentrating and containing is the
5. objective of treatment activities for longer-lived radioactivity. The waste is contained in corrosion resistant containers and transported to disposal sites. Leaching of heavy metals and radionuclides from these sites is a problem of growing concern.

Control and Management

- Three ways are employed to manage nuclear wastes
- **Spent Fuel Pools** - The spent fuel discharged from the reactors is temporarily stored in the reactor pool. The Spent fuel rods are used in stored cooling ponds. They protect the surroundings from radiation and absorb the heat generated during radioactive decay.
- **Vitrification method** – This prevents reaction or degradation of nuclear waste for extended periods of time and encased in dry cement caskets.
- **Geological Repositories -** A deep geological repository is a nuclear waste repository excavated deep within a stable geologic environment. It is suited to provide a high level of long-term isolation and containment without future maintenance. In India at Tarapur and Kalpakkam, a wet storage facility of Spent Fuel is the main mode of storage.

----------ALL THE BEST----------