केन्द्रीय विद्यालय संगठन
KENDRIYA VIDYALAYA SANGATHAN

शिक्षा एवं प्रशिक्षण का आंचलिक संस्थान, चंडीगढ़
ZONAL INSTITUTE OF EDUCATION AND TRAINING, CHANDIGARH

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निदेशक महोदय का संदेश

विद्यार्थियों की शैक्षिक प्रगति को ध्यान में रखते हुए उपयोगी अध्ययन सामग्री उपलब्ध कराना हमारा महत्त्वपूर्ण उद्देश्य है। इससे न केवल उन्हें अपने लक्ष्य को प्राप्त करने में सरलता एवं सुविधा होगी बल्कि वे अपने आंतरिक गुणों एवं अभिरुचियों को पहचानने में सक्षम होंगे। बोर्ड परीक्षा में अधिकतम अंक प्राप्त करना हर एक विद्यार्थी का सपना होता है। इस संबंध में तीन प्रमुख आधार स्तंभों को एक कड़ी के रूप में देखा जाना चाहिए- अवधारणात्मक स्पष्टता, प्रासंगिक परिचितता एवं आनुप्रयोगिक विशेषज्ञता।

राष्ट्रीय शिक्षा नीति 2020 के उद्देश्यों की मूलभूत बातों को गौर करने पर यह तथ्य स्पष्ट है कि विद्यार्थियों की सोच को सकारात्मक दिशा देने के लिए उन्हें तकनीकी आधारित समेकित शिक्षा के समान अवसर उपलब्ध कराया जाए। बोर्ड की परीक्षाओं के तनाव और दबाव को कम करने के उद्देश्य को प्रमुखता देना अति आवश्यक है।

यह सर्वमान्य है कि छात्र-छात्राओं का भविष्य उनके द्वारा वर्तमान कक्षा में किए गए प्रदर्शन पर ही निर्भर करता है। इस तथ्य को समझते हुए यह अध्ययन सामग्री तैयार की गई है। उम्मीद है कि प्रस्तुत अध्ययन सामग्री के माध्यम से वे अपनी विषय संबंधी जानकारी को समृद्ध करने में अवश्य सफल होंगे।

शुभकामनाओं सहित।

मुकेश कुमार
उपायुक्त एवं निदेशक

INDEX

MARKS WEIGHTAGE FOR SESSION 2022-23

CLASS XII

BIOLOGY (044)

Time: 03 Hours **Max. Marks: 70**

Unit	**Title**	**Marks**
Unit-VI	**Reproduction**	16
	Chapter 2: Sexual Reproduction in Flowering Plants Chapter-3: Human Reproduction Chapter 4: Reproductive Health	
Unit-VII	**Genetics and Evolution**	20
	Chapter-5: Principles of Inheritance and Variation Chapter-6: Molecular Basis of Inheritance Chapter-7: Evolution	
Unit-VIII	**Biology in Human Welfare**	12
	Chapter-8: Human Health and Disease Chapter-10: Microbes in Human Welfare	
Unit-IX	Biotechnology	12
	Chapter-11: Biotechnology : Principles and Processes Chapter-12: Biotechnology and its Applications	
Unit-X	Ecology	10
	Chapter-13: Organisms and Populations Chapter-14: Ecosystem Chapter-15: Biodiversity and Conservation Chapter-16: Environmental Issues	
	Total marks	**70**

Detail syllabus (https://cbseacademic.nic.in/curriculum_2023.html)

Unit-VI Reproduction

Chapter-2: Sexual Reproduction in Flowering Plants Flower

structure; development of male and female gametophytes; pollination - types, agencies and examples; out breeding devices; pollen-pistil interaction; double fertilization; post fertilization events - development of endosperm and embryo, development of seed and formation of fruit; special modes- apomixis, parthenocarpy, polyembryony; Significance of seed dispersal and fruit formation.

Chapter-3: Human Reproduction

Male and female reproductive systems; microscopic anatomy of testis and ovary; gametogenesis - spermatogenesis and oogenesis; menstrual cycle; fertilization, embryo development up to blastocyst formation, implantation; pregnancy and placenta formation (elementary idea); parturition (elementary idea); lactation (elementary idea).

Chapter-4: Reproductive Health

Need for reproductive health and prevention of Sexually Transmitted Diseases (STDs); birth control - need and methods, contraception and medical termination of pregnancy (MTP); amniocentesis; infertility and assisted reproductive technologies - IVF, ZIFT, GIFT (elementary idea for general awareness).

Unit-VII Genetics and Evolution

Chapter-5: Principles of Inheritance and Variation

Heredity and variation: Mendelian inheritance; deviations from Mendelism – incomplete dominance, co-dominance, multiple alleles and inheritance of blood groups, pleiotropy; elementary idea of polygenic inheritance; chromosome theory of inheritance; chromosomes and genes; Sex determination - in humans, birds and honey bee; linkage and crossing over; sex linked inheritance - **haemophilia, colour** blindness; Mendelian disorders in humans - thalassemia; chromosomal disorders in humans; Down's syndrome, Turner's and Klinefelter's syndromes.

Chapter-6: Molecular Basis of Inheritance

Search for genetic material and DNA as genetic material; Structure of DNA and RNA; DNA packaging; DNA replication; Central Dogma; transcription, genetic code, translation; gene expression and regulation - lac operon; Genome, Human and rice genome projects; DNA fingerprinting.

Chapter-7: Evolution

Origin of life; biological evolution and evidences for biological evolution (paleontology, comparative anatomy, embryology and molecular evidences); Darwin's contribution, modern synthetic theory of evolution; mechanism of evolution - variation (mutation and recombination) and natural selection with

examples, types of natural selection; Gene flow and genetic drift; Hardy - Weinberg's principle; adaptive radiation; human evolution.

Unit-VIII Biology and Human Welfare

Chapter-8 Human Health and Diseases

Pathogens; parasites causing human diseases (malaria, dengue, chikungunya, filariasis, ascariasis, typhoid, pneumonia, common cold, amoebiasis, ring worm and their control; Basic concepts of immunology - vaccines; cancer, HIV and AIDS; Adolescence - drug and alcohol abuse.

Chapter-10: Microbes in Human Welfare

Microbes in food processing, industrial production, sewage treatment, energy generation, microbes as bio-control agents and bio-fertilizers. Antibiotics; production and judicious use.

Unit-IX Biotechnology and its Applications

Chapter-11: Biotechnology

Principles and Processes Genetic Engineering (Recombinant DNA Technology).

Chapter-12: Biotechnology and its Applications

Application of biotechnology in health and agriculture: Human insulin and vaccine production, stem cell technology, gene therapy; genetically modified organisms - Bt crops; transgenic animals; biosafety issues, bio piracy and patents.

Unit-X Ecology and Environment

Chapter-13: Organisms and Populations

Population interactions- mutualism, competition, predation, parasitism; population attributes - growth, birth rate and death rate, age distribution. (Topics excluded: Organism and its Environment, Major Abiotic Factors, Responses to Abiotic Factors, Adaptations)

Chapter-14: Ecosystem

Ecosystems: Patterns, components; productivity and decomposition; energy flow; pyramids of number, biomass, and energy (Topics excluded: Ecological Succession and Nutrient Cycles)

Chapter-15: Biodiversity and its Conservation

Biodiversity-Concept, patterns, importance; loss of biodiversity; biodiversity conservation; hotspots, endangered organisms, extinction, Red Data Book, Sacred Groves, biosphere reserves, national parks, wildlife, sanctuaries and Ramsar sites.

CHAPTER -2
SEXUAL REPRODUCTION IN FLOWERING PLANTS

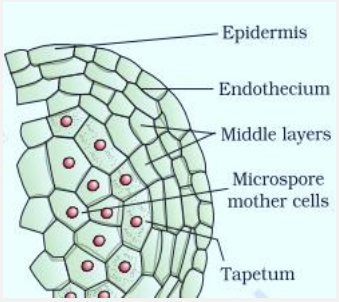
Key words

Flower	Reproductive part of plant
Stamen	Pollen-producing reproductive organ of a flower.
Dithecous	Two theca in each lobe in anther
Pollen sac	The microsporangium in which pollen is produced
Tapetum	Innermost layer of microsporangium nourishes the developing pollen grains.
Sporogenous tissue	Compactly arranged homogenous cells in the center of microsporangia, undergo meiosis (Microsporogenesis) to form tetrads of microspores
Microspore	Male gamete/ pollen grain
Sporopollenin	Present in outermost layer of pollen grain, highly resistant protein
Germ pore	Apertures in pollen grain, facilitate exchange of gases and water, help in emerging of pollen tube
Autogamy	When pollination occur in between same flower of same plants
Egg apparatus	Consists of synergids and filliform apparatus, help in entry of pollen tube into embryo sac
Synergid	Present in embryo sac, two in number
Filliform apparatus	Present in synergids , guider pollen tube entry into embryo sac
Megaspore	Four megaspore are formed after meiotic division MMC
Monosporic Development	Out of four megaspore develops into embryo sac
Geitnogamy	Transfer of pollen grains from the anther to the stigma of another flower of the same plant
Xenogamy	Transfer of pollen grains from anther to the stigma of a different plant
Triple fusion	Male gamete fuses with two polar nuclei to form triploid endosperm
Embryogeny	Formation of embryo
Cotyledons	the embryonic leaf in seed-bearing plants
Scutellum	Cotyledons of monocotyledon plants
Dormancy	State of inactiveness
Parthenocarpy	Development of fruit without fertilization ex- banana , orange
Polyembryony	Occurrence of more than one embryo in seed Ex- lemon

Pre-fertilization events

- It takes place in flower before fertilization. It involves gametogenesis and gamete transfer.
- Gametogenesis: Development of male & female reproductive structures, Formation of male & female gametes
- Gamete transfer- Bringing together male & female gamete

Male reproductive structure- Stamen



- Stamens consists of – Filament, Stalk and Anther .
- Anther- it is Bilobed, Dithecous structure, each lobe has 2 pollen sacs/ microsporangia
- Microsporangia produce micro spores (pollen). Microsporangia have four layers Epidermis, Endothecium, Middle layers and Tapetum.
- Tapetum provides nourishment to the pollen grains.

Microsporogenesis (formation of microspore)

- Sporogenous cells in microsporangium differentiate to form Meiocytes.
- Meiocytes undergo meiosis and form microspore tetrad (4 haploid microspores).
- Each microspores matures in to Pollen grains (male gametophyte)

Pollen grains

- Pollen grain is composed of two layers inner Intine and outer Exine. Exine is composed of sporopollenin n, one of the most resistant organic materials.
- Intine is composed of cellulose & pectin

Female reproductive structure (Carpel)

- Carpel has stigma, style and ovary
- Ovary encloses ovules (mega sporangium) in it.
- Ovule consists of Funicle, Hilum, Integuments, Micropyle, Chalaza, Nucellus and embryo sac.
- Embryo sac is 7 celled and 8 nucleate structure-
  7 cell- 3 antipodal cell + 2 synergids + egg + central cell
  8 nucleate- 3 antipodal cell + 2 synergids + egg + 2 polar nuclei

Megasporogenesis (formation of megaspore)

- Inside ovule Megaspore Mother Cell (MMC) is formed. MMC undergo meiosis 4 haploid megaspores are formed (Megaspore tetrad).
- Only one of megaspores develops into female gametophyte. This is known as Monosporic development.

POLLINATION

Autogamy	Transfer of pollen grains from anther to stigma of the same flower
Geitonogamy	Transfer of pollen grains from anther to stigma of another flower of same plant
Xenogamy	Transfer of pollen grains from anther to stigma of a different plant

Adaptation in pollination

- Adaptation in flower for pollination Wind pollination- pollen grains are light and non-sticky, often possess well-exposed stamens, large often-feathery stigma, often have a single ovule in each ovary and numerous flowers packed into an inflorescence.
- Water pollination- Pollen grains are long, ribbon like, protected from wetting by a mucilaginous covering.
- Insect pollination- Flowers are large, colourful, fragrant and rich in nectar. When the flowers are small, a number of flowers are clustered into an inflorescence to make them conspicuous.

FERTILIZATION (Fusion of male and female gametes)

- After pollination the male gametes enter into the cytoplasm of synergids through the micropylar end of ovule and fuses with egg to form zygote. This is known as Syngamy.
- Another male gamete fuses with two polar nuclei and pen (Primary endosperm nucleus) . The process is known as triple fusion.
- Both Syngamy and triple fusion together known as double fertilization.

POST FERTILIZATION EVENT

- PEC matures into Endosperm
- Zygote develops in Embryo
- Seed develops from ovule
- Ovary develops into fruit

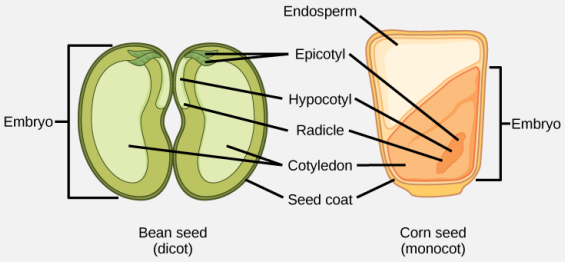
Endospermic seeds or Albuminous seeds	Seeds which have endosperm	wheat, rice
Non-endospermic seeds or Non-albuminous seeds	Seeds which lack endosperm at maturity	pea, bean

EMBRYO

- Zygote develops in embryo.
- Zygote undergoes mitosis division to form 2- cell stage, 8-cell stage, Globular, Heart shaped stage, Torpedo stage and finally the mature embryo.

Structure of a dicotyledonous embryo

Embryonal axis	Main axis of the embryo which divides it into different regions
Cotyledons	Helps in Food storage and Provide nourishment
Epicotyl	Part of embryonal axis above the cotyledons
Hypocotyl	Part of embryonal axis below the cotyledons
Plumule an radicle	Stem tip and root tip respectively
Root cap	Covering of root tip



Structure of monocot embryo

Embryonal axis	Main axis of the embryo which divides it into different regions
Cotyledons/ Scutellum	Helps in Food storage and Provide nourishment
Coleorrhiza	Sheath enclosing radicle & root cap
Coleoptile	Sheath enclosing plumule

OUT BREEDING DEVICES

Continued self-pollination results in inbreeding depression. Plants develop devices to discourage self-pollination/ autogamy.

- Pollen release and stigma receptivity are not synchronized.
- Stigma and anther position in same flower are such in way that they can't come in contact.
- Self - incompatibility
- Production of unisexual flower.

ARTIFICIAL HYBRIDIZATION

- Emasculation- removal of anther before attaining maturity
- Bagging- bagging of emasculated flower with paper bag
- Dusting- removal of bag and dusting with desire pollen on stigma
- Advantage- to prevent self -pollination and inbreeding depression

POLLEN PISTIL INTERACTION

- Compatibility- Pollen of the same species as the stigma)
- Self-incompatible - Pollen of the wrong type, either from other species or from the same plant
- The pistil has the ability to recognize Compatible or Incompatible pollen.
- If the pollen is of the wrong type, the pistil rejects the pollen by preventing pollen germination on the stigma or the pollen tube growth in the style.
- In some plants, pollen grains are shed at two-celled condition (a vegetative cell and a generative cell). In such plants, the generative cell divides and forms the two male gametes during the growth of pollen tube in the stigma.
- In plants which shed pollen in the three-celled condition, pollen tubes carry the two male gametes from the beginning.

SEED

- Ovule matures in to seed.
- Seed consists of -Seed coat, Radicle give rise root), Plumule (give rise shoot) cotyledons (for storage of for and nourishment).
- Seeds may be Dicotyledonous (2 cotyledons) and Monocotyledonous (1 cotyledon)

Importance of seeds

Protect embryo, provide nourishment to young seedlings, undergo dormancy to overcome stressed situation

APOMIXIS

- Formation of seed without fertilization is known as apomixis.
- Diploid nucellar cells divide and enter inside embryo sac and later develop into embryos.

- Sometimes, the egg cell is diploid due to the failure of meiosis. Such diploid egg cell later directly develops into an embryo.

Polyembryony- occurrence of many embryos in othe vule. E.g. Citrus, mango etc.

IMPORTANT QUESTIONS

Very Short Answer Type Questions

1. **How many thecas are present in bilobed anther?**
   Ans: four
2. **In a bilobed anther one locule contains 100 pollen mother cells. Calculate the amount of pollen tetrad that plant will form.**
   Ans: 100 x 4 = 400
3. **Compare the role of Tapetum and Sporogenous tissues in male flower.**
   Ans: Tapetum: provide nourishment to developing pollen
   Sporogenous tissue: divide to form pollen grains.
4. **Exine is not in continuous fashion. Write its advantage.**
   Ans: Form germ pore. Germ pore is site for gaseous exchange and pollen tube emergence
5. **How many male gametes are present in 3- celled stage pollen grains?**
   Ans: 2
6. **Mention one method by which pollen grains can be preserved.**
   Ans: cryopreservation
7. **What is Monosporic development of embryo sac?**
   Ans: only one megaspore is functional and develops into the female gametophyte or the embryo sac
8. **Embryo sacs are 7 celled and 8 nucleate. Explain.**
   Ans: Cells – 3 antipodal + 2 synergids + 1 egg cell+ 1 central cell
   Nucleus: 3 antipodal + 2 synergids + 1 egg cell+ 2 Polar nuclei
9. **What is role of egg apparatus?**
   Ans: Egg: fuses with male gamete to form zygote
   Synergids: to guide the entry of pollen tube and release of male gamete
10. **Give an account of the significance of double fertilization?**
    Ans: formation of embryo
    Formation of endosperm cell

Short Answer Type Questions

1- **Why geitnogamy do is considered as genetically autogamy?**
Ans: in this is the transfer of pollen to stigma takes place from another flower of the same plant.

2- **Write the pollination pattern in the – Vallisnaria, Hydrilla, Zostera, water lily.**
Ans: Valisnaria, Hydrilla, Zoostera- water pollination
Water lily- Insect pollination or wind pollination

3- **Briefly explain the floral reward provided by yucca plant.**
Ans: providing safe place to lay eggs, provide nector

4- **How does self-incompatibility restrict autogamy?**
Ans: Self-incompatibility is a genetic mechanism that prevents self-pollination. This is done by inhibiting pollen germination or pollen tube growth in the pistil.

5- **What is advantage of emasculation and bagging ion artificial hybridization?**
Ans: Emasculation is removal of anther before attaining maturity
Bagging is covering of emasculated flower by paper.
The advantage of both is that self-pollination can't occur i.e. prevention from inbreeding depression.

6- **Write name of different layers of anther. Mention role of any one of these**.
Ans: epidermis, endothecium, middle layer, and Tapetum.
Tapetum provides nourishment to developing pollen.

7- **If ploidy on egg is "n", what will be ploidy of endosperm of same plant? Why endosperm is supposed as nutritive tissue?**
Ans: ploidy of egg – haploid – n
Ploidy of endosperm- triploid- 3n
Endosperm provides nutrition to the developing embryo therefor supposed as nutritive tissue.

8- **What is the fate of floral parts after fertilization?**
Ans: After fertilization the petals, stamens, style and stigma degenerates. Calyx sometimes degenerates or remains intact in dried form. Ovary becomes fruit and ovules become seeds. Ovary wall becomes pericarp of the fruit.

9- **Describe double fertilization in flowering plants. Also mention the products of double fertilization.**
Ans: Syngamy: One male gamete fuses with egg to form zygote which later develops into embryo.
Triple fusion: other male gamete fuses with two polar nuclei to form triploid endosperm.

10- **Differentiate between parthenocarpy and parthenogenesis. Give one example of each?**
Answer: Parthenocarpy- Development of fruit without fertilization
Parthenogenesis- development of new individual without fertilization. E.g. Turkey birds, few lizards

Long Answer Types Questions

1- **Compare adaptation in flowers showing different pollination pattern.**
Ans:
Wind pollination - The flowers are small, inconspicuous, colourless, odourless and nectarless, Pollen grains are light, small, powdery and produced in large numbers, The stigmas are large, sometimes feathery and branched adapted to catch the pollens.
Insect pollination- The flowers are showy, brightly coloured and scented, The flowers produce nectar or edible pollen

Water pollination: Flowers are light, small and inconspicuous; Pollen grains are light, protected by mucilage covering, Stigma long and sticky.

2- Give importance of out breeding devices. How can be it achieved?

Ans: Outbreeding devices refers to plants' processes or mechanisms to avoid self-pollination and encourage cross pollination.

It can be achieved by

i- Unisexual flower- in this only cross-pollination is possible.

ii- Non-Synchronization in release of pollen and stigma receptivity and vice versa.

iii- Position of anther and stigma- anther and stigma are placed at different positions so that the pollen cannot come in contact with the stigma of the same flower

iv- Self-incompatibility: This is a genetic mechanism and prevents self-pollen from fertilizing the ovules by inhibiting pollen germination or pollen tube growth in the pistil.

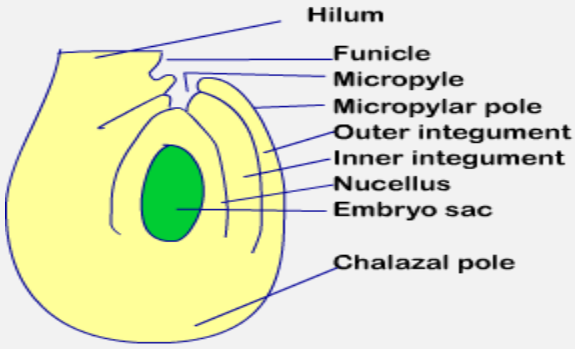
3- Does apomixis require fertilization and pollination? Write any two ways by which apomictic seeds may be developed in angiosperms?

Ans: No

i- the nucellar cells surrounding the embryo sac start dividing, protrude into the em diploid egg cell is formed without reduction division and develops into

ii- the embryo without fertilization embryo sac and develop into the embryos

4- With a neat labeled diagram, describe the parts of a typical angiosperm ovule?



Structure of Ovule

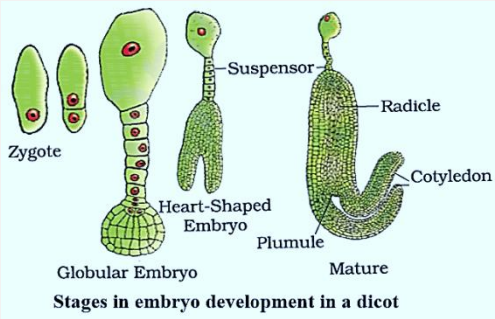
5- **Explain the development of embryo in a dicotyledonous plant with neatly labeled diagrams.**

Ans:

The embryo develops at the micropylar end where the zygote is located.

The zygote starts developing only after certain amount of endosperm is formed to assure nutrition to the embryo.

The zygote divides mitotically to form various stages including pro- embryo, globular, heart shaped and finally the mature embryo.



Stages in embryo development in a dicot

UNIT VI – REPRODUCTION
CHAPTER -HUMAN REPRODUCTION

Key Words

Scrotum	It is pouch like structure outside the abdominal cavity in which the testes is situated. It helps in maintaining the low temperature of the testes (2–2.5° C lower than the normal internal body temperature) necessary for spermatogenesis.
Somniferous tubule	In each testicular lobule 1- 3 highly coiled seminiferous tubules in which sperms are produced.
Male germ cell	Present in seminiferous tubule. These undergo meiotic division to form sperms.
Sertoli cells	Sertoli cells provide nutrition to the male germ cells.
Leydig cell	Present in interstitial space (regions outside the seminiferous tubules). It secrete testicular hormones called androgens
Urethral meatus	It is external opening of penis.
Seminal plasma	Secretion of the male accessory glands (seminal vesicles, prostate and bulbourethral gland) constitute the seminal plasma.
Male accessory glands	Paired seminal vesicles, a prostate and paired bulbourethral glands
Endometrium	Inner lining of uterine wall. Undergo cyclic changes during menstrual cycle.
Lactiferous duct	Through which milk is sucked out.
Spermatogonia	Immature diploid male germ cells (Spermatogonia) produce sperms by spermatogenesis. These are present on the inside wall of seminiferous tubule.
Spermatogenesis	Formation of sperm
Acrosome	Cap like structure on sperm head. it is with enzymes that help fertilization of the ovum.
Semen	The seminal plasma along with the sperms constitutes the semen.
Oogonia	Gamete mother cells (oogonia) are formed within each fetal ovary which later develops into egg.
Antrum	Fluid filled cavity in Graafian follicle.
Graafian follicle	Mature follicle formed during oogenesis. When it own ruptures releases the secondary oocyte (ovum) and reaming part forms carpus luteum.
Zona pellucida	Membrane on secondary oocyte, prevent polyspermy
Menstrual cycle	In human females, menstruation is repeated at an average interval of about 28/29 days, and this cyclic events is called the menstrual cycle
Carpus luteum	After ovulation remaining parts of the Graafian follicle transform in corpus luteum. It secretes progesterone hormone, which is essential for maintenance of the endometrium.
Polar body	It is a small haploid cell that is formed during oogenesis. It doesn't have the ability to be fertilized.
Cleavage	The mitotic division in zygote is called cleavage.
Trophoblast	Outer layer of blastocyst get attached to endometrium to form chorionic villi and placenta.
Implantation	Blastocyst embedded in the endometrium of the uterus. This is called implantation.
Placenta	The chorionic villi and uterine tissue become interdigitated with each other and jointly form a structural and functional unit called placenta
Chorionic villi	After implantation, finger-like projections appear on the trophoblast called chorionic villi which are surrounded by the uterine tissue and maternal blood.
Stem cell	Inner cell mass contains certain cells called stem cells which have the potency to give rise to all the tissues and organs.

IMPORTANT DIFFERENCES

SPERMATOGENESIS AND OOGENESIS	
SPERMATOGENESIS	**OOGENESIS**
Formation of spermatozoa	Formation of ovum
PRIMARY OOCYTE AND SECONDARY OOCYTE	
PRIMARY OOCYTE	**SECONDARY OOCYTE**
Oogonia that divide enter into Meiotic prophase-I and arrest at that stage are called primary oocytes (Diploid)	Formed from the primary oocyte after meiosis I (haploid)
MENARCH AND MENOPAUSE	
MENARCH	**MENOPAUSE**
Start of menstrual cycle	menstrual cycles ceases around 50 years of age; that is termed as menopause
BLASTOMERE AND BLASTOCYST	
BLASTOMERE	**BLASTOCYST**
After cleavage zygote divides in to 2, 4,8,16 celled stage. These cells are called Blastomere.	Blastomere form Morula and Morula develops into blastocyst. It consists of an outer cell layer called the Trophoblast and the inner cell mass
PARTURITION AND LACTATION	
PARTURITION	**LACTATION**
Process of child birth	The mammary glands start producing milk towards the end of pregnancy by the process of lactation.
OXYTOCIN AND RELAXIN	
OXYTOCIN	**RELAXIN**
Help in strong uterine contraction during child birth.	it relaxes the ligaments in the pelvis and softens and widens the cervix and thus help in parturition.
TROPHOBLAST AND INNER CELLMASS	
TROPHOBLAST	**INNER CELLMASS**
Outer layer of blastocyst which get attached with endometrium.	Inner cell mass gets differentiated as the embryo

IMPORTANT PROCESS

SPERMATOGENESIS	Process of sperm formation
OOGENESIS	Process of ovum formation
MENSTRUAL CYCLE	Cyclic event takes place in the endometrium of the uterus.
FERTILIZATION	Fusion of male and female gamete
IMPLANTATION	Implantation is the process in which the mammalian embryo (blastocyst) becomes attached to the endometrium of the uterus.
FETUS EJECTION REFLEX	Mild uterine contractions generated by placenta when the foetus is fully developed, at the time of parturition.

SPERMATOGENESIS

- Site- seminiferous tubule of testes
- Male germ cells (Spermatogonia) divide mitotically to form a large number of Spermatogonia.
- Spermatogonia undergo meiotic division to form primary spermatocyte, then secondary spermatocytes, and finally four spermatids.

Hormonal control of spermatogenesis

- Gonadotropin-releasing hormone (GnRH) from the hypothalamus stimulates the anterior pituitary to secrete luteinizing hormone (LH), follicle-stimulating hormone (FSH).
- LH acts at the Leydig cells and stimulates the secretion of androgens. Androgens help in spermatogenesis.
- FSH acts on the Sertoli cells and secrete two factors- androgen binding protein (ABP) and inhibin which helps in spermatogenesis.

OOGENESIS

- Site – ovary
- Some of the germinal epithelial cells divide by mitosis to produce a large number Oogonia.
- Oogonia multiply by mitosis and form primary oocytes.
- **Primary oocyte** surrounded by a layer of granulosa cells and called primary follicle.
- The primary follicles convert into secondary follicles and then into tertiary follicle which is characterized by a fluid filled cavity called Antrum.
- **The primary oocyte** within the tertiary follicle grows in size and completes its first meiotic division which is an unequal division and forms a large secondary oocyte and tiny **first polar body**.
- The tertiary follicle changes into the mature follicle or **Graafian follicle**.
- The secondary oocyte forms a new membrane called Zona pellucida
- The Graafian follicle ruptures to release the secondary oocyte by the process called ovulation. The remaining part of Graafian follicles acts as carpus luteum.
- If a sperm can enter the secondary oocyte then secondary oocyte completes meiosis II and thus results in the formation of **second polar body** and an **ovum**.

Hormonal control of Oogenesis

- LH- acts on Graffian follicle and causes ovulation.
- FSH- responsible for follicular development
- Estrogen- proliferation of endometrium layer of uterus
- Progesterone- maintenance of endometrium layer and helps in pregnancy.3

MENSTRUAL CYCLE

Menstrual phase (3-5 days)

- If fertilization not takes place, the endometrial lining of the uterus breaks along with the blood vessels which releases through vagina as menses..

Follicular phase

- In this follicular development takes place.
- Endometrium regenerates through proliferation.

Luteal phase

- Graafian follicle ruptures and form yellow body called Corpus luteum.
- The corpus luteum secretes progesterone hormone which maintains the endometrium of uterus for implantation of the fertilized ovum.

FERTILIZATION

- The fusion of sperm and ovum is called fertilization.
- Site- ampulla-isthmic junction.
- Zona-pellucida layer of the ovum Block the entry of the additional sperms thus only one sperm fertilizes the ovum**.**

IMPLANTATION

- Zygote divides mitotically and moves towards the uterus.
- Zygote forms 2, 4, 8, 16 daughter cells called as Blastomere.
- The embryo with 8 to 16 Blastomere is called a Morula.
- The Morula transforms into blastocyst.
- Blastocyst has outer layer (Trophoblast) and inner cell mass.
- The Trophoblast layer forms placenta and umbilical cord while inner cell mass forms embryo.
- Inner cell mass divide to cover the blastocyst which gets embedded in the endometrium of the uterus and the process is called as implantation.

PREGNANCY AND EMBRYONIC DEVELOPMENT

- After implantation, finger-like projections (chorionic villi) appears on Trophoblast.
- The chorionic villi and uterine tissue jointly form placenta.
- The placenta is connected to the embryo through an umbilical cord.
- Placenta also acts as an endocrine tissue and produces several hormones like human chorionic gonadotropin (hCG), human placental lactogen (hPL), estrogens, progestogens, etc.
- In addition, during pregnancy the levels of other hormones like estrogens, progestogens, cortisol, prolactin, Thyroxine, etc., are increased several folds in the maternal blood.
- Immediately after implantation, the inner cell mass (embryo) differentiates into an ectoderm (outer layer), mesoderm (middle) and endoderm (inner layer). These three layers give rise to all tissues (organs) in adults.

STAGES OF EMBRYO DEVELOPMENT

One month	Heart is formed
Two month	Development of limbs and digits
12 weeks (first trimester)	Most of the major organ systems are formed, for example, the limbs and external Genital organs are well developed.
Fifth month	First movements of the foetus and appearance of hair on the head
After 24 weeks (end of second trimester)	The body is covered with fine hair, eye-lids separate, and eyelashes are formed.
9 month	Foetus is fully developed

PARTURITION

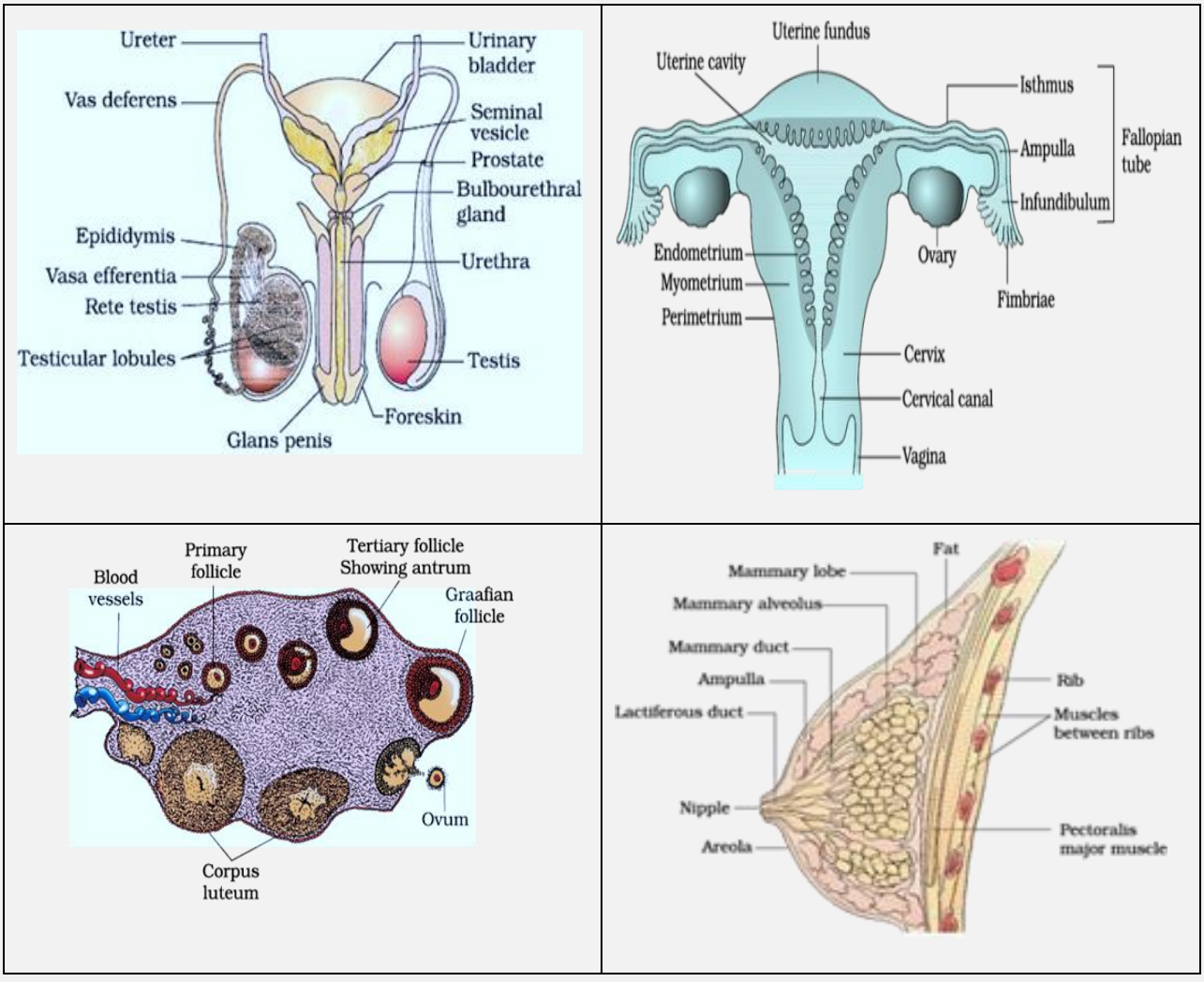
Gestation period: The average duration of human pregnancy (9 months).

Parturition: process of delivery of the foetus.

Parturition is a neuroendocrine mechanism. The signals for parturition originate from the fully developed foetus and placenta which induces mild uterine contractions called **foetal ejection reflex**. Due to this oxytocin hormone is released from the maternal pituitary which causes stronger uterine contractions, which in turn stimulates further secretion of oxytocin. Continuous secretion of oxytocin causes stronger and stronger contractions. This leads to expulsion of the baby out of the uterus through the birth canal – parturition.

LACTATION

- The mammary glands of the female starts producing milk towards the end of pregnancy by the process called lactation.
- The milk produced during the initial few days of lactation is called colostrum which contains several antibodies absolutely essential to develop resistance for the new-born babies.



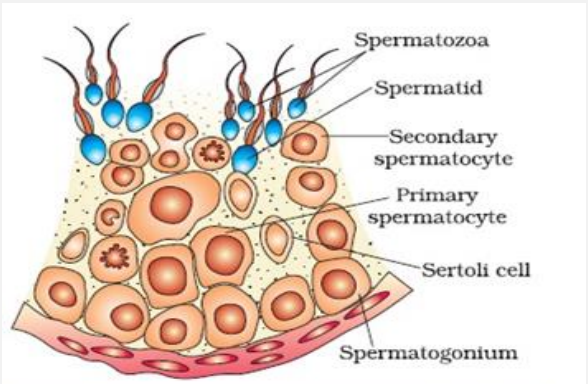
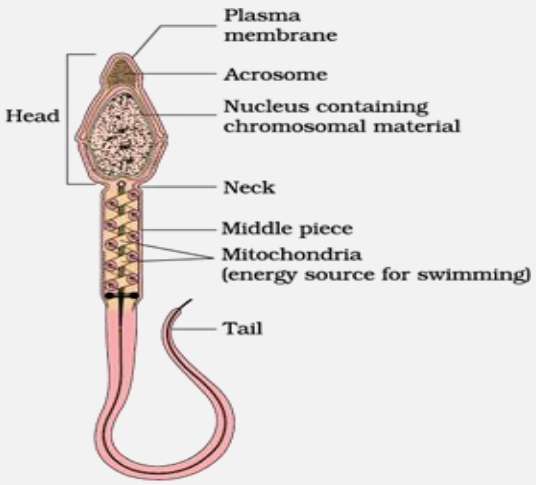


Figure 3.5 Diagrammatic sectional view of a seminiferous tubule (enlarged)



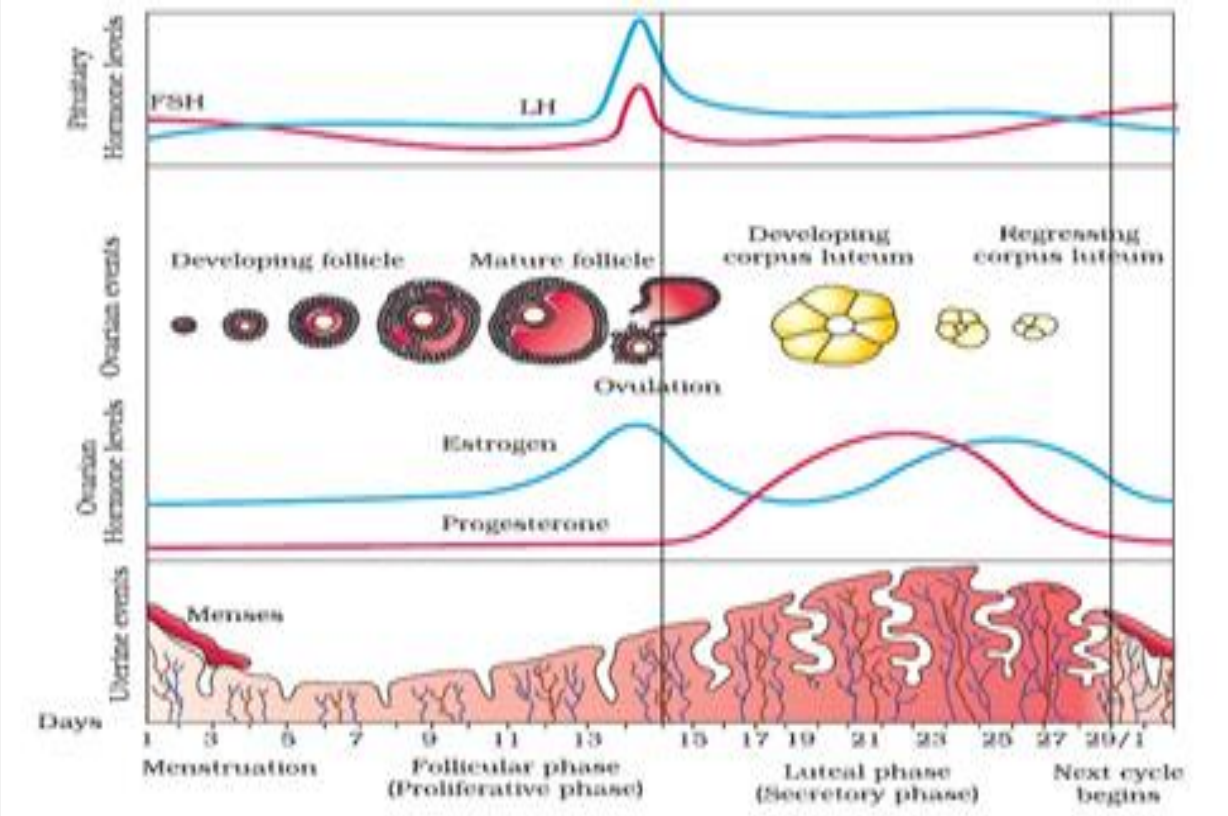
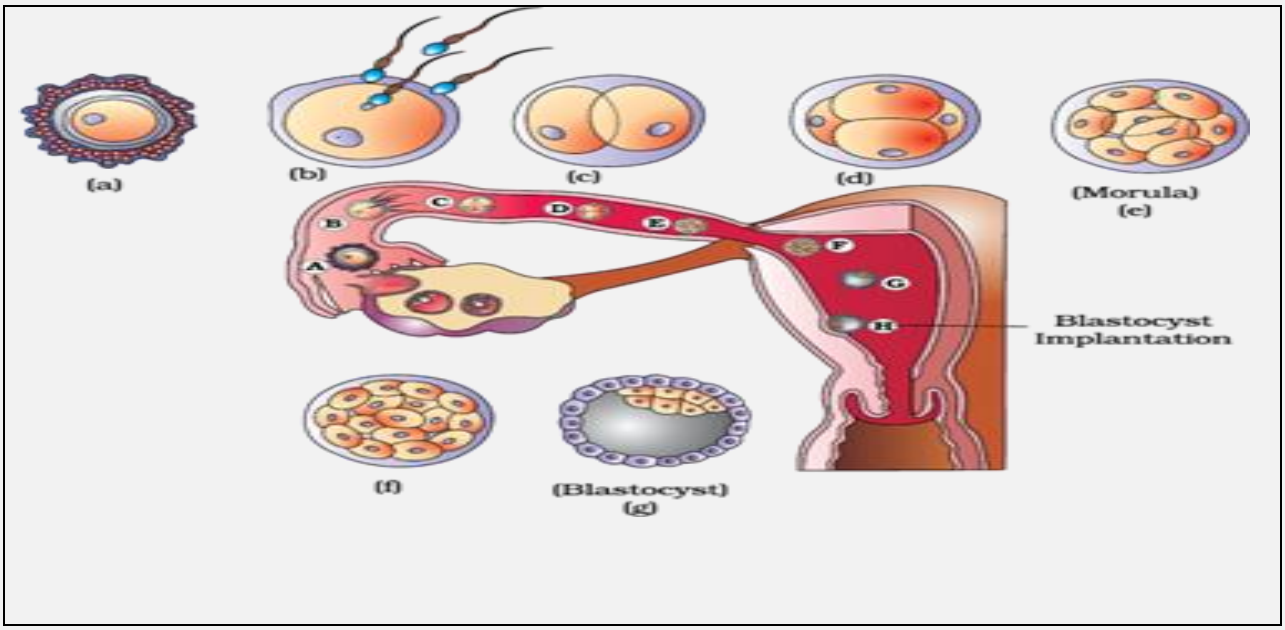
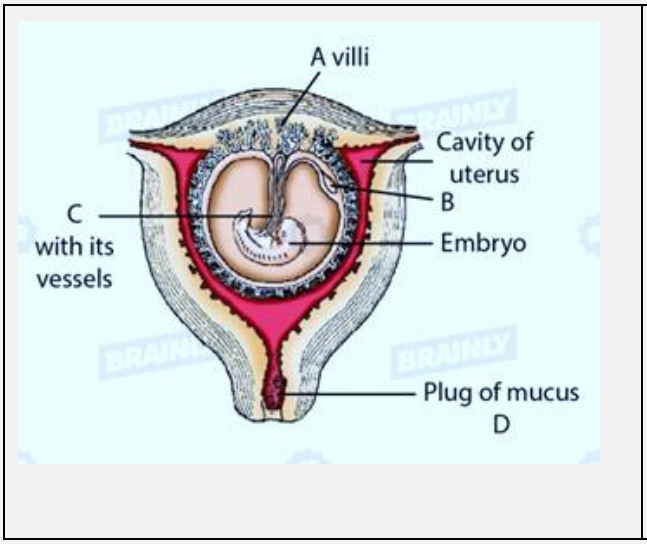
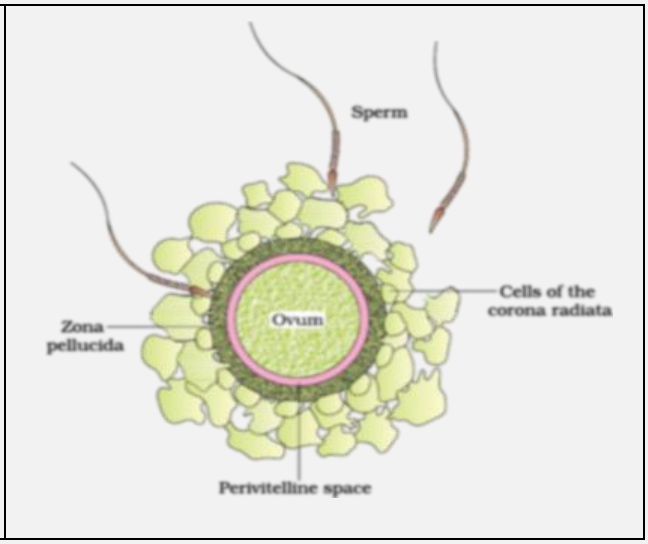


Figure 3.9 Diagrammatic presenation of various events during a menstrual cycle







IMPORTANT QUESTIONS

Very Short Answer Type Questions

1- **What is the significance of LH surge through the menstrual cycle?**
Ans: Luteinizing hormone causes ovulation by rupture of Graafian follicle.

2- **Failure of testes to descend into scrotal sacs leads to sterility. Why?**
Ans: High temperature of abdomen kills the Spermatogonia tissue of the testes, so spermatogenesis (formation of sperm) takes place.

3- **Despite the presence of So many sperms in the vicinity of an egg cell, only one sperm enters the ovum. Why?**
Ans: Because when a sperm comes in contact with ovum (Zona pellucida) & induces changes in membrane to block entry of other sperms

4- **Define spermiogenesis. Where does it occur?**
Ans: The transformation of non-motile spermatids into motile spermatozoa is called spermiogenesis. It occurs inside seminiferous tubules of testes.

5- **Name the cells which produce testosterone. What is the function of this hormone?**
Ans: Interstitial cells (Leydig's cells) of testis secrete the testosterone hormone. Function. They control secondary sexual characters.

6- **The Spermatogonia cell has 46 chromosomes in human male. Give the number of chromosomes in (a) Primary spermatocyte (b) Spermatid**
Ans: (a) Primary spermatocyte – 46 (b) Spermatid- 23

7- **How does colostrum provide initial protection against diseases to new born infants? Give one reason.**
Ans: Colostrum contains immunoglobin which provide immunity to the infants.

8- **Name the embryonic stage which gets implanted in the uterine wall of a human female.**
Ans: blastocyst stage

9- **Name the hormone which causes strong uterine contraction during parturition. Does the parturition signal originate from the mother or the fetus?**
Ans: Hormone - is Oxytocin
The signal originates from the placenta and fully developed fetus.

10- **Where are sperms stored in males?**
Ans: Epidedymis

Short Answer Type Questions

1- **How is a primary oocyte different from a secondary oocyte?**
Ans: The primary oocyte is a diploid cell (2n) whereas secondary oocyte is a haploid cell (n). The primary oocyte is formed when oogonia are at the prophase-I of the meiotic division in the foetal ovary whereas secondary oocyte is formed from primary oocyte after meiosis – I division to produce ova in females during the stage of puberty.

2- **Name the muscular and glandular layer of the human uterus. Which one of these layers undergoes cyclic changes during the menstrual cycle? Name the hormone essential for the maintenance of this layer.**
Ans: Muscular layer – Myometrium
Glandular layer – Endometrium.
Endometrium undergoes cyclic changes during the menstrual cycle.
LH hormone maintains the lining of the uterus.

3- **State the fate of the Trophoblast of a human blastocyst at the time of implantation and that of the inner cell mass immediately after implantation.**
Ans: The Trophoblast layer of the human blastocyst gets attached to the endometrium and the inner cell mass gets differentiated into an embryo. After attachment, the uterine cells divide rapidly and cover the blastocyst. As a result, the blastocyst becomes embedded in the endometrium of the uterus. It is termed Implantation.

4- **Where are fimbriae present in human female reproductive system? Give their function.**
Ans: Fimbriae are fingerlike projections present at the end of the fallopian tubes.

Through fimbriae eggs move from the ovaries to the uterus.

5- **Name the muscular and glandular layer of the human uterus. Which one of these layers undergoes cyclic changes during the menstrual cycle? Name the hormone essential for the maintenance of this layer.**

Ans: Muscular layer – Myometrium

Glandular layer – Endometrium.

Endometrium undergoes cyclic changes during the menstrual cycle.

Progesterone hormone maintains the lining of the uterus.

6- **What are the functions of placenta other than its endocrine function?**

Ans: The placenta helps in the supply of nutrients and oxygen to the embryo.

Placenta also helps in elimination of excretory wastes and carbon dioxide produced by the embryo.

7- **What is corpus luteum? How does it function as endocrine gland?**

Ans. During LH surge the Graafian follicle ruptures to release secondary oocyte. The remaining part of Graafian follicle forms corpus luteum. Corpus luteum functions as endocrine glands as they secrete progesterone.

8- **Differentiate between Sertoli cells and Leydig cells with reference to their location in the organ**

and their function.

Ans: Sertoli cells are the nutritive cells present inside seminiferous tubules. They provide nourishment to the male germ cells.

Leydig cells are present outside the seminiferous tubules in the interstitial spaces, they secrete androgens.

9- **Draw a sectional view of seminiferous tubule of human female and label any four parts.**

Ans: fig 3.4, page 47, NCERT

10- **What are the various male accessory glands? Give their function.**

Ans. The male accessory glands include paired seminal vesicles, a prostate gland and paired bulbourethral glands.

These glands secrete seminal plasma rich in fructose, calcium and certain enzymes. Secretions of bulbourethral glands help in lubrication of the penis.

Long Answer Type Questions

1- **Explain the organization of the mammary gland with the help of a diagram**.

Ans: Mammary gland occurs in pair. It contains glandular tissues which are organized into 15-20 mammary lobes in each breast. Mammary lobes possess alveolar cells. These cells secrete milk. The alveoli open into the mammary tubules which combine to form the mammary duct. Mammary ducts join to form a mammary ampulla that is connected to the lactiferous ducts. Through these structures, milk is sucked.

Fig- 3.4, page 46, NCERT

2- **Explain the menstrual cycle in human female by giving suitable diagram.**

Ans: Menstrual cycle has three phases: menstrual, proliferative and secretory.

a) Menstrual Phase (3-5 days)- During the endometrial lining of the uterus is ruptured and is released out from vagina along with blood vessels and mucus.

b) Proliferative or Follicular Phase 9about 11 days): in this phase ovarian follicle is matures into Graffian follicle. The endometrial layer again proliferates. In this phase ovulation occurs.

c) Secretory Phase 9about 12 days)- Corpus Luteum is formed from ruptured Graffian follicle. The endometrium grows and thickens further.

Fig-3.9, page 50, NCERT

3- Explain the changes that take place during maturation of a follicle top Graffian follicle in ovary.

Ans: Oogonia (gamete mother cells) are formed within each fetal ovary. No more Oogonia are formed after birth.

Oogonia enter into the prophase-I stage of meiotic division and form primary oocyte.

The primary oocytes get surrounded by granulosa layers form the primary follicle and then secondary follicles.

The secondary follicle is transformed into a tertiary follicle characterized by antrum (a fluid-filled cavity).

The tertiary follicle matures into the Graafian follicle.

4- **Give schematic representation of spermatogenesis and oogenesis**.

Ans: Fig 3.8, page 49, NCERT

5- Describe the hormonal control of the male reproductive system.

Ans:

i- Hypothalamus: It releases GnRH (gonadotropin-releasing hormones) which stimulate the pituitary glands to secrete gonadotropins.

ii- LH and FSH

iii- Follicle Stimulating Hormone (FSH): It stimulates spermatogenesis in seminiferous tubules of the testis.

iv- LH stimulates testosterone production from the interstitial cells of testes.

v- Sertoli cells secrete androgen binding protein (ABP) which concentrates testosterone in the seminiferous tubules.

CHAPTER- 4
REPRODUCTIVE HEALTH

According to the World Health Organisation (WHO) - reproductive health means a total Well-being in all aspects of reproduction i.e. physical, emotional, behavioral and social.

REPRODUCTIVE HEALTH: PROBLEM AND STRATEGIES

- In India "family planning" plan was initiated in 1951.
- Reproductive and child health care (RCH) program- Creating awareness among the people about various reproduction related aspects and providing facilities and support for building up a reproductively healthy society.
- Important role is played by - Audio-visual, print-media governmental and non-governmental agencies, Parents, teachers and friends.
- Proper education about reproductive organs, adolescence and related changes, safe and
- Hygienic sexual practices, sexually transmitted diseases (STD), AIDS should be encouraged to provide right information to the young generation.
- Education about birth control options of fertile couples, care of pregnant mothers, post-natal care of the mother and child, importance of breast feeding, equal opportunities for the male and the female child should be properly addressed.

Amniocentesis –

- Amniocentesis is a procedure used to take out a small sample of the amniotic fluid for testing of chromosomal abnormalities in developing embryo.
- Misuse- It is also misused to check foetal sex determination based on the chromosomal pattern in the amniotic fluid surrounding the developing embryo.

POPULATION EXPLOSION AND BIRTH CONTROLL

- MMR- Maternal mortality rate (MMR)
- IMR- Infant mortality rate

CONTRACEPTIVE METHODS

Natural methods	work on the principle of avoiding chances of ovum and sperms meeting.
Periodic abstinence	couples avoid or abstain from coitus from day 10 to 17 of the menstrual cycle when ovulation could be expected
Withdrawal or coitus interruptus	Male partner withdraws his penis from the vagina just before ejaculation so as to avoid insemination
Lactational amenorrhea	as long as the mother breast-feeds the child fully, chances of conception are almost nil (up to 6 months)
Barrier methods	Ovum and sperms are prevented from physically meeting with the help of barriers.
Condoms	Made of thin rubber/ latex sheath that are used to cover the penis in the male/ vagina or cervix in the female, just before coitus so that the semen would not enter into the female reproductive tract. Also protect from STDs
Other examples of barrier methods	Diaphragms, cervical caps and vaults.
IUDs	These are inserted by doctors or expert nurses in the uterus through vagina.

	IUDs increase phagocytosis of sperms within the uterus and the Cu ions released suppress sperm motility and the fertilizing capacity of sperms. The hormone releasing IUDs, in addition, make the uterus unsuitable for implantation and the cervix hostile to the sperms.
Non-medicated	Lippes loop
Copper releasing	CuT, Cu7, Multiload 375
Hormone releasing IUDs	Progestasert, LNG-20
Pills	Pills of either progestogens or progestogen–estrogen combinations Pills have to be taken daily for a period of 21 days starting preferably within the first five days of menstrual cycle. After a gap of 7 days (menses) it has to be repeated in the same pattern. Pills inhibit ovulation and implantation, alter the quality of cervical mucus to prevent/ retard entry of sperms. CDRI:- Central drug research institute (Lucknow) It develops Saheli–a new oral contraceptive pill for the females. Saheli –the new oral contraceptive for the females contains a non-steroidal preparation. It is a 'once a week' pill with very few side effects and high contraceptive value.
Injection	Progestogens alone or in combination with estrogen can also be used by females as injections or implants under the skin. Administration of progestogens or progestogen-estrogen combinations or IUDs within 72 hours of coitus have been found to be very effective as emergency contraceptives as they could be used to avoid possible pregnancy due to rape or casual unprotected intercourse.
Surgical methods/ Sterilization	
Vasectomy	in male a small part of the vas deferens is removed or tied up through a small incision on the scrotum
Tubectomy	a small part of the fallopian tube is removed or tied up through a small incision in the abdomen or through vagina.

An ideal contraceptive should be-

- User friendly
- Easily available
- Effective
- Reversible
- No side effects
- No way interferes with sexual desire and sexual act.

MEDICAL TERMINATION OF PREGNANCY (MTP)

- Voluntary termination of pregnancy before full term is called MTP or induced abortion.
- In India, MTP is legalized in 1971 with some strict conditions to avoid its misuse like female foeticide.
- MTP is used to get rides of unwanted pregnancy due to unprotected intercourse or failure of contraceptives used during coitus or rapes.
- It is relatively safe during first trimester or up to 12 weeks of pregnancy.

SEXUALLY TRANSMITTED DISEASES (STDS)

- Diseases or infections which are transmitted through sexual intercourse are collectively called sexually transmitted diseases (STD) or venereal diseases (VD) or reproductive tract infections (RTI).
- Examples- HIV- AIDS, Genital warts, Hepatitis, Gonorrhea, syphilis, genital herpes, chlamydiasis, trichomoniasis etc.
- Some infections like Hepatitis-B and HIV is also transmitted by sharing of injection needles, surgical instruments with infected person, transfusion of blood, or from infected mother to foetus.

One could be free of these infections by following the simple principles given below:

(i) Avoid sex with unknown partners/multiple partners.

(ii) Always use condoms during coitus.

(iii) In case of doubt, one should go to a qualified doctor for early detection and get complete treatment if diagnosed with disease.

INFERTILITY

The couples which are unable to reproduce children in spite of unprotected sexual cohabitation are called infertile.

Reason of infertility

Physical, Congenital, Diseases, Drugs, Immunological, Psychological,

ART (assisted reproductive technologies)- Infertile couples can be assisted to have children through certain special techniques commonly called (ART).

Examples of ARTs-

In vitro fertilization (IVF)/ Test Tube baby	The ovum from wife/donor and sperms from husband/ donor are collected and induced to fertilize in laboratory conditions. The zygote or early embryo (8 blastomeres) could be transferred into fallopian tube called **ZIFT (zygote infra fallopian transfer)** and embryo with more than 8 **Blastomere IUT (intra uterine transfer)** into the uterus to complete the further development
GIFT (gamete intra fallopian transfer)	Transfer of gametes collected from a donor into fallopian tube of another female who do not produce ovum.
Intra cytoplasmic sperm injection (ICSI)	Specialized procedure to form an embryo in laboratory in which sperm is directly injected into ovum.
AI (Artificial insemination)	infertility cases in which male partner is unable to produce healthy sperms are treated by this technique in which semen collected from donor is artificially introduced into vagina or into uterus, IUI (intra uterine insemination) of the female.

IMPORTANT QUESTIONS

Very Short Answer Type Questions

1- **Define reproductive health according to WHO. Which society will be called a reproductively healthy society?**

Ans: According to the World Health Organisation (WHO) - reproductive health means a total Well-being in all aspects of reproduction i.e. physical, emotional, behavioral and social. Reproductively healthy society includes people having physically and functionally healthy reproductive organs. They have normal behavioural and emotional interaction in sex-related matters.

2- **Give the term for prenatal diagnostic technique aimed to know the sex of developing foetus and to detect congenital disorders.**

Ans: Amniocentesis

3- **Which research institute develops contraceptive pill "Saheli"?**

Ans: CDRI (Central Drug Research Institute) located at Lucknow.

4- **Why tubectomy is considered a contraceptive method?**

Ans: In tubectomy, a small part of fallopian tube is cut and tied up to block the entry of sperm, so as to prevent fertilization.

5- **Which methods of contraception are also known as sterilization method?**

Ans: Tubectomy and Vasectomy

6- **Expand ICSI.**

Ans: Intra cytoplasmic sperm injection.

7- **Categorize the following contraceptive methods as natural, IUDs, Barrier or hormonal-**

Lippes loop, lactation amenorrhea, Vault, Saheli

Ans: Lippes loop- IUD, Lactational amenorrhea – Natural, Vault- Barrier, Saheli- Hormonal

8- **Why has the Government imposed a statutory ban on amniocentesis?**

Ans: The Government has banned amniocentesis to check on the incidences of female foeticides.

9- **Name two STDs that can be transmitted through contaminated blood.**

Ans: Hepatitis, HIV-AIDS

10- **How can a possible pregnancy due to rape or casual unprotected intercourse avoided?**

Ans: Administration of progestogens or progestogens-estrogen combinations or IUDs within 72 hours of coitus

Short Answer Types Questions

1- **Removal of gonads cannot be considered as a contraceptive option. Justify.**

Ans: Removal of gonads leads to sterility of individuals therefore it is not considered as a contraceptive option.

2- **What do oral pills contain and how do they act as effective contraceptives.**

Ans: Oral contraceptive or pills are either progestogens or progestogen- estrogen combinations. They function as contraceptives by

(i) Inhibiting ovulation.

(ii) Inhibiting implantation.

(iii) Altering the quality of cervical mucus to prevent or stop the entry of sperms

3- Mention simple principles by which one could be free of STDs?

Ans- i- Avoid sex with unknown partner/ multiple partner.

Ii-Always use barrier method of contraceptive

Iii-Consult doctor in case of any symptom for early detection and treatment

4- Fill the a. b, c, d with appropriate answer in the given table-

Method of Birth Control	Device
1. Barrier	a
2. IUD	b
3. Surgical Technique	c
4. Natural	d

Ans: a- Condom, b- Cu- t, Vasectomy d- Coitus interruptus

5- Mention at least four reason of sterility?

Ans: physical, congenital diseases, drugs, immunological or physiological

6- Expand ZIFT and IUT. How these are different from each other?

Ans: ZIFT (zygote intra fallopian transfer) – it is transfer of the zygote or early embryos (with up to 8 blastomeres) into the fallopian tube.

IUT– intra uterine transfer- in this Embryo with more than 8 blastomeres is transferred into the uterus

7- Mention one positive and one negative application of amniocentesis.

Ans- Positive- helpful in detection of congenital disorder

Negative- used in sex determination and female foeticides

8- An infertile couple is advised to adapt test tube baby programme. Describe two principle procedures adapted to such technologies.

Ans: In-vitro fertilization (IVF): In this process, the fertilization takes place outside the body (test tube baby). The following techniques are included in IVF:

ZIFT - In this sperm from a male donor and ovum from a female donor are fused in the laboratory. The zygote (8 blastomere stage) so formed is transferred into the fallopian tube.

GIFT (Gamete Intrafallopian Transfer)- In GIFT, females who cannot produce ovum, but can provide suitable conditions for the fertilization of ovum, are provided with ovum from a donor.

9- Describe Lactational amenorrhea method of birth control.

Ans: Lactational Amenorrhea is a natural method of contraception. In lactating mother there is complete absence of menstruation and the chances of conceiving are almost negligible.

10- How are non-medicated IUDs different from hormone releasing IUDs? Give examples.

Ans. (a) Non- medicated IUDs - Lippes loop, Copper releasing IUDS (CuT, Multiload 375), these increase phagocytosis of sperms within uterus and release copper ions which suppress sperm motility and fertilizing capacity of sperm.

(b) Hormone releasing IUDs – Progestasert, L**N**G-20 -These makes uterus unsuitable for implantation and the cervix hostile to sperms.

Long Answer Type Questions

1- What is MTP? What is its safety concern and in what cases MTPs are allowed in India.

Ans: MTP is Medical termination of pregnancy or induced abortion.

MTPs are considered relatively safe during the first trimester, i.e., up to 12 weeks of pregnancy. Second trimester abortions are much more risky

Government of India legalized MTP in 1971 with some strict conditions to avoid its misuse. It is to get rid of unwanted

pregnancies either due to casual unprotected intercourse or failure of the contraceptive used during coitus or rapes. MTPs are also essential in cases where pregnancy could be harmful or even fatal to the mother/ foetus or both.

2- Some contraceptive can be taken orally. Give examples of such contraceptives and explain mechanism of their action. In what dose it is advised to take by females?

Ans: Oral contraceptives (pills) contain progestogens or progestogen–estrogen combinations.

Pills have to be taken daily for a period of 21 days starting preferably within the first five days of menstrual cycle. After a gap of 7 days (during which menstruation occurs) it has to be repeated in the same pattern.

They inhibit ovulation and implantation as well as alter the quality of cervical mucus to prevent retard entry of sperms.

Pills have to be taken daily for a period of 21 days starting preferably within the first five days of menstrual cycle. After a gap of 7 days (during which menstruation occurs) it has to be repeated in the same pattern.

Example- Saheli

3- Describe any three types of contraceptive methods widely used by couple to avoid pregnancy.

Ans:

Natural Method	
Periodic abstinence	couples avoid or abstain from coitus from day 10 to 17 of the menstrual cycle when ovulation could be expected
Withdrawal or coitus interruptus	Male partner withdraws his penis from the vagina just before ejaculation so as to avoid insemination
Lactational amenorrhea	as long as the mother breast-feeds the child fully, chances of conception are almost nil (up to 6 months)
IUDs	These are inserted by doctors in the uterus through vagina. IUDs increase phagocytosis of sperms within the uterus and the Cu ions released suppress sperm motility and the fertilizing capacity of sperms. It also make the uterus unsuitable for implantation and the cervix hostile to the sperms.
	Non-medicated -Lippes loop
	Copper releasing - CuT, Cu7, Multiload 375
	Hormone releasing - Progestasert, LNG-20
Injection	Progestogens alone or in combination with estrogen.

4- What are STDs? Give five examples of STDs and also suggest ways to prevent them.

Ans: Diseases or infections which are transmitted through sexual intercourse are collectively called sexually transmitted diseases (STDs).

Examples- HIV-AIDS, Gonorrhoea, syphilis, genital herpes, chlamydiasis, genital warts, trichomoniasis, hepatitis-B.

Ways to prevent-

(i) Avoid sex with unknown partners/multiple partners.

(ii) Always use condoms during coitus.

(iii) In case of doubt, one should go to a qualified doctor for early detection and get complete treatment if diagnosed with disease.

5- Reproductive and Child Healthcare (RCH) programs are currently in operation. One of the major tasks of these programs is to create awareness amongst people about the wide range of reproduction-related aspects. This is important and essential for building a reproductive health society.

"Providing sex education in schools is one of the ways to meet this goal." Give four points in support of your opinion regarding this statement. Also List any two indicators that indicate a reproductively healthy society.

Ans: Sex education is important in schools:

(a) To aware about myths and misconceptions.

(b) For awareness about reproduction.

(c) To aware STDs

(d) Proper guidance about sex abuse, sex-related crimes, etc.

Indicators about a reproductively healthy society-

(a) Low infant mortality rate (IMR)

(b) Low maternal mortality rate (MMR)

CHAPTER – 5
PRINCIPLES OF INHERITANCE AND VARIATION

Key words

Genetics	Study of inheritance, heredity and variation of characters or Study of genes and chromosomes.
Inheritance	Transmission of characters from parents to progeny.
Variation	Difference between offspring and parents
Gene	It is short fragment of DNA that encodes for a certain trait
Allele	An allele is a variant form of a gene
Homozygous	Individuals carrying two identical alleles (RR or rr) are known as homozygous.
Heterozygous	individual organisms bearing different alleles (Rr) are known as heterozygous
Hybrid	An individual produced by the mating of genetically unlike parents
Mendelian factors	Genes
Dominance	It can express in both homozygous and heterozygous condition
Recessive	It can express only in homozygous
F	Filial generation
Test cross	Cross between offspring and recessive parent
Back cross	It is crossing of a hybrid with one of its parents or an individual genetically similar to its parent
Co dominance	Codominance is a heterozygous condition in which both alleles at a gene locus are fully expressed in the phenotype
Incomplete dominance	Both alleles of a gene at a locus are partially expressed, often resulting in an intermediate or different phenotype.
Multiple allelism	occurrence of three or more than three alleles for a particular gene
Linkage	Tendency of closely situated gene to inherit together
Crossing over	It is exchange of genetic material during sexual reproduction
Genotype	Specific combination of alleles for a given gene
Phenotype	An individual's observable traits
Punnet square	Square diagram used to predict the genotypes of a particular cross
Monohybrid	Offspring with one particular character
Dihybrid	Offspring with two different character
Polygenic inheritance	The inheritance of a trait governed by more than one genes
Pleiotropy	In which a single gene has multiple phenotypic expressions
Mutation	A change in the DNA sequence of an organism
Sex-linked disorder	Inherited through sex chromosomes (X or Y chromosomes)
Autosome-linked disorder	It is the pattern of inheritance in which the transmission of traits depends on the genes in the autosome
Chromosomal Disorders	A disorder due to change in the chromosome number
Aneuploidy	Aneuploidy is a type of chromosomal aberration, where there is one extra chromosome or one missing chromosome
Polyploidy	cells of an organism have more than one pair of chromosomes.
Syndrome	A syndrome is a set of medical signs and symptoms which are correlated with each other and often associated with a particular disease or disorder.

Gregor Johann Mendel
Father of genetics
Proposed law of inheritance
Worked on Pea plant (Pisum sativum)

Reason of selection of pea plant by Mendel

- ✓ The pea plant can be easily grown.
- ✓ The flowers of this plant are bisexual.
- ✓ They have a short life period, and produce larger flowers
- ✓ They are naturally self-pollinating but can also be cross-pollinated.
- ✓ Pure line has contrast characters

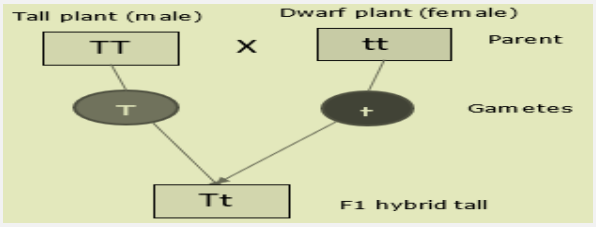
Contrasting characters observed by Mendel

	Charactor	Dominant	Recessive
1.	Stem length	Tall	Dwarf
2.	Flower position	Axialz	Terminal
3.	Pod shape	Inflated	Constricted
4.	Pod colour	Green	Yellow
5.	Seed shape	Round	Wrinkled
6.	Seed colour	Yellow	Green
7.	Flower colour	Violet	White

MENDEL'S PRINCIPLES OR LAWS OF INHERITANCE

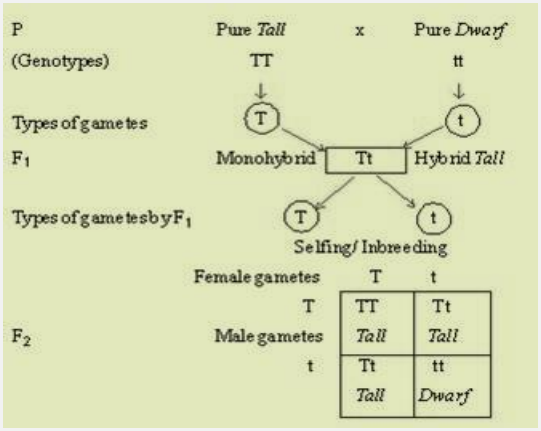
LAW OF DOMINANCE

Each character is controlled by distinct units called factors, which occur in pairs. If both the factors are present in the organism, one act as dominant over the other.



LAW OF SEGREGATION

Law of segregation states that the pair of alleles segregates from each other during meiosis (gamete formation) so that only one factor will be present in each gamete.



LAW OF INDEPENDENT ASSORTMENT

Mendel's law of independent assortment states that the alleles of two (or more) different genes get sorted into gametes independently of one another.

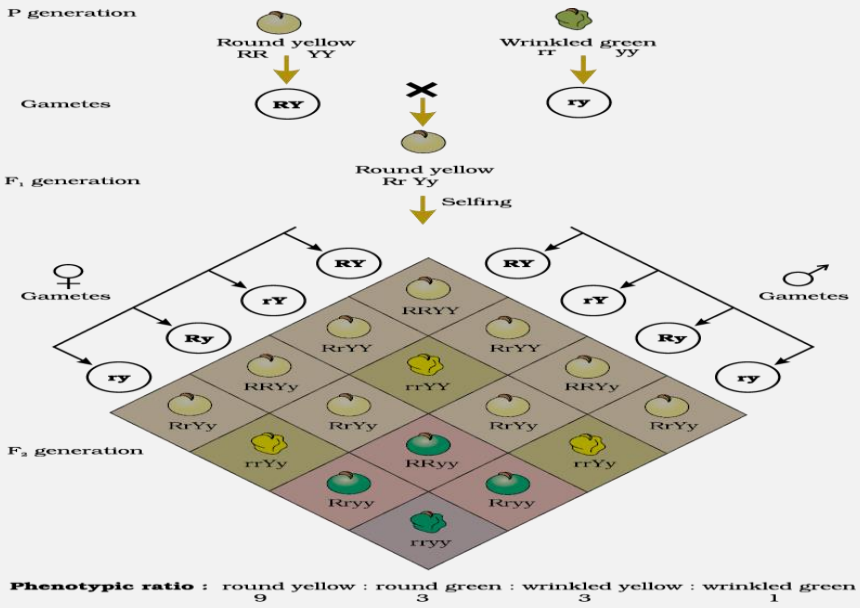
DIHYBRID CROSS

Dihybrid Ratio

Genotype ratio: -9:3:3:1

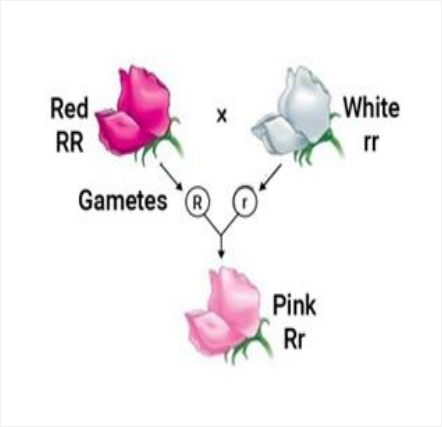
Phenotypic ratio:-

9 Round yellow: 3 Round green: 3 Wrinkled yellow: 1 Wrinkled green



INCOMPLETE DOMINANCE

- When both alleles of a gene at a locus are partially expressed and produce an intermediate phenotype, such phenomenon is called as incomplete dominance.
  Ex. Pink flowers of Snapdragon or Antirrhinum sp.
- When plants with homozygous red flowers (RR) and homozygous white flower (rr) are crossed the F1 offsprings shows pink colour flower (Rr).
- Conclusion: Neither 'R' nor 'r' shows dominance.
- In F2 generation the characters again segregates.



HUMAN BLOOD GROUP SHOWS DOMINANCE, CO DOMINANCE AND MULTIPLE ALLELISM.

DOMINANCE

- Alleles I^A and I^B are dominant over '**I**'

CODOIMINANCE

- It is the inheritance in which both alleles of a gene are expressed in a hybrid.
- Example – Blood group 'AB'
- Blood group AB is controlled by two alleles I^A and I^B.
- When I^A and I^B present together they represent blood group AB.

ABO Blood Type

- **ABO blood type in humans is determined by three alleles:**
  I^A I^B i
- **I^A and I^B are codominant alleles.**
- **Both I^A and I^B are dominant to the allele i.**

Genotype	Blood Type
I^AI^A	A
I^Ai	A
I^BI^B	B
I^Bi	B
I^AI^B	AB
ii	O

Alleles	Blood group	Phenomenon
I^AI^A, I^Ai	A	Dominance
I^BI^B, I^Bi	B	Dominance
I^AI^B	AB	Co-dominance
ii	O	Recessive

MULTIPLE ALLELISM

- When a trait is controlled by multiple alleles it is called multiple allelism. Human blood group is controlled by I^A, I^B and i.

CHROMOSOMAL THEORY OF INHERITANCE

- Proposed by Walter Sutton & Theodore Boveri
- Chromosomes occur in pair
- Genes are located at specific locations on the chromosomes.
- Chromosomes as well as gene both occur in pairs.
- Homologous chromosomes separate during meiosis.
- Fertilization restores chromosome number to diploid condition.
- Chromosomes segregate as well as assort independently.

Thomas Hunt Morgan
Worked on fruit flies Drosophila melanogaster
He proposed linkage theory

Reason of working on Drosophila

- They could be grown on simple synthetic medium in the laboratory
- They complete their life cycle in about two weeks
- Single mating could produce a large number of progeny flies
- Very clear differentiation of male and female

LINKAGE

- Linkage is the physical association of two or more genes on a chromosome.
- Closely situated gens are more linked than distantly situated.
- Linked genes has tendency to inherit together.
- Linkage is responsible for similarity of progenies to their parents.
- He concluded that when two genes were situated closely on the same chromosome (linked genes), the proportion of parental gene combinations was much higher than the non-parental type.
- Tightly linked genes show low recombination. Loosely linked genes show high recombination

RECOMBINATION AND CROSSING OVER

- ✓ Crossing over is the exchange of genetic material between non-sister chromatids of homologous chromosomes during meiosis, which results in new allelic combinations in the daughter cells.

- ✓ Crossing over occurs at the pachytene stage of prophase I of meiosis.
- ✓ The distantly located genes have more tendency of crossing over than closely situated genes.
- ✓ It is the basis of variation in sexually reproducing organism.

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

POLYGENIC INHERITANCE

- Traits of inheritance that are controlled by three or more genes called polygenic traits.
- Example -Human skin colour is controlled by more than two genes.
  AABBCC – this is dominant trait and dark skin colour
  AABBCC- this is recessive and light in light skin colour
- Other examples are height and eye colour in human.

PLEIOTROPY

- In pleiotropy a single gene has multiple phenotypic expressions.
- Example – Phenylketonuria disease is caused by mutation in the gene those codes for the enzyme phenyl alanine hydroxylase (single gene mutation). This causes mental, retardation and a reduction in hair and skin pigmentation

SEX DETERMINATION

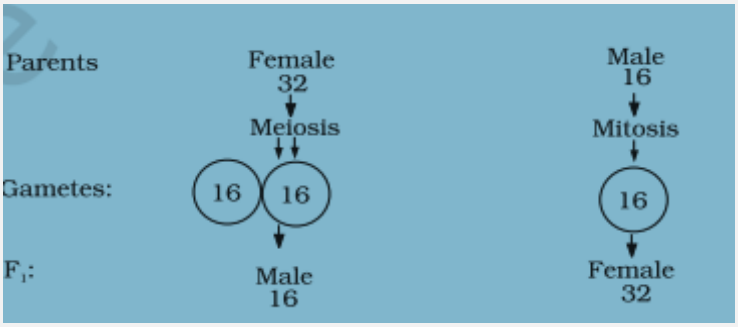
- Allosomes (sex chromosomes) are involved in sex determination.
- Henking (1891) studied spermatogenesis in some insects and observed that 50 % of sperm received a nuclear structure after spermatogenesis, and other 50 % sperm did not receive it. Henking called this structure as the **X body** (now it is called as X-chromosome).

Mechanism of sex determination

XX-XY type	Male is heterogametic (X Y)	Female is homogametic (XX).	Human Drosophila
XX-XO type	male is heterogametic (XO)	female is homogametic, i.e. XX	Grasshopper.
ZZ-ZW type	Male is homogametic (ZZ)	female is heterogametic (Z & W).	Birds.

SEX DETERMINATION IN HONEYBEE

- In honey bees, the male is haploid (n=16) while the female is diploid (2n=32).
- Male (drones) insects are haploid because they develop by parthenogenesis from unfertilized eggs.
- Females (worker bee) grow from fertilized eggs and are hence diploid.



MENDELIAN DISORDER

- Mendelian Disorders can be defined as a type of genetic disorder that arises due to alterations in one gene or as a result of abnormalities in the genome.
- Examples: Colour Blindness, Haemophilia, Thalassemia

COLOUR BLINDNES

- It is a sex-linked recessive disorder.
- In this patient cannot discriminate between red and green colour.
- This defect is due to mutation in certain genes present in the X chromosome.

Condition	Colourblind or not
X^cX^c	Colourblind
X^cY	Colourblind
XX	Normal
XY	Normal
X^cX	Carrier

HAEMOPHILIA

- It is sex linked recessive disease.
- In this disease if cut may cause permanent bleeding due to defect in blood clotting mechanism.
- Queen Victoria shows a number of haemophilic descendent as she was a carrier of the disease

Condition	Haemophilic or not
X^hX^h	Haemophilic
X^hY	Haemophilic
XX	Normal
X^hX	Carrier

THALASSEMIA

- This is an autosome-linked recessive blood disease.
- It results in reduced synthesis of α or β globin chains of haemoglobin and causes anaemia.
- It is a quantitative disorder.
- α Thalassemia - production of α globin chain is affected. It is controlled by two closely linked genes HBA1 and HBA2 on chromosome 16 of each parent.
- β Thalassemia- production of β globin chain is affected. It is controlled by a single gene HBB on chromosome 11 of each parent.

CHROMOSOMAL DISORDERS

- Chromosomal disorders are caused due to absence or excess or abnormal arrangement of one or more chromosomes.
- This is due to failure of segregation of chromatids during cell division cycle results in the gain or loss of a chromosome (aneuploidy)
- Examples: Down's syndrome, Klinefelter's Syndrome, Turner's Syndrome

Disorder	Explanation
DOWN'S SYNDROME	Caused due to presence of an additional copy of the chromosome no 21 (trisomy of 21). First described by Langdon Down (1866). Features - short statured with small round head, furrowed tongue and partially open mouth, palm is broad with palm crease, retorted physical, psychomotor and mental development.
KLINEFELTER'S SYNDROME	Caused due to the presence of an additional copy of Xchromosome resulting into a karyotype of 47, XXY. Features- individual has overall masculine development, however, the feminine development (development of breast, i.e., Gynaecomastia) is also expressed. Such individuals are sterile.
TURNER'S SYNDROME	Caused due to the absence of one of the X chromosomes, i.e., 45 with X0. Features- sterile females with rudimentary ovaries, lack of other secondary sexual characters.

IMPORTANT QUESTIONS

VERY SHORT ANSWER QUESTIONS

1- **Name the scientists who rediscovered the Mendel's work.**
Ans: Hugo DeVries, Carl Correns and Tschermak.

2- **Write the karyotype of Klinefelter's Syndrome and Turner's syndrome.**
Ans: 47, XXY and 45 with X0

3- **Give an example of XO type of sex determination.**
Ans: Grasshopper

4- **Who observed that during spermatogenesis only 50 % of insect sperm received a specific structure, whereas 50 % sperm did not receive it? Also mention the name of that specific structure**.
Ans: Henking, X-body

5- **What is the cross known as when the F1 progeny is crossed with homozygous recessive parent? Write one advantage of such cross.**
Ans: The cross is a test cross.
It is advantageous to determine the genotype of the parent plant.

6- **Write the Dihybrid cross ratio when self-cross is carried out between two heterozygous gametes.**
Ans: 9:3:3:1

7- **Name any one plant that shows the phenomenon of incomplete dominance during the inheritance of its flower colour.**
Ans: Dog flower (Snapdragon or Antirrhinum sp.)

8- **For which types of reproduction Mendel's laws of inheritance are applicable?**
Ans: Sexual reproduction

9- **What term used in which there are extra set of chromosome is present.**
Ans: aneuploidy

10- **A haemophilic man marries a normal homozygous woman. What is the probability that their daughter will be haemophilic?**

Ans: no chance (0%), she will be carrier only

SHORT ANWER TYPE QUESTIONS

1- **In a plant 2n= 12 and in other plant 2n= 20. What will be the ploidy of plant obtained by crossing of these plants?**

Ans- 2n = 12 then gamete (n)= 6

2n = 20 then gamete (n)= 10

Progeny = n+n = 6+ 10 = 16

2- **What observations we can get from law of dominance.**

Ans: Law of inheritance provide knowledge The law of dominance is used to explain the expression of only one of the parental characters in a monohybrid cross in the F1 and the expression of both in the F2. It also explains the proportion of 3:1 obtained at the F2

3- **The human male never passes on the gene for haemophilia to his son. Why is it so?**

Ans: haemophilia is sex (X) linked recessive disorder. The male can transfer only 'Y' chromosome to his son.

4- **The child has a blood group of O. If the father has blood group A and mother has blood group B, work out the genotypes of the parents and the possible genotypes of the other Offsprings.**

Ans: Genotype of father I^AI^A

Genotype of mother $I^B I^O$

Genotype of child I^OI^O

♀ \ ♂	I^A	I^O
I^B	$I^A I^B$	$I^B I^O$
I^O	$I^A I^O$	$I^O I^O$

5- **In Snapdragon, a cross between true-breeding red-flowered (RR) plants and true-breeding white-flowered (RR) plants showed a progeny of plants with all pink flowers.**

(i) The appearance of pink flowers is not known as blending. Why?

(ii) What is this phenomenon known as?

Ans: i- This is not blending as neither of genes can express in heterozygous condition but can express when they are in homozygous condition.

Ii-Incomplete dominance.

6- **What are the possible effects of modified alleles?**

Ans: (i) the normal/less efficient enzyme, or

ii- a non-functional enzyme, or

iii- no enzyme at al

7- **Differentiate between co-dominance and incomplete dominance.**

Ans: Co-dominance –condition when phenotypes of all the alleles are expressed.

Incomplete dominance- When both alleles of a gene at a locus are partially expressed and produce an intermediate phenotype, such phenomenon is called as incomplete dominance

8- **Describe multiple allelism by citing one example?**

Ans: when a single trait is controlled by more than 2 alleles, it is called as multiple allelism.

Example: Human blood group is controlled by three alleles I^A,I^B and i.

9- **Explain the cause of Klinefelter's syndrome. Give any three symptoms shown by sufferer of this syndrome.**

Ans. Caused due to the presence of an additional copy of X chromosome resulting into a karyotype of 47, XXY.

Features- individual has overall masculine development, however, the feminine development (development of breast, i.e., Gynaecomastia) is also expressed. Such individuals are sterile.

10- **How does distance between genes affect linkage and crossing over?**

Ans: (a) closely situated genes shows more linkage and less crossing over

(b) Distantly located gene shows more crossing over and less linkage.

Very Long Answer Type Questions

1- **Discuss in detail the contributions of Morgan and Sturtevant in the area of genetics.**

Ans:

i- Morgan worked on fruit fly (Drosophila melanogaster).

ii- He stated and established that genes are located on the chromosome.

iii- He established the principle of linkage.

iv- Established the technique of chromosome mapping.

Sturtevant was student of Morgan .His contributions are-

i- He constructed the first genetic map of a chromosome while working on the Drosphila genome.

ii- Established concept of linkage group.

2- **Diagrammatically represent results of a dihybrid cross where the two parents differed in two pairs of contrasting traits: seed colour and seed shape of pea plant.**

Ans: 5.7, page 79, NCERT

3- **What is recombination? Mention its applications with reference to genetic engineering.**

Ans: Recombination is the process of producing a new combination of genes by crossing over during meiosis. It is characteristic feature of sexually reproducing organisms.

Applications:

i- It causes variation in a population.

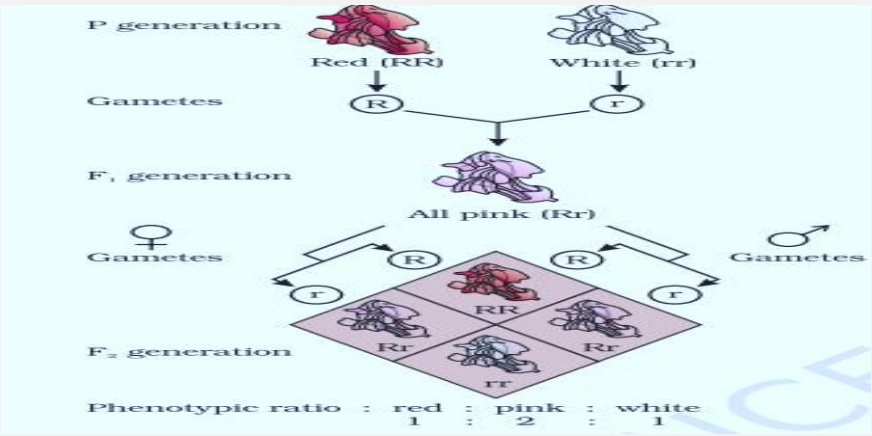
ii- Variability leads to better adaptation and survival

iii- With help of linkage groups, chromosome map can be prepared.

iv- The desired recombinants can be produced.

4- **A cross between a red flower-bearing plant and a white flower-bearing plant of Antirrhinum produced all plants having pink flowers. Work out across, to explain how is this possible?**

Ans: It is due to incomplete dominance. In this both alleles of a gene at a locus are partially expressed and produce an intermediate phenotype



5- A dihybrid heterozygous round, yellow seeded garden pea (Pisum sativum) was crossed with a double recessive plant.

a- What type of cross is this?

b- Workout on the genotype and phenotype of the progeny.

c- What principle of Mendel is illustrated through the result of this cross?

Ans:

a- It is a dihybrid test cross

b-

Gametes (RY), (Ry), (rY), (ry) X (ry)

Gametes	RY	Ry	rY	ry
F_1 progeny ry	RrYy Round, Yellow	Rryy Round and Green	rrYy Wrinkled Yellow	rryy Wrinkled, Green
Phenotypic ratio	: 1	: 1	: 1	: 1
Genytopic ratio	: 1	: 1	: 1	: 1

c- It illustrates the Principle of independent assortment.

CHAPTER- 6
MOLECULAR BASIS OF INHERITANCE

Key words

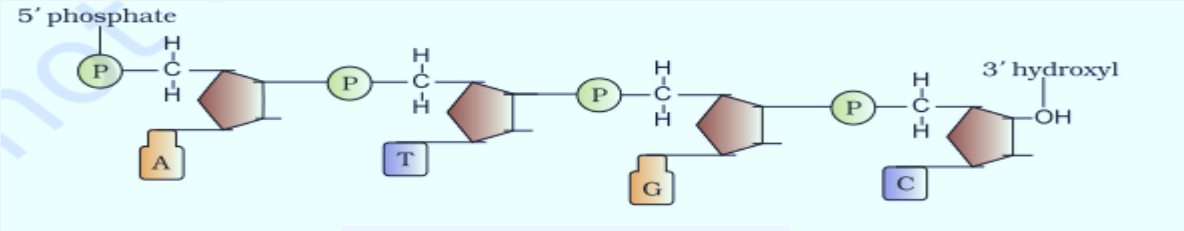
DNA	Deoxyribonucleic acid
RNA	Ribonucleic acid
Nitrogenous Bases	Adenine, thymine, guanine, cytosine
Phosphodiester bond	Bond between two nucleotide
Ribose sugar	Pentose sugar
Histone	Positively charged proteins
Nucleosome	Histone octamer + DNA
Chromatin	Chromatin is a complex of DNA and protein found in eukaryotic cells
Euchromatin	Loosely packed chromatin, transcriptionally active
Heterochromatin	Densely packed chromatin, transcriptionally inactive
Transformation	Transfer of DNA into bacteria
Replication	Synthesis of new DNA from parental DNA
Transcription	Synthesis of RNA from DNA
Translation	Protein synthesis
Ribosome	Organelles for protein synthesis
Genetic code	Set of codons
Operon	Set of genes that regulate gene expression
HGP	Human genome project
VNTR	Variable number of tandem repeats
Cistron	As a segment of DNA coding for a polypeptide
Exons	Coding sequence on mRNA
Introns	Intervening sequences do not appear in mature or processed RNA
Splicing	Mechanism of removal of introns and ligation of exons.

POLYNUCLEOTIDE CHAIN

- ✓ DNA / RNA both are made of polynucleotide chain.
- ✓ In polynucleotides the nucleotides are joined with Phosphodiester bond.
- ✓ Nucleotides are made up of Nucleoside + Phosphoric acid
- ✓ Nucleosides consists of Nitrogenous bases + Pentose sugar
- ✓ Pentose sugar may be –
  - i- Deoxyribose (DNA)
  - ii- Ribose (RNA)
- ✓ Nitrogenous bases may be –

Purine	Pyrimidine
Adenine and Guanine	Thymine (only in DNA), Cytosine and Uracil (only in RNA)

- ✓ A nitrogenous base is linked to the OH of 1' C pentose sugar through a N-glycosidic linkage to form a nucleoside e.g.- adenosine or deoxyadenosine, guanosine or deoxyguanosine, cytidine or deoxycytidine and uridine or deoxythymidine
- ✓ Two nucleotides are linked through 3'-5' phosphodiester linkage to form a dinucleotide. More nucleotides can be joined in such a manner to form a polynucleotide chain



THS DNA

- ✓ Friedrich Meischer in 1869 identify DNA as an acidic substance present in nucleus and named it as 'Nuclein'
- ✓ DNA is a long polymer of deoxyribonucleotides.
- ✓ The length of DNA is usually defined as number of nucleotides/ base pairs present in it.

Organism	Length of DNA
Bacteriophage ϕ ×174	5386 nucleotides
Bacteriophage lambda	48502 bp
Escherichia coli	4.6 × 106 bp
Human (haploid content)	3.3 × 109 bp

Double Helical Model of DNA

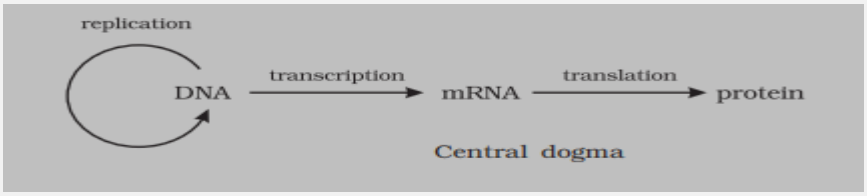
- ✓ James Watson and Francis Crick, based on the X-ray diffraction data produced by Maurice Wilkins and Rosalind Franklin, proposed Double Helix model of DNA. The salient features of that model is as given below
- ✓ DNA is made of two polynucleotide chains where the backbone is constituted by sugar-phosphate.
- ✓ The two chains have anti-parallel polarity i.e. if one chain has the polarity 5' to 3', the other has 3' to 5'.
- ✓ The nitrogenous bases are held by hydrogen bond in between two polynucleotide chain.
- ✓ Adenine forms two hydrogen bonds with Thymine. Similarly, Guanine is bonded with Cytosine with three H-bonds.
- ✓ The two chains are coiled in a right-handed fashion.
- ✓ The pitch of the helix is 3.4 nm.
- ✓ There are roughly 10 bp in each helix; consequently, the distance between a bp in a helix is approximately 0.34 nm.

Erwin Chargaff
He found that in DNA, the ratios of adenine (A) to thymine (T) and guanine (G) to cytosine (C) are equal.
A= T and G=C
[A] + [G] = [T] + [C] or [A] + [G] / [T] + [C] =1

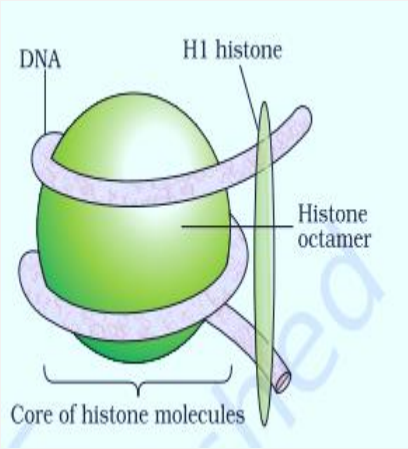
CENTRAL DOGMA

- ✓ Proposed by Francis Crick
- ✓ Genetic information flows from DNA to RNA to Protein

✓ The process of making protein from DNA is known as the “central dogma”



PACKAGING OF DNA HELIX



- ✓ The process of tightly packing the DNA molecule to fit into the nucleus of a cell is known as Packaging of DNA Helix.
- ✓ In eukaryotes a set of positively charged, basic proteins (histones) are present. The positive charge is due to basic amino acids lysine and arginine.
- ✓ Histones are organised to form a unit of eight molecules called histone octamer.
- ✓ The negatively charged DNA is wrapped around the positively charged histone octamer to form bead like structure called nucleosome.
- ✓ A typical nucleosome contains 200 bp of DNA helix.

THE SEARCH FOR GENETIC MATERIAL

TRANSFORMING PRINCIPLE

- It is proposed by Frederick Griffith in 1928.
- He used mice & *Streptococcus pneumoniae*. Streptococcus pneumoniae has 2 strains:
  Smooth (S) strain (Virulent): Has polysaccharide mucus coat, cause pneumonia.
  Rough (R) strain (Non-virulent): No mucus coat, do not cause Pneumonia.

Experiment:

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

He concluded due to transfer of genetic material some R strain bacteria transformed in to S stain (Virulent).

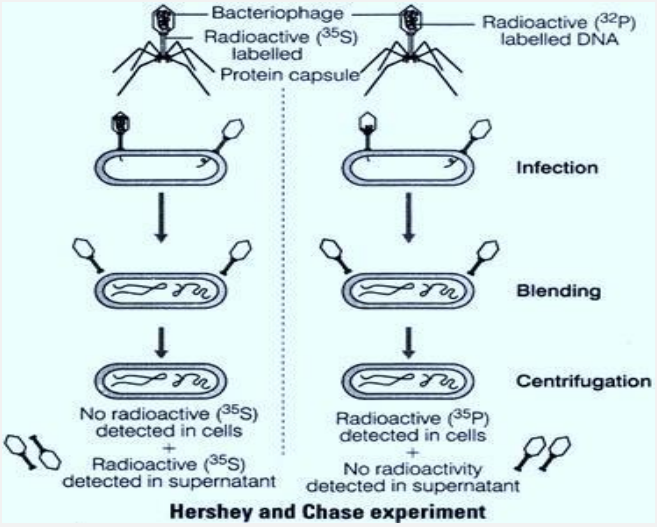
BIOCHEMICAL CHARACTERIZATION OF TRANSFORMING PRINCIPLE

- It is carried out by - Oswald Avery, Colin Macleod & Maclyn McCarty to determine the biochemical nature of ‘transforming principle’ in Griffith's experiment.

- They purified biochemical (proteins, DNA, RNA etc.) from heat killed S cells using suitable enzymes.
- They discovered that digestion of protein and RNA (using Proteases and RNases) did not affect transformation. It means that the transforming substance was not a protein or RNA.
- Digestion of DNA with DNase inhibited transformation. It means that DNA caused transformation of R cells to S cells. They concluded that DNA is the hereditary material.

HERSHEY-CHASE EXPERIMENT

- It is carried by Alfred Hershey and Martha Chase (1952) to prove that DNA is genetic material.
- They worked with viruses that infect bacteria called bacteriophages.
- They used two types of radioactive chemicals ^{32} **P** (present in DNA) **and** ^{35} **S** (present in protein)
- The viruses grown in ^{32} P medium has radioactive DNA while those grown in ^{35} S medium has labeled protein coat.
- They infect one group of bacteria with ^{32} P labeled virus and other group with ^{35} S containing viruses.



Hershey and Chase experiment

- After blending and centrifugation they observed and concluded that bacteria infected with ^{32} P produces offspring labeled with ^{32} P while no of the progeny is radioactively labeled of ^{35} S labeled virus therefor DNA is main genetic material.

PROPERTIES OF GENETIC MATERIAL (DNA VERSUS RNA)

A molecule that can act as a genetic material must fulfill the following criteria:
(i) It should be able to generate its replica (Replication).
(ii) It should be stable chemically and structurally.
(iii) It should provide the scope for slow changes (mutation) that are required for evolution.
(iv) It should be able to express itself in the form of 'Mendelian Characters'.
DNA is more stable than RNA because –

- DNA is double stranded
- Thymine in DNA is less reactive than Uracil of RNA
- Mutation rate in RNA is more than DNA
- Absence of 2'-OH in sugar in DNA makes it less reactive.

RNA WORLD

- RNA was the first genetic material.
- Essential life processes (such as metabolism, translation, splicing, etc.), evolved around RNA.
- RNA used to act as a genetic material as well as a catalyst.

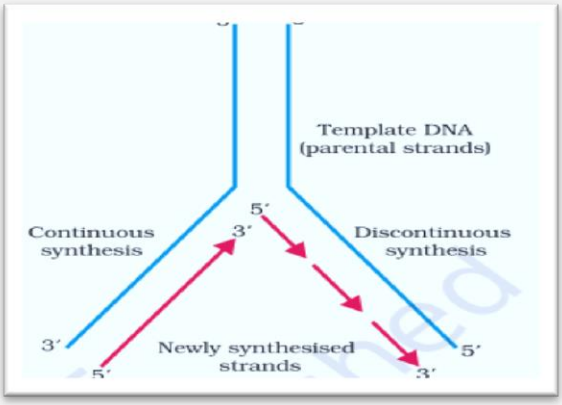
- RNA can directly code for the protein synthesis, hence can easily express the characters. DNA is dependent on RNA for protein synthesis

TYPES OF RNA

Type	Explanation
mRNA	It contains messages of DNA in the form of codons. Eukaryotic mRNA undergo splicing before undergo translation process. Prokaryotic mRNA does not need to be processed.
rRNA	rRNA forms ribosomes along with protein. The ribosomes contain an exit (E), peptidyl (P), and acceptor (A) site to bind aminoacyl-tRNAs and link amino acids together to create polypeptides.
tRNA	It is also known as adapter RNA. They have a cloverleaf structure that consists of a 3' acceptor site, 5' terminal phosphate, D arm, T arm, and anticodon arm. The primary function of a tRNA is to carry amino acids to the ribosome.

REPLICATION

- DNA replication is the process by which DNA makes a copy of its own during S- phase of cell division.
- Watson and Crick had proposed a scheme for replication of DNA as copying mechanism for the genetic material.
- The replication is semiconservative type i.e. daughter DNA has one parental DNA strand and one new DNA strand.
- Matthew Meselson and Franklin Stahl provide the experimental proof of semiconservative nature of replication.
- Main enzyme for replication is DNA-dependent DNA polymerases.
- Replication starts at within a small opening of the DNA helix, called as replication fork.



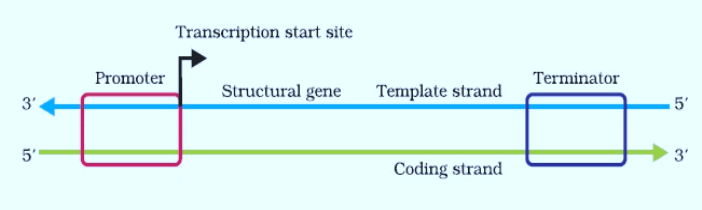
- The DNA-dependent DNA polymerases catalyze polymerization only in one direction, which is 5' to 3'.
- On one strand replication is in continuous manner (leading strand synthesis) while on other it is discontinuous manner (lagging strand synthesis).
- The discontinuously synthesized fragments (Okazaki fragments) are later joined by the enzyme DNA ligase.
- The DNA replication starts at specific point known as origin of replication.

TRANSCRIPTION

- The process of copying genetic information from one strand of the DNA into RNA is termed as transcription.
- The main enzyme is DNA dependent RNA polymerase.

- In transcription only a segment of DNA and only one of the strands is copied into RNA.

A transcription unit in DNA consists of -



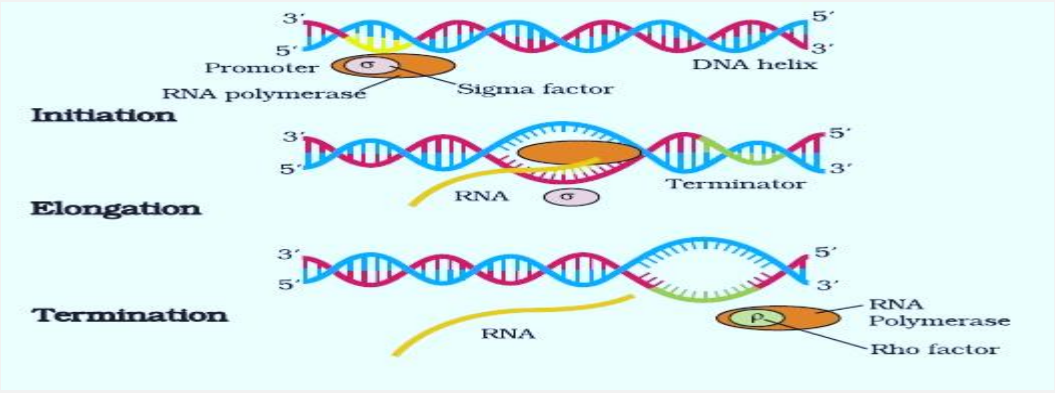
(i) A Promoter
(ii) The Structural gene
(iii) A Terminator

- Polymerization takes place only from 5’ end to 3’ end.
- The strand with 3’ to 5’ end polarity is known as template strand and other is known as coding strand.

3′-ATGCATGCATGCATGCATGC-5′ Template Strand
5′-TACGTACGTACGTACGTACG-3′ Coding Strand

Structural gene is the region which is transcribed is flanked with promoter (towards 5’ end; upstream) and terminator towards 3’ end; downstream).

- Promoter provides binding site for RNA polymerase while at terminator the process of transcription stops.
- RNA polymerase binds to promoter and initiates transcription (Initiation) with thel of sigma factor. Polymerase uses nucleoside triphosphates as substrate for polymerization
- After completion of polymerization of structural gene the factor (ρ) terminate the transcription process.



Complexities in Eukaryotic Transcription

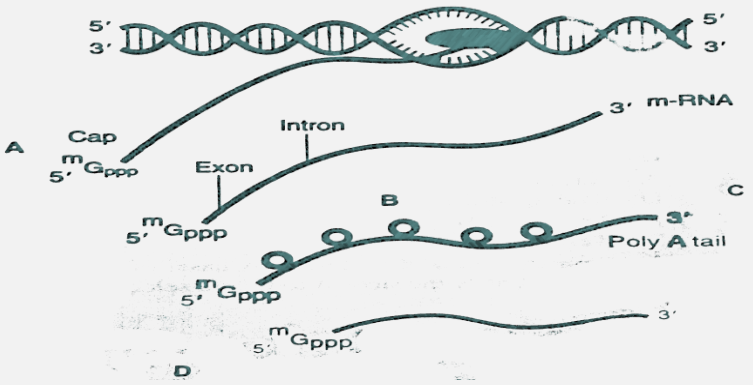
i- Three different RNA Polymerases

RNA polymerase I	Transcribes rRNAs (28S, 18S, and 5.8S),
RNA polymerase II	Transcribes mRNA, heterogeneous nuclear RNA (hnRNA)
RNA polymerase III	Transcribes of tRNA, 5srRNA, and snRNAs

ii- Splicing Mechanism

Primary transcripts contain both the exons and the introns. Introns are removed by splicing process and exons are joined in a defined order.

iii- **Capping and Tailing**- In capping an unusual nucleotide (methyl guanosine triphosphate) is added to the 5'-end of hnRNA. In tailing, adenylate residues (200-300) are added at 3'-end. It is the fully processed hnRNA, now called mRNA that is transported out of the nucleus for translation



GENETIC CODE

Genetic code is sequence of codons on m RNA that contain information obout amino acids.
The salient features of genetic code are as follows:

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

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

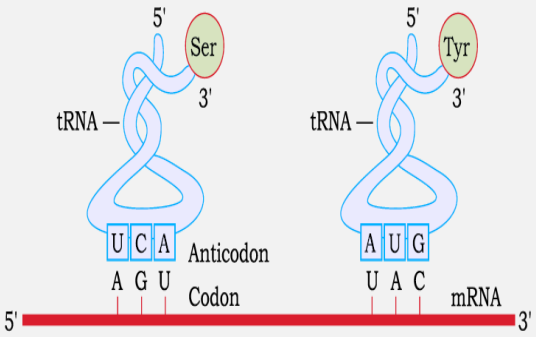
TRANSLATION

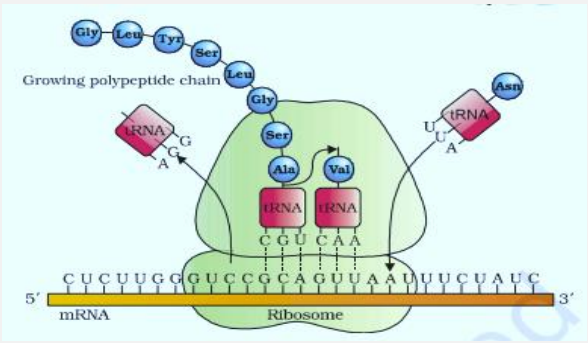
Translation refers to the process of polymerization of amino acids to form a polypeptide (protein).

- The sequence of amino acids in a polypeptide is based on mRNA in the form of triplet codons.
- The tRNA carries amino acid to the ribosome where synthesis of polypeptide takes place.
- The tRNA gets activated in presence of ATP and form aminoacyl tRNA. The first amino acid is always methionine in a polypeptide sequence.

- Ribosome provide site for protein synthesis. There are two sites in the large subunit, for amino acids to bind. The aminoacyl tRNA brings amino acids to this site where formation of peptide bond in between amino acids takes place.
- The ribosome moves from codon to codon along the mRNA. Amino acids are added one by one, translated into Polypeptide
- A translational unit in mRNA is the sequence of RNA that is flanked by the start codon (AUG) and the stop codon and codes for a polypeptide.
- At the end, a release factor binds to the stop codon, terminating translation and releasing the complete polypeptide from the ribosome

UTR- these are untranslated region on mRNA. these are present at both 5' -end (before start codon) and at 3' -end (after stop codon). They are required for efficient translation process.





REGULATION OF GENE EXPRESSION

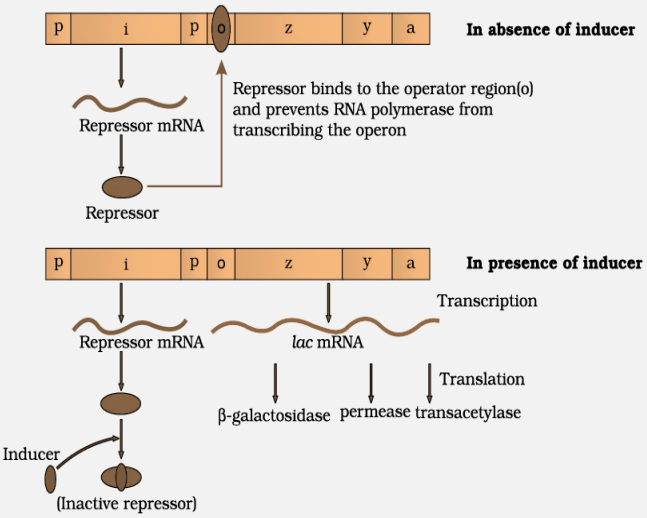
In eukaryotes, the regulation could be exerted at-
(i) Transcriptional level (formation of primary transcript),
(ii) Processing level (regulation of splicing),
(iii) Transport of mRNA from nucleus to the cytoplasm,
(iv) Translational level.

THE LAC OPERON

- Francois Jacob and Jacque Monod proposed Lac operon for lactose metabolism in E. coli
- Genes on Lac Operon

Regulator gene (i)	Codes for the repressor of the lac operon.
Promotor (p)	It is binding site for RNA Polymerase
operator gene (o)	It is binding site for repressor
structural genes (z, y, a)	The z gene (beta-galactosidase (β-gal) –breakdown lactose into galactose and glucose. The 'y' gene (permease)- increases permeability of the cell to β-galactosides. The 'a' gene encodes a transacetylase.

- Lactose is the substrate for the enzyme beta-galactosidase and it regulates switching on and off of the operon. Hence, it is termed as inducer.
- When lactose is absent the regulator gene synthesizes repressor protein. The repressor protein binds on operator and prevents RNA polymerase from transcribing the operon.
- When lactose is present the repressor is inactivated by interaction with the inducer. This allows RNA polymerase access to the promoter and transcription proceeds.



HUMAN GENOME PROJECT

It is an international scientific project with the goal of determining the sequence of nucleotide base pairs human genome and its mapping.

Goals of HGP

- Identify all the approximately 20,000-25,000 genes in human DNA
- Determine the sequences of the 3 billion chemical base pairs that make up human DNA
- Store this information in databases
- Improve tools for data analysis
- Transfer related technologies to other sectors, such as industries
- Address the ethical, legal, and social issues (ELSI) that may arise from the project

Methodologies

- The methods involved two major approaches –
- ESTs (Expressed sequence tags) - identifying all the genes that are expressed as RNA
- Sequence Annotation- Sequencing the whole set of genome that contained all the coding and non-coding sequence
- For sequencing, the total DNA from a cell is isolated, cleaved into smaller fragments and cloned/ amplify in suitable host using specialized vectors.
- The commonly used hosts were bacteria and yeast, and the vectors were called as BAC (bacterial artificial chromosomes), and YAC (yeast artificial chromosomes).
- The fragments were sequenced using automated DNA sequencers. (**Frederick Sanger** is credited to develop methodology of automatic sequencer)

SALIENT FEATURES OF HUMAN GENOME

- The human genome contains 3164.7 million base pairs and 30000 genes. 99.9 % nucleotide bases are exactly the same in all people
- The average gene consists of 3000 bases. Largest gene is of dystrophin (2.4 million bases)
- Function of 50 % gene is still unknown and Less than 2 % of the genome codes for proteins
- Repetitive sequences are stretches of DNA sequences that are repeated many times.
- Chromosome 1 has most genes (2968), and the Y has the fewest (231)
- There are about 1.4 million locations where single base DNA differences (SNPs – single nucleotide polymorphism; 'snips') occur in humans.

DNA FINGERPRINTING

- DNA fingerprinting is a technique of determining nucleotide sequences of certain areas (VNTRs) of DNA which are different in different individual. DNA fingerprinting involves identifying differences in repetitive DNA.
- **Alec Jeffreys** develops technique of DNA Fingerprinting. He used satellite DNA as probe that shows very high degree of polymorphism called as **VNTRs** (as Variable Number of Tandem Repeats)
- These sequences with high degree of polymorphism form the basis of DNA fingerprinting.
- The repetitive DNA are separated from bulk genomic DNA as different peaks during density gradient centrifugation. The bulk DNA forms a major peak and the other small peaks are referred to as satellite DNA (such as micro-satellites, mini-satellites etc.)
- DNA Polymorphism (variation at genetic level) arises due to mutations.
- It is widely used in forensic science, paternity dispute etc.

Steps of DNA Fingerprinting

- Isolation of DNA
- Digestion of DNA by restriction endonucleases
- Separation of DNA fragments by electrophoresis
- Transferring (blotting) of separated DNA fragments to synthetic membranes, such as nitrocellulose or nylon
- Hybridization using labelled VNTR probe
- Detection of hybridized DNA fragments by autoradiography

IMPORTANT QUESTIONS

Very Short Answer Type Questions

1- **By which method detection of hybridized DNA fragments is possible.**
Ans: Autoradiography

2- **Who invented methodologies of automatic DNA sequencing and Lac operon?**
Ans: Frederick Sanger, Alec Jefferys

3- **Give name of commonly used vectors in human genome project.**

Ans: BAC (Bacterial artificial chromosome), YAC (yeast artificial chromosome)

4- **What are two basic approach adapted as methodologies in HGP.**
Ans: Expressed Sequence Tags (ESTs) and Sequence Annotation

5- **What are inducers in lac operon, give two examples of inducer.**
Ans: inducer binds with repressor protein so that they can't bind on operator gene.
Example- Lactose and Allolactose

6- **What are untranslated regions (UTR)? Give their importance**.
Ans: The UTRs are present at both 5' -end (before start codon) and at 3' -end (after stop codon). They are required for efficient translation process.

7- **What are initiator tRNA? How many tRNAs are present in cell for 20 different amino acid?**
Ans: Initiator tRNA is for initiation of translation process. It always carries methionine amino acid.
There are 20 different tRNAs for 20 different amino acids.

8- **What is dual nature of codon AUG?**
Ans: It codes for amino acid methionine.
This is also known as initiation codon responsible for initiation of translation process.

9- **What is the role of sigma factor and DNA ligase?**
Ans: Sigma factor initiates the process of transcription
DNA ligase is to join adjacent nucleotides.

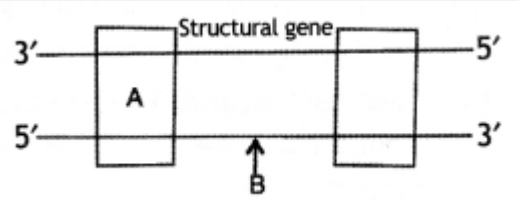
10- **Name the bacteria used by Fredrik Griffith in his experiment. Also mention the types of strain he used to prove the nature of genetic material**.
Ans: Bacteria- Streptococcus pneumonia
Strain- S strain (virulent) R strain (non- virulent)

Short Answer Type Questions

1- **The sequence of the coding strand of DNA in a transcription unit is mentioned below**
3' TATAGCATCTATTAGG 5'
Write the sequence of RNA formed on this DNA.
Ans: 3' UAUAGCAUCTAUUAGG 5'

2- **Three codons on mRNA are not recognised by tRNA during translation process. Mention these codons? Write the importance of these in protein synthesis?**
Ans: Stop codons- UAA, UAG and UGA
Help in termination of translation process and release of polypeptide into cytoplasm

3- **Label the parts 'A' and 'B' of the transcription unit given below**



Ans: A- Promoter B- Coding strand

4- **Describe any three steps required for maturation of nascent mRNA into the cell.**

Ans: Splicing**-** Primary transcripts contain both the exons and the introns. Introns are removed by splicing process and exons are joined in a defined order.

Capping**-** addition of unusual nucleotide (methyl guanosine triphosphate) at 5' end (capping)

Tailing- adding of polyadenylate residue at 3' end.

5- **List the features which must be present in a good genetic material.**

Ans: (i) It should be able to generate its replica (Replication). (ii) It should be stable chemically and structurally. (iii) It should provide the scope for slow changes (mutation) that are required for evolution. (iv) It should be able to express itself in the form of 'Mendelian Characters'.

6- **Describe role of the followings-**

Sigma factor, Rho factor, Release factor, Histone protein

Ans:

- Sigma factor- initiate transcription process
- Rho factor- termination the transcription process
- Release factor- help in termination of translation and dissociate ribosome subunits, release of polypeptide
- Histone Protein- help in formation of nucleosome

7- **Give two reasons why both the strands of DNA are not copied during transcription process?**

Ans: 1- If the strands codes for RNA, two different RNA molecules & two different proteins are formed.

2- The two RNA molecules if produced simultaneously would be complementary to each other, hence would form a double stranded RNA. This would prevent RNA from being translated into protein.

8- **RNA was the first genetic material, DNA evolved later on. Explain.**

Ans: RNA can directly code for the synthesis of proteins, hence can easily express the characters. RNA used to act as a genetic material as well as a catalyst.

Essential life processes like metabolism, translation, splicing, etc. evolved around RNA.

9- **Briefly describe the termination of a polypeptide chain.**

Ans: When ribosome reach to the Stop codons (UAA, UAG, and UGA) on mRNA, RF Protein (Release factor) binds on it and dissociate subunits of ribosome and polypeptide is released in cytoplasm.

10- **List two essential roles of ribosome during translation.**

Ans: i- provide attachment site for mRNA

ii) Provide site of polypeptide synthesis

Long Answer Type Questions

1- **a- What is DNA fingerprinting?**

b- What are the steps of DNA fingerprinting?

C-Mention its application

Ans: a- DNA fingerprinting is a technique of determining nucleotide sequences of certain areas (VNTRs) of DNA which are different in different individual

b- 1- Isolation of DNA 2- Digestion of DNA by restriction endonucleases 3- Separation of DNA fragments by electrophoresis 4- Transferring (blotting) of separated DNA fragments to synthetic membranes, such as nitrocellulose or nylon 5- Hybridization using labelled VNTR probe 6- Detection of hybridized DNA fragments by autoradiography

c- Paternity disputes can be solved by DNA fingerprinting

It is useful in detection of crime and legal pursuits.

2- a- Differentiate between the genetic codes given below:

(i) Unambiguous

(ii) Degenerate

b- What is significance of Severo Ochoa enzyme?

Ans: a- i- Unambiguous: one Condon code for only one amino acid.

Ii-Degenerate: When an amino acid is coded by more than one codon

b- Severo Ochoa enzyme (polynucleotide phosphorylase) is useful in polymerizing RNA with defined sequences in a template independent manner (enzymatic synthesis of RNA)

3- i- Write the stages at which Regulation of gene expression can be achieved in eukaryotes.

ii-What is meaning of I, p and o in operon?

Ans: i- transcriptional level (formation of primary transcript), processing level (regulation of splicing), transport of mRNA from nucleus to the cytoplasm, translational level.

ii-Regulator gene (i) Codes for the repressor of the lac operon, promoter (p) is binding site for RNA Polymerase and operator gene (o) It is binding site for repressor.

4- i- Why is DNA molecule a more stable genetic material than RNA? Explain

ii-Draw double helical diagram of DNA showing phosphodiester bond.

Ans: the hydrogen between purine and pyrimidine provide stability to DNA.

The DNA lacks 2'OH group which makes it less reactive than RNA.

The thymine in DNA is less reactive than Uracil in RNA.

RNA mutates easily.

ii-Fig6.2, page 98 NCERT

5- Provide any five silent feature of human genome.

Ans: The human genome contains 3164.7 million bp., The total number of genes is estimated at 30,000, Almost all (99.9 per cent) nucleotide bases are exactly the same in all people, The functions are unknown for over 50 per cent of the discovered genes, Less than 2 per cent of the genome codes for proteins, Chromosome 1 has most genes (2968), and the Y has the fewest (231), there are about 1.4 million locations where single base DNA differences (SNPs – single nucleotide polymorphism : 'snips') occur in humans.

Chapter-7
Evolution

key words

Evolution	Evolution is a process of gradual change that takes place over many generations, during which species of animals, plants, or insects slowly change some of their physical characteristics
Big bang theory	Explains the origin of the earth
Homologous organs	organs having the same basic structure but different functions.
Analogous organs	organs having different basic structures but have a similar appearance and perform similar functions.
Adaptive radiation	This is an evolutionary process of organisms that are grouped into a wide variety of types adapted to specialized modes of life.
branching descent	The process of developing a new species from a single common descendant is known as branching descent
Natural selection	Process through which populations of living organisms adapt and change
Saltation	Single step large mutation
mya	Millom years ago,

ORIGIN OF LIFE (Big Bang Theory)

The single huge explosion resulted in the origin of the universe about 20 billion years ago. The earth was formed about 4.5 billion years ago. There was no atmosphere on early earth. Water vapor, CH_4, CO_2 & NH_3 released from molten mass covered the surface. The UV rays from the sun broke up water into Hydrogen and Oxygen and the lighter H_2 escaped. Oxygen is combined with ammonia and methane to form water, CO_2, etc. The ozone layer was formed. As it cooled, the water vapor fell as rain and form oceans. Life appeared four billion years back.

THEORIES OF ORIGIN OF LIFE

Theory of spontaneous generation (Abiogenesis)	It states that life came out of decaying and rotting matter like straw, mud, etc.
Theory of biogenesis	Proposed by Louis Pasteur. He demonstrated that life comes only from pre-existing life.
Theory of Panspermia	It states that the units of life (spores) were transferred to different planets including earth.
Theory of special creation	It states that living things were created by some supernatural power
Theory of chemical evolution	Proposed by Oparin & Haldane. It states that the first form of life originated from non-living inorganic & organic molecules.
Harold Urey & Stanley Miller Experiment	They experimentally proved the theory of chemical evolution. They created a condition like that of primitive earth (i.e. high temperature, volcanic storms, reducing atmosphere with CH4, NH3, H_2O, H_2, etc). When an electric discharge is produced in a closed flask containing CH_4, NH_3, H_2, and water vapor, at 800° C biomolecules (amino acids) like present-day were formed.

EVIDENCE FOR EVOLUTION

1- **Fossils**: Fossils are remnants of life forms found in rocks (earth crust). The study of fossils is known as Palaeontology.

Fossils provide evidence for phylogeny (evolutionary history or race history). E.g., Horse evolution, Used to study the connecting link between two groups of organisms (E.g. Archaeopteryx), to study extinct animals (E.g. Dinosaurs), to study geological periods by analysing fossils in different sedimentary rock layers.

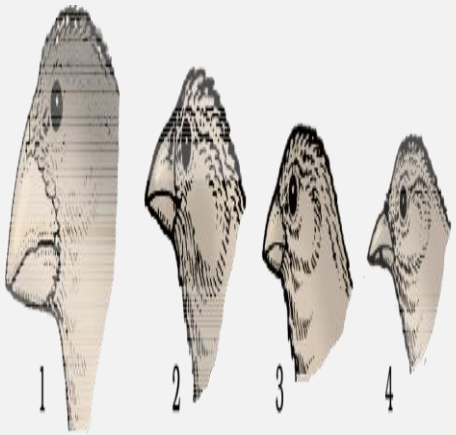
2- **Morphological & Anatomical evidences**

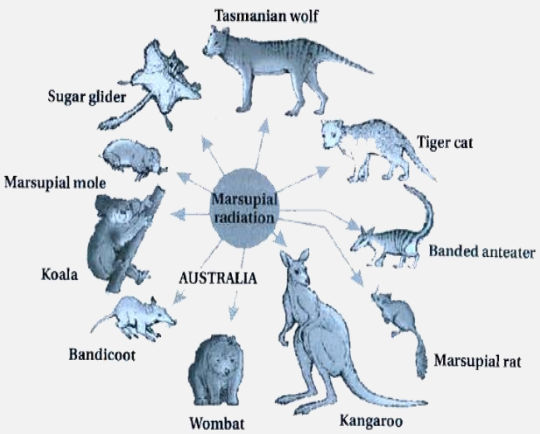
Homologous organs	These organs have similar structures and origins but different functions. The origin of homologous organs is due to Divergent evolution. Homology indicates common ancestry.	The human hand, Whale's flippers Bat's wing & Cheetah's foot humerus, radius, ulna, carpals, metacarpals & phalanges Thorns of Bougainvillea and tendrils of Cucurbita
Analogous organs	These organs have similar functions but different structures & origins. The origin of analogous organs is due to Convergent evolution. It is the evolution by which unrelated species become more similar to survive and adapt to similar environmental conditions.	Wings of insects and birds Eyes of Octopus and mammals Flipper of Penguins and Dolphins. The trachea of insects and lungs of vertebrates Sweet potato & Potato

3- **Adaptive radiation**

This is the evolution of different species from an ancestor in a geographical area starting from a point. It is a type of divergent evolution. E.g., Darwin's finches in Galapagos Islands,
Australian marsupials (Marsupial radiation), Placental mammals in Australia

When more than one adaptive radiation appears in an isolated geographical area, it results in convergent evolution. E.g., Australian Marsupials and Placental mammals





Adaptive radiation of marsupials of Australia

4- **Embryological evidences**

Proposed by Ernst Haeckel

- He observed that all vertebrate embryos have some common features that are absent in adults.

- For E.g., all vertebrate embryos develop vestigial gill slits just behind the head. But it is functional only in fish and not found in other adult vertebrates.

5- Biochemical evidence

Organisms show similarities in proteins, genes, other biomolecules & metabolism. It indicates common ancestry.

Lamarckism (Theory of Inheritance of Acquired characters)

- It is proposed by Lamarck.
- It states that the evolution of life forms occurred by the inheritance of acquired characters. Acquired characters are developed by the use & disuse of organs.

Evolution by use of organs	Evolution by disuse
The long neck of a giraffe	Disappearance of limbs in snakes

Darwinism

(Theory of Natural selection)

- Proposed by Charles Darwin.
- It was based on observations during a sea voyage isailingsail ship called H.M.S. Beagle.
- Alfred Wallace (who worked in the Malay Archipelago) had also come to similar conclusions.
- Work of Thomas Malthus on populations influenced Darwin.
- Darwinism is based on 2 key concepts: Branching descent and Natural selection

Natural selection is based on the following facts:

- Heritable minor variations
- Limited natural resources
- Struggle for existence
- Survival of the fittest

Darwin Finches- He observed many varieties of finches on the same island. All varieties of finches had evolved from original seed-eating finches. here was alternation in beaks enabling some to become insectivorous and some vegetarian.

MUTATION

- Hugo de Vries proposed the Mutation Theory of evolution.
- He conducted experiments evening primrose

HARDY-WEINBERG PRINCIPLE

- It states that allele frequencies in a population are stable and are constant from generation to generation in the absence of disturbing factors.
- the allelic frequency in a population will remain constant from one generation to the next in the absence of disturbing factors.

Hardy Weinberg equilibrium equation

- Sum total of all the allelic frequencies = 1

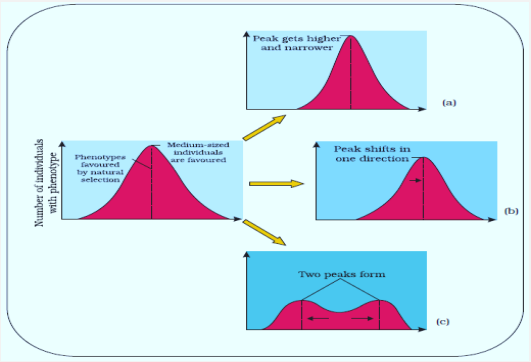
$$p2 + 2pq + q2 = 1$$

Factors affecting Hardy-Weinberg equilibrium

Gene migration, Genetic drift, Mutation, Genetic recombination, Natural selection

Types of Natural selection:

Stabilizing selection	More individuals acquire mean character value.
Directional selection	Individuals of one extreme are more favoured.
Disruptive selection	It breaks a homogenous population into many different forms. Individuals of both extremes are more favoured



ORIGIN AND EVOLUTION OF MAN

Dryopithecus and Ramapithecus	About 15 mya, primates called Dryopithecus and Ramapithecus were existing. They were hairy and walked like gorillas and chimpanzees. Ramapithecus was more man-like while Dryopithecus was more ape-like.
Australopithecus	About two mya Australopithecines probably lived in East African grasslands. They hunted with stone weapons, essentially ate the fruit.
Homo habilis	Brain capacities - 650-800cc. They probably did not eat meat.
Homo erectus	About 1.5 mya, Homo erectus arose. Brain capacity- 900cc. Homo erectus probably ate meat.
Neanderthal man	Brain size- 1400cc They used hides to protect their body and buried their dead.
Homo sapiens or modern man	Arose in Africa During the ice age between 75,000-10,000 years ago, Homo sapiens arose.
Pre-historic cave art developed about 18,000 years ago. Evidence -Bhimbetka rock shelter in Raisen district of Madhya Pradesh. Agriculture came around 10,000 years back and human settlements started.	

IMPORTANT QUESTIONS

Very Short Answer Type Questions

1- **Name the scientist who used pre-sterilized flasks and yeast to disprove the theory of abiogenesis?**
Ans: Louis Pasteur

2- **What postulate was given by Oparin and Haldane about the origin of life?**
Ans: The first form of life could have come from pre-existing non-living organic molecules. evolution.

3- **Which scientist come to the same conclusion as Darwin?**
Ans: Alfred Wallace (worked in the Malay Archipelago)

4- **What was the observation of Ernst Heckel regarding evidence of the origin of life?**
Ans: Embryological support for evolution

5- **Give two examples of adaptive radiation.**
And: Darwin finches, Australian marsupials.

6- **What is speciation? What is the main cause of speciation according to Hugo DeVries?**

Ans: speciation is the formation of new species.
The mutation is the main cause of speciation.

7- **Would you consider the wings of a butterfly and a bat as homologous or analogous?**
Ans: It is an example of the analogous organ as the basic structure is different but the function is the same.

8- **State the significance of biochemical similarities among diverse organisms in evolution.**
Ans: Similarities in biochemicals like DNA, help in deriving the line of evolution. Organisms with more similar DNA sequences are shows the same ancestor.

9- **What is the basis of the Darwinian theory of evolution?**
Ans: Branching descent and natural selection

10- **What do you mean by panspermia?**
Ans: Early Greek thinkers thought units of life called spores were transferred to different planets including earth.

Short answer types questions

1- **What is the founder effect? Mention its importance,**
Ans: When a population gets separated from the existing population it becomes the founder of a new population. This is known as the founder effect. The founder effect affects the genetic diversity of a population.

2- **Explain convergent evolution by giving a suitable example?**
Ans: when two different species with different ancestors tend to develop similar traits during the course of evolution Examples: Some of the marsupials of Australia resemble placental mammals that live in similar habitats to other continents.

3- **Illustrate contribution of the Lamarck to the understanding of evolution?**
Ans: he proposed the theory of Inheritance of Acquired characters, Use, and disuse of organs.

4- **identify the following pairs as homologous of analogous organs:**
(i)Sweet potato and potato (ii) Eye of Octopus and eye of mammals.
(iii)Thorns of Bougainvillea and tendrils of Cucurbits (iv)Forelimbs of bat and whale.
Ans: (i) and (ii) Analogous organs, (iii) and (iv) Homologous organs.

5- **Compare the brain capacity of Homo habilis and Homo erectus.**
Ans: Homo habilis- 650-800cc, Homo erectus- 900cc

Long Answer Type Question

1- **Describe the three different ways by which natural selection can affect the frequency of a heritable trait in a population. Provide a diagram also in support of your answer.**
Ans- The three different ways by which natural selection can affect the frequency of a heritable trait in a population are
(i)Stabilisation It results in a greater number of individuals acquiring the mean character value, i.e., variation is much reduced.
(ii) Directional change It results in more individuals acquiring value other than mean character value, i.e., the peak shift towards one direction.
(iii) Disruption In this more individuals acquire peripheral character value at both ends of the distribution curve, i.e., two peaks are formed at the periphery
Fig, 7.8 page 136, NCERT

2- **Diagrammatic representation of Miller's experiment and label any ten parts.**
Ans: fig 7.1, page 128 NCERT

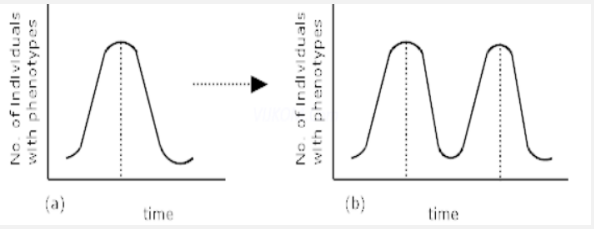
3- Which law states that the sum of allelic frequencies in a population is constant? Write its mathematical formula used to derive allelic frequency. List the five factors that influence the law.

Ans: The law is Hardy-Weinberg equilibrium.

Mathematical equation- P2 + 2pq + q 2= 1 where p and q are allelic frequencies

Factors affecting are - Genetic drift, Mutation, Gene flow, Genetic Recombination, Natural Selection

4- Study the figures given below & answer the following question.



i) Under the influence of which type of natural selection would graph (a) become like (b).

ii) What could be the likely reason for new variations arising in a population.

iii) Who suggested natural selection as the mechanism of evolution?

Ans: (i) Disruptive & elective.

(ii) Individuals at the extremes contribute more offspring compared to those in the centre & produce two peaks in the distribution of a trait.

(iii) Charles Darwin

5- Explain the evolution of human beings in a sequential manner.

Ans: Dryopithecus and Ramapithecus - about 15 mya, primates called Dryopithecus and Ramapithecus were existing. They were hairy and walked like gorillas and chimpanzees. Ramapithecus was more man-like while Dryopithecus was more ape-like.

Australopithecus- about two mya, Australopithecines probably lived in East African grasslands, they hunted with stone weapons, essentially ate the fruit.

Homo habilis- Brain capacities - 650-800cc, they probably did not eat meat.

Homo erectus- about 1.5 mya, brain capacity- 900cc., Homo erectus probably ate meat.

Neanderthal man- brain size- 1400cc, they used buried their dead.

Homo sapiens or modern man- Arose in Africa, During the ice age between 75,000-10,000 years ago.

Chapter-8
Human Health and Diseases

Key words

Health	complete physical, mental and social well-being
Disease	Any condition which impairs health, or interferes with the normal functioning of the body is called a disease
Infection	The invasion and growth of the pathogen in the body
Pathogen	Disease-causing organisms
Infectious diseases	Diseases that are easily transmitted from one person to another
Immunity	The ability of the host to fight the disease-causing organisms
Interferons	Proteins are secreted by virus-infected cells and protect non-infected cells from further viral infection.
Primary response	The encounter of body pathogen for the first time
Allergy	The exaggerated response of the immune system to certain antigens present in the environment
MALT	Mucosa-associated lymphoid tissue
AIDS	Acquired Immuno Deficiency Syndrome
Retrovirus	RNA containing virus
Carcinogens	Cancer causing agents

FACTORS AFFECTING HEALTH

- genetic disorders – deficiencies with which a child is born and deficiencies/defects which the child inherits from parents from birth;
- infections
- Lifestyle

INFECTIOUS AND NON-INFECTIOUS DISEASE

Infectious	transmitted from one person to another like AIDS
Non- infectious	Not transmitted from one person to another like Cancer

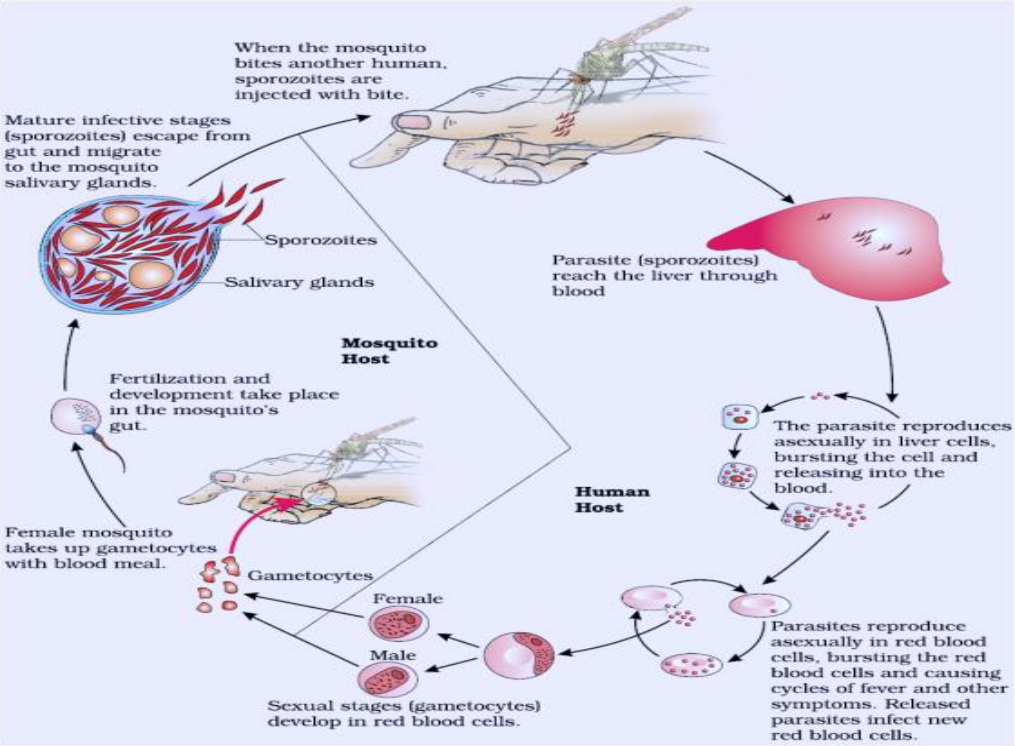
COMMON DISEASES IN HUMAN

Typhoid	Salmonella typhi	Test- Widal Test Intestinal perforation Sustain high fever (39-40 ^{0} C), weakness, stomach pain, constipation, headache and loss of appetite
Pneumonia	Streptococcus pneumoniae Haemophilus influenzae	Infects the alveoli (air filled sacs) of the lungs. Problems in respiration, fever, chills, cough, headache, lips and fingernails may turn grey to bluish in colour
Common cold	Rhino Virus	Infection of the nose and respiratory passage but not the lungs. Nasal congestion and discharge, sore throat, hoarseness, cough, headache, tiredness.
Malaria	Plasmodium	Chill and high fever recurring every three to four days
Amoebiasis (amoebic dysentery)	Entamoeba histolytica	Infection of large intestine Constipation, abdominal pain and cramps, stools with excess mucous and blood clots.
Ascariasis	Ascaris	Infect intestine internal bleeding, muscular pain, fever, anemia and blockage of the intestinal passage

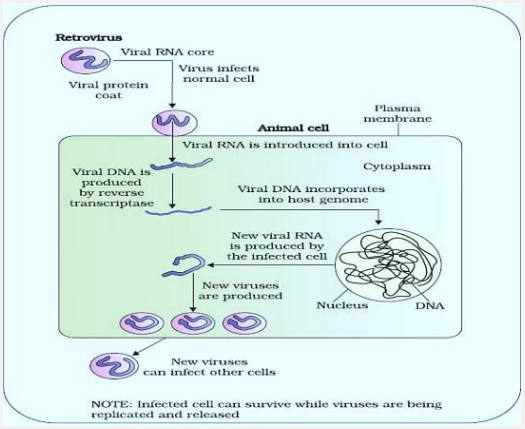
Elephantiasis or Filariasis	Wuchereria (W. bancrofti and W. malayi)	Infect lymphatic vessels Chronic inflammation of the organs like lower limbs and genitals.
Ringworms	Microsporum, Trichophyton and Epidermophyton	Appearance of dry, scaly lesions on various parts of the body such as skin, nails and scalp
AIDS	HIV	Syndrome
Dengue	Dengue virus	high fever, headache, joint pains, chill, rashes, abdominal pain, Liver disorder, fall in platelets
Chikungunya	Virus	rashes on limbs and trunk, arthritis of multiple joints, high fever, conjunctivitis

MALARIA

- Pathogen- Plasmodium (P. vivax, P. malaria and P. falciparum). Malignant malaria caused by Plasmodium falciparum is the most serious and can be fatal.
- Vector- female Anopheles mosquito
- Plasmodium enters the human body as sporozoites (infectious form) through the bite of infected female Anopheles mosquito.
- The parasites in the liver cells and then rupture the RBCs.
- The rupture of RBCs results in formation of haemozoin, which is responsible for the chill and high fever recurring every three to four days.
- When a female Anopheles mosquito bites an infected person, these parasites enter the mosquito's body and undergo further development and again form sporozoite.
- The sporozoites are stored in their salivary glands.



AIDS (Acquired Immuno Deficiency Syndrome)



- Pathogen –HIV a retrovirus (RNA containing virus)
- Transmission- occurs by (a) sexual contact with infected person, (b) by transfusion of contaminated blood (c) by sharing infected needles (d) from infected mother to her child through placenta.
- After infection, the virus enters into macrophages (HIV factory). In macrophages viral RNA replicates to form viral DNA with the help of the enzyme reverse transcriptase.
- This viral DNA gets incorporated into host cell's DNA and directs the infected cells to produce virus particles.
- Simultaneously, HIV attacks helper T-lymphocytes (TH). Thus number of TH cells decreases significantly. Due to this the infected person starts suffering from various infections like of Mycobacterium, viruses, fungi and Toxoplasma.
- Symptoms- fever, diarrhoea and weight loss etc.
- Diagnostic test- ELISA (enzyme linked immuno-sorbent assay)
- Treatment- Anti-retroviral drugs

IMMUNITY

Ability of the host to fight the disease-causing organisms, conferred by the immune system is called immunity.

Types - (i) Innate immunity and (ii) Acquired immunity.

Innate Immunity	Non- specific, present at the time of birth
Acquired immunity	Pathogen specific, after birth

Barriers of Innate immunity

Physical barriers	Skin, Mucus coating of the epithelium lining	It prevents entry of the micro-organisms
Physiological barriers	Acid in the stomach, saliva in the mouth, tears from eyes	prevent microbial growth
Cellular barriers	WBC, polymorpho-nuclear leukocytes (PMNL-neutrophils)	Phagocytose and destroy microbes.
Cytokine barriers	Virus-infected cells secrete proteins called interferons	protect non-infected cells from further viral infection

Acquired Immunity

- It is characterised by memory.

Primary response- When or body encounters a pathogen for the first time produces low intensity response.

Secondary response- Subsequent encounter with the same pathogen elicits a highly intensified secondary or anamnestic response.

The primary and secondary immune responses are carried out with the help of two special types of lymphocytes present in our blood- (i) B-lymphocytes and (ii) T lymphocytes.

B lymphocyte- they produces Antibodies (immunoglobin) in response to pathogens

T-cells - help B cells produce antibodies.

Antibody

- **H2L2 structure** – Antibodies are composed of four peptide chains, two small (light chains) and two longer (heavy chains).
- Types of antibodies - IgA, IgM, IgE, IgG.

Humoral immune response- Antibody mediated response.
Cell-mediated immune response or cell-mediated immunity (CMI)- -lymphocytes mediated response
Active and Passive Immunity

Active Immunity – In this antibodies are produced in the host cell after infection with antigens. Active immunity is slow and takes time to give its full effective response
Passive Immunity- When ready-made antibodies are directly given to protect the body against foreign agents. e.g. baby receives a mother's antibodies through the placenta or breast milk.

Vaccination and Immunisation

Vaccination

- In this a preparation of antigenic proteins of pathogen or inactivated/weakened pathogen (vaccine) are introduced into the body.
- The antibodies produced in the body against these antigens would neutralise the pathogenic agents during actual infection.
- The vaccines also generate memory – B and T-cells that recognise the pathogen quickly on subsequent exposure and overwhelm the invaders with a massive production of antibodies.

Immunisation

- This is a process by which the body produces antibodies against the vaccine (primary response) and develop the ability to neutralise pathogens during actual infection (secondary response), i.e. the body become immune to that antigen or infection.

Allergies

- The exaggerated response of the immune system to certain antigens (allergens) present in the environment is called allergy. Common allergens are - pollen grains, mite in dust, animal dander etc.
- Allergic reactions are due to chemicals like histamine and serotonin released from the mast cells.
- Antibody IgE are produced in response to allergens.
- Symptoms of allergy - sneezing, watery eyes, running nose, difficulty in breathing.
- Treatment- Antihistamine, adrenaline and steroids

Auto Immunity

- It is an abnormal in which immune response starts rejecting its own body cell or self-cells and molecules e.g. Rheumatoid Arthritis. Such diseases are known as auto-immune disease.

CANCER

- Cancer is a disease in which some of the body's cells grow uncontrollably and spread to other parts of the body.
- It shows uncontrolled proliferation of cells without any differentiation.

Contact inhibition- This is the process which inhibits the uncontrolled growth of a normal cell due to its contact with the surrounding cells. Cancerous cell lost this property.

Tumor- The repeated division of cancerous cells form a large mass of cells called tumours.

Tumors are of two types: benign and malignant.

Benign tumors	Remain confined to their original location and do not spread to other parts of the body and cause little damage.
Malignant tumors	These cells grow very rapidly, invading and damaging the surrounding normal tissues of other organs

Metastasis- Cancer cells move from tumour to new sites through blood for forming secondary tumours. This invasion of cancer cells from one part to other parts by the body fluids is called metastasis.

Carcinogens (cancer causing agents)

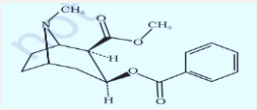
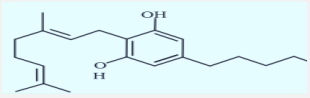
Chemicals	nicotine
Biological	Oncogenic viruses
ionising radiation	X-rays and y-rays
non-ionising radiations	UV-rays

- **Oncogenic virus**- These are cancer causing viruses is called oncogenic viruses. They have genes called viral oncogenes.

Diagnosis- Biopsy and histopathological studies of the tissue and blood and bone marrow tests for increased cell counts in the case of leukemias, Radiography by X-rays, CT scan, MRI, use of Antibodies against cancer -specific antigens

Treatment of cancer- (a) Surgery (b) Radiation therapy (c) Chemotherapy (d) Immunotherapy- use of Biological modifiers like a-interferon

DRUGS AND ALCOHOL ABUSE

Drug	Common name and source	Effect
Opoids 	Heroin (smack) Source - Latex of poppy (*Papaver somniferum*)	Bind to specific opioid receptors present in our CNS and gastrointestinal tract. Heroin is a depressant and slows down body functions
Cannabinoids 	Example- marijuana, hashish, charas and ganja. Obtained from *Cannabis sativa*.	Interact with cannabinoid receptors present principally in the brain. Effects on cardiovascular system of the body.
Coca alkaloid	coke or crack Obtained from coca plant Erythroxylum coca.	interferes with the transport of the neuro-transmitter dopamine. It acts on CNS producing a sense of euphoria and may cause hallucinations.
Nicotine	Tobacco	Stimulates adrenal gland , raise blood pressure and increase heart rate
Barbiturates, Amphetamines, Benzodiazepines, lysergic acid diethyl amides (LSD), used as medicine to help patients cope with mental illnesses like depression and insomnia.		

ADOLESCENCE, ADDICTION AND DEPENDENCE

- Adolescence (12-18 years) is a bridge linking childhood and adulthood. It is accompanied by several biological and behavioural changes. Adolescence thus is a very vulnerable phase of mental and psychological development of an individual.
- Addiction is a psychological attachment to certain effects –such as euphoria and a temporary feeling of well-being – associated with drugs and alcohol.
- Dependence is the tendency of the body to manifest a characteristic and unpleasant withdrawal syndrome if regular dose of drugs/alcohol is abruptly discontinued.

IMPORTANT QUESTIONS

Very Short Answer Type Questions

1- Give any two molecular diagnosis techniques used to diagnose disease.

Ans: Widol test for typhoid
Biopsy- Cancer

2- Malignant malaria is caused by which pathogen?

Ans: Plasmodium falciparum

3- Interferons are secreted by which type of cell. What is the chemical nature of interferon?

Ans: interferon is secreted by virus infected cell. Interferons are protein.

4- Name the infective stage of malaria parasite in human. In which organ of mosquito that is situated?

Ans: Sporozoite. Situated in mosquito salivary gland

5- **Malaria parasite requires two hosts to complete its life cycle. Identify the host where following events takes place**-

(i)Asexual reproduction and gametocyte formation (ii) Fertilization (fusion of gametocyte)

Ans: (i) Human (ii) Mosquito

6- **Name any four types of immunoglobin present in human immune system**.

Ans: IgA, IgM, IgE, IgG

7- Provide two means of passive immunity through which foetus and newly born baby get protected from infection.

Ans: The yellowish fluid colostrum secreted by mother during the initial days of lactation. The foetus also receives some antibodies from their mother, through the placenta during pregnancy.

8- **Identify the type of immunoglobins in the followings**-

(i)In colostrum (ii) released during allergic response

Ans: (I) Ig A (II) Ig E

9- Why it is not possible to treat autoimmune diseases. Give one example of such disease.

Ans: there is no treatment of such diseases because immune system of body attacks self-cells. Example- Rheumatoid arthritis

10- Mention any two drugs that are used treat mental illnesses like depression and insomnia.

Ans: Barbiturates, Amphetamines

Short Answer Type Question

1- Give detailed account on factors which affects disease.

Ans: (i) genetic disorders – deficiencies with which a child is born and deficiencies/defects which the child inherits from parents from birth
(ii) Infections

(iii) Life style including food and water we take

2- Explain disease and its type with two examples of each.

Ans: Complete physical, mental and social well-being is known as health.

Infectious disease – cancer, arthritis

Non infectious disease- flu, tuberculosis

3- **Primary immune response is of slow intensity than secondary immune response. Justify the statement**.

Ans: when our body pathogen for the first time it produces primary response which is of low intensity. Subsequent encounter with the same pathogen shows quick and highly intensified secondary or anamnestic response. This is because in primary response antibodies are formed which have property of memory.

4- (i) Draw the structure of immunoglobin.

(ii) Why immunoglobins are called as H_2L_2 molecules.

Ans: (i) fig 8.4, page 151, NCERT

(ii) Because it contains two heavy chains (H2) and two light chains (L2) of polypeptide

5- (i) What is allergy?

(ii) Name two factors which are responsible for allergy in out body.

(iii) List any two medicine advised by doctors to reduce the effect of allergy.

Ans: (i) he exaggerated response of the immune system to certain antigens present in the environment is called allergy

(ii) Histamine and serotonin

(iii) Anti-histamine, adrenalin

6- Which cell is known as factory of HIV and why?

Ans: Macrophages are called as HIV factory. After entering into the e host body, HIV moves into macrophages where its RNA replicates to form viral DNA. This viral DNA gets incorporated into the host cells' DNA and directs the infected cells to produce more viruses. Hence macrophages continue to produce viruses and act as HIV factories.

7- **What are the different diagnosis techniques to detect cancer in a patient?**

Ans: CT scan, MRI, Biopsy, Blood and bone marrow tests are done for increased cell counts in case of leukaemia, X ray, Monoclonal antibodies test

8- (i) Name two recent incidences of wide-spread diseases caused by Aedes mosquitoes.

(ii) Mention the name of two pathogens which are responsible ringworm disease.

(iii) Which pathogen infects alveoli (of the lungs that result in severe breathing problem?

Ans: (i) Dengue and Chikungunya

(ii) Microsporum, Trichophyton

(iii) Streptococcus pneumoniae or Haemophilus influenzae

9- Differentiate between two different types of tumours? Which one is lethal and why?

Ans: (i) Benign tumour - tumour remain confined to place of origin or affected organ. Rate of growth of tumour is low.

(ii) Malignant tumour- it invades surrounding tissue & spread throughout the body. Rate of growth of tumour is rapid

Malignancy is lethal as it spreads all over body through the process of metastasis.

10- A person undergoes ELISA testing and tested positive-

(**i) ELISA is widely conducted to diagnose which disease.**

(ii) Write the causative agent of that disease.

(iii) Which organization in India educates people about that disease?

Ans:

(i)AIDS , (ii) HIV , (iii) NACO (National AIDS Control Organisation)

Long Answer Type Question

1- Describe different mechanism by which innate immunity protect the human body since birth.

Ans: Physical barriers - Skin prevents entry of the micro-organisms. Mucus coating of the epithelium lining (respiratory, gastrointestinal &urogenital tracts also help in trapping microbes entering our body)
Physiological barriers- Acid (stomach), saliva (mouth) , tears (eyes) prevent microbial growth.
Cellular barriers- Leukocytes (WBC) like polymorpho-nuclear leukocytes (PMNL-neutrophils), monocytes and natural killer in the blood, macrophages in tissues can phagocytose and destroy microbes
Cytokine barriers- Virus-infected cells secrete proteins called interferons which protect non-infected cells from further viral infection.

2- A disease has symptoms of high fever with chill. The causative agents depend on red blood cells of human body for their life cycle. Based on the statement answer the following questions-

(i) Why do patients suffer from high fever with chill?

(ii) Name the disease and its causative agent.

(iii) Represent the life cycle of the pathogen diagrammatically.

Ans. (i) due to release of chemical haemozoin from ruptured RBC, (ii) Malaria, Plasmodium (P. vivax, P. Malariae and P. falciparum). (iii) Life cycle of Plasmodium: Fig. 8.1 Page 148, NCERT

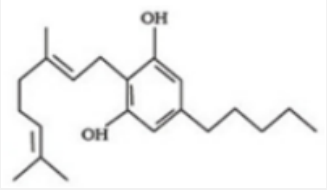
3- How addiction and dependence differ to each other? What are consequences of withdrawal syndrome?

Ans: Addiction is a psychological attachment to certain effects –such as euphoria and a temporary feeling of well-being – associated with drugs and alcohol.
Dependence is the tendency of the body to manifest a characteristic and unpleasant withdrawal syndrome if regular dose of drugs/alcohol is abruptly discontinued.
Withdrawal syndrome occurs if regular dose of drugs/alcoholic abruptly discontinued. This is characterised by anxiety, shakiness, nausea and sweating, which may be relieved when use is resumed again. In some cases, withdrawal symptoms can be severe and even life threatening and the person may need medical supervision

4- How does humoral immune system works when our body is infected?

Ans: Humoral immunity is also called as antibody mediated immunity.
In this Immunoglobins (antibodies) are developed from B- lymphocytes.
These antibodies (B-cell) have receptors on its surface that recognize a specific antigen.
The antibody binds to antigen- forming an antigen-antibody complex which is later digested by phagocytic cells like macrophages.

5- By observing the diagram answer the flowing questions-



(i) Mention the group of drug this structure represents.

(ii) How these drugs are taken by drug abusers?

(iii)Name the source of plant from which these are isolated.

(iv)Which part of human body is affected by this drug?

(v) Provide any two common names for this drug.

Ans: (i) Cannabinoids (ii) Oral Ingestion or inhalation (iii) Cannabis sativa
(iv) Cardiovascular system (v) Charas, ganja

CHAPTER- 10

Microbes in Human Welfare

Keywords

LAB	lactic acid bacteria
Fermenters	Large vessels used to culture microorganisms
Antibiotics	Substance produced by microorganism, that is detrimental to other microorganisms
Sewage	Sewage is a type of wastewater that is produced by a community of people
STPs	Sewage treatment plants
Flocs	masses of bacteria associated with fungal filaments form mesh like structures
BOD	biochemical oxygen demand
Methanogens	Methane producing bacteria
IARI	Indian Agricultural Research Institute
KVIC	Khadi and Village Industries Commission
Bio fertilizer	Microorganism used as fertilizer to improve soil quality
Bio pesticide	Living organisms used as pesticide
Mycorrhiza	Association between fungus and root of plants
Biocontrol	use of biological methods for controlling plant diseases and pests
IPM	Integrated pest management

MICROBES IN HOUSEHOLD PRODUCTS

- LAB- Lactobacillus group of bacteria are called lactic acid bacteria (LAB). The LAB produces lactic acid which coagulates and partially digests the milk proteins. This results in formation of curd. Curd is rich in vitamin B12 and it checks the disease causing microbes in stomach.
- Fermentation property – Microorganisms are also used to ferment dough which is widely used in formation of dosa, idli, bread. The puffed-up appearance of dough is due to the production of CO_2 gas.
- In bread formation baker's yeast (Saccharomyces cerevisiae) is used.
- Fermentation of palm sap is used to make traditional drinks like toddy.
- In cheese formation specific microbes are used-
- The large holes in 'Swiss cheese' are due to production of a large amount of CO2 by a bacterium named
- Propionibacterium sharmanii.
- The 'Roquefort cheese' is ripened by growing specific fungi on them.

MICROBES IN INDUSTRIAL PRODUCTS

- Beverages - wine, beer, whisky, brandy or rum. Brewer's yeast (Saccharomyces cerevisiae) is used for fermenting malted cereals and fruit juices, to produce ethanol.
- Wine and beer are produced without distillation.
- Whereas whisky, brandy and rum are produced by distillation of the fermented broth.

ANTIBIOTICS

- Antibiotics are chemical substances, which are produced by some microbes and can kill or retard the growth of other (disease-causing) microbes.
- Alexander Fleming discovered first antibiotic Penicillin from Penicillium notatum.

- Ernest Chain and Howard Florey established the full potential of Penicillin as an effective antibiotic.
- Antibiotics have greatly improved our capacity to treat deadly diseases such as plague, whooping cough, diphtheria, and leprosy etc.

CHEMICALS, ENZYMES AND OTHER BIOACTIVE MOLECULES

Microorganism	Name	Product
Fungus	Aspergillus niger	Citric acid
Bacterium	Acetobacter aceti	Acetic acid
Bacterium	Clostridium butylicum	Butyric acid
Bacterium	Lactobacillus	Lactic acid
Yeast	Saccharomyces cerevisiae	Ethanol
Lipases are used in detergent formulations and are helpful in removing oily stains from the laundry.		
Bottled fruit juices bought from the market are clearer as compared to those made at home. This is because the bottled juices are clarified by the use of pectinases and proteases.		

Product	Microorganism	Use
Streptokinase	Streptococcus	clot buster
Cyclosporin A	Trichoderma polysporum	immunosuppressive agent
Statins	Monascus purpureus	Blood-cholesterol lowering agents.

MICROBES IN SEWAGE TREATMENT

This municipal waste-water is also called sewage. Sewage) contains large amount of organic matter and pathogenic microbes, human excreta etc. Before disposal, hence, sewage is treated in sewage treatment plants (STPs)

Sewage treatment is done in two stages- primary treatment and secondary biological) treatment

Primary Treatment

- This involves physical removal of particles from the sewage through filtration and sedimentation.
- The effluent from the primary settling tank is taken for secondary treatment.

Secondary treatment (Biological treatment)

- The primary effluent is passed into large aeration tanks where it is constantly agitated mechanically and air is pumped into it.
- This allows vigorous growth of useful aerobic microbes as **flocs**. These microbes consume the major part of the organic matter in the effluent. This significantly reduces the BOD.
- Once the BOD of sewage reduced significantly, the effluent is then passed into a settling tank where the bacterial 'flocs' are allowed to sediment. This sediment is called **activated sludge**.
- A small part of the activated sludge is pumped back into the aeration tank to serve as the **inoculum**.
- The remaining major part of the sludge is pumped into large tanks called **anaerobic sludge digesters**. Here anaerobic bacteria produce biogas (methane, hydrogen sulphide and carbon dioxide).

- The effluent from the secondary treatment plant is generally released into natural water bodies like rivers and streams.

MICROBES IN PRODUCTION OF BIOGAS

- Biogas is (containing methane) produced by the microbial activity of methanogen on cow dung and cellulosic waste. Cow dung is common source of methanogens e.g. Methanobacterium.
- The biogas plant consists of a concrete tank (10-15 feet deep) in which bio-wastes are collected and slurry of dung is fed. Biogas plant has A floating cover is placed over the slurry (which keeps on rising as the gas is produced in the tank) an outlet (supply biogas to nearby houses).
- The spent slurry is removed through another outlet and may be used as fertilizer. The biogas thus produced is used for cooking and lighting.

MICROBES AS BIOCONTROL AGENTS

Biological control of pests and diseases

Bio- control refers to the control of pests by microorganisms.

- The organic farmer, therefore, works to create a system where the insects that are sometimes called pests are not eradicated, but instead are kept at manageable levels by a complex system of checks and balances within a living and vibrant ecosystem.
- The use of bio control measures will greatly reduce our dependence on toxic chemicals and pesticides.

Ladybird	aphids
Dragonflies	mosquitoes
Bacillus thuringiensis	Insects caterpillar
Trichoderma	Several plant pathogens
Baculoviruses e.g. NPV	insects

MICROBES AS BIOFERTILISERS

Bio-fertilizers are organisms that enrich the nutrient quality of the soil.

- Bacteria- Rhizobium in the root nodule of leguminous plants fixes atmospheric nitrogen into organic forms, which is used by the plant as nutrient. Azospirillum and Azotobacter are also used as nitrogen enriching bio fertilizers.
- Fungi- Many speciues of fungus form symbiotic association with roots of plants (Mycorrhiza).e.g.- Genus Glomus form mycorrhiza. The fungal mycelium absorbs phosphorus from soil and passes it to the plant. Such plants also show resistance to root-borne pathogens, tolerance to salinity and drought.
- Cyanobacteria- These blue green algae may fix atmospheric nitrogen. E.g. Anabaena, Nostoc, Oscillatoria etc. Blue green algae also add organic matter to the soil and increase its fertility

IMPORTANT QUESTIONS

Very Short Answer Type Questions

1- **Which organism is involved in curd formation? Mention the process of curd formation.**
Ans: Lactic acid bacteria are used in formation of curd.
The LAB produces lactic acid which coagulates and partially digests the milk proteins.

2- **Swiss cheese has large holes. Give the reason. Also mention the name of microorganism responsible for this.**

Ans: the large holes in 'Swiss cheese' are due to production of a large amount of CO_2 by a bacterium named Propionibacterium sharmanii.

3- **Full potential of Penicillin is established by which scientist?**
Ans: Ernest Chain and Howard Florey

4- **Write scientific name of baker's yeast and brewer's yeast.**
Ans: Saccharomyces cerevisiae

5- **What for Nucleopolyhedra viruses (NPV) are being used nowadays?**
Ans: NPV is used as bio control agents for insect control

6- **Name a biological product which is used to remove stain from the clothes?**
Ans: Lipase

7- **List an immune immunosuppressive agent and also, mention the name of source organisms.**
Ans: Cyclosporin A, source organism: Trichoderma polysporum

8- **Why bottled juice looks clearer than homemade juice.**
Ans: Proteases and pectinases are used which digest pectin and make juice clearer.

9- **Why is secondary treatment of water in sewage treatment plant called biological treatment?**
Ans: In this treatment Organic wastes of sewage water are decomposed by certain microorganisms in presence of water.

10- **Name the plant whose sap is used in making Toddy. Mention the process involved in it.**
Ans: Palm tree, Fermentation process

Short Answer Types Questions

1- **Expand BOD. Mention its significance in sewage treatment plant.**
Ans: BOD refers to the amount of the oxygen that would be consumed if all the organic matter in one liter of water were oxidized by bacteria. The sewage water is treated till the BOD is reduced. The greater the BOD of waste water, more is its polluted.

2- **Alexander Fleming observed that in presence of Penicillium notatum a particular species "A" can't grow. Give the reason and also identify "A".**
Ans: "A" is Staphylococci bacteria.
- 'A' is unable to grow because chemical Penicillin (now called as antibiotic) is released by Penicillium notatum

3- **Give two examples each of distilled and non-distilled beverages.**
Ans: Wine and beer (without distillation), whisky, brandy (distillation) of the fermented broth

4- **Name the type of association that genus Glomus exhibits with the higher plant. How it is beneficial for plants?**
- Ans: Mycorrhiza
- The fungal mycelium absorbs phosphorus from soil and passes it to the plant. Such plants also show resistance to root-borne pathogens, tolerance to salinity and drought.

5- **From which organism we can obtain clot buster. Write its use.**
Ans: clot buster is obtained from Streptococcus. It is used for removing clots from the blood vessels of patients who have undergone myocardial infarction.

6- **How Flocs are formed during sewage treatment. Mention its application.**
- Ans: Flocs are mesh like structure containing aerobic bacteria and fungal mycelium.
- These are forms in aerobic tank when organic matter is abundant.

- Flocs digest organic matter and reduce the BOD of sewage water.

7- Why is sewage water treated until the BOD is reduced? Give a reason.at which stage of sewage treatment BOD reduces significantly.

- Ans: The greater the BOD of sewage water more is its polluting potential. So, the sewage water is treated, till its BOD is reduced to reduce the organic matter present in it.
- At secondary level during biological treatment flocs reduces BOD significantly.

8- A farmer is advised to add a culture of microorganisms in the soil before sowing the crop. Name two microorganisms which can be helpful for farmer. How these microbes useful to the crop?

Ans: bio fertilizers: Rhizobium, Cyanobacteria

These microorganisms enrich the nutrient quality of the soil.

They can fix atmospheric nitrogen into organic forms, which is used by the plants as nutrient.

9- Why are biofertilizers or biopesticides preferred to chemical fertilizers or pesticides?

Ans: They do not cause any pollution.

They do not spoil the quality of the soil.

Biopesticides are target specific.

They are less expensive and are biodegradable.

10- Write the chemical nature of biogas. Name one organism which produces biogas. Name the institutions that developed technology of biogas production in India.

Ans: Chemical nature of biogas – CH_4 , CO_2 , H_2.

Organism: Group of bacteria known as methanogens. E.g. Methanobacterium

Indian Agricultural Research Institute (IARI) and Khadi and Village Industries Commission

Long Answer Type Questions

1- Explain the process of secondary sewage treatment.

Ans: •The primary effluent is passed into large aeration tanks where it is constantly agitated mechanically and air is pumped into it.

•This allows vigorous growth of useful aerobic microbes as flocs. These microbes consume the organic matter in the effluent. This significantly reduces the BOD.

•Once the BOD of sewage reduced significantly, the effluent is then passed into a settling tank where the bacterial 'flocs' are allowed to sediment. This sediment is called activated sludge.

•The major part of the sludge is pumped into anaerobic sludge digesters. Here anaerobic bacteria produce biogas (methane, hydrogen sulphide and carbon dioxide).

•The effluent from the secondary treatment plant is generally released into natural water bodies like rivers and streams.

2- (i) Draw a typical biogas plant.

(ii) Describe how biogas is obtained from the activated sludge?

Ans: (i) Fig. 10.8, Page 186, NCERT

(ii) Biogas formation from activated sludge:

- Major portion of activated sludge is pumped into anaerobic sludge digesters.
- Here, anaerobic bacteria digest the organic material of the sludge.

- During this digestion, the methanogen bacteria produce biogas (methane, carbon dioxide hydrogen sulphide)

3- Organic farmers use microbes to decrease the use of chemical pesticides. By giving five examples, Explain how can this be accomplished?

Ans: Organic farmer believes that use of bio control measures will greatly reduce our dependence on toxic chemicals and pesticides.

Ladybird	Aphids
Dragonflies	Mosquitoes
Bacillus thuringiensis	Insects caterpillar
Trichoderma	Several plant pathogens
Baculoviruses, NPV	Insects

4- Microbes may be very useful for human being. Give at least five examples in favour of your answer.

Ans: Microbes are the major components of biological systems on this earth. They may be very useful for mankind in following ways-

- As biofertilizers- Rhizobium, Cyanobacteria, Azotobacter are goof nitrogen fixing organisms
- Biopesticides- Trichoderma, NPV, Dragonfly, and Bacillus thuringiensis are good biopesticides.
- Sewage treatment and Biogas formation- Aerobic bacteria and methanogens
- Antibiotics- Penicillum ntatum produce Penicillin
- Food and beverages – LAB- curd formation, (Saccharomyces cerevisiae) in bakery and brewers industry

5- Various bioactive molecules and chemical are produced from microorganisms by using modern technology. Give a brief account on them

Ans:

Microorganism	**Name**	**Product**
Fungus	Aspergillus niger	Citric acid
Bacterium	Acetobacter aceti	Acetic acid
Bacterium	Clostridium butylicum	Butyric acid
Bacterium	Lactobacillus	Lactic acid
Yeast	Saccharomyces cerevisiae	Ethanol
Lipases are used in detergent formulations and are helpful in removing oily stains from the laundry.		
Bottled fruit juices bought from the market are clearer as compared to those made at home. This is because the bottled juices are clarified by the use of pectinases and proteases.		
Product	**Microorganism**	**Use**
Streptokinase	Streptococcus	clot buster
Cyclosporin A	Trichoderma polysporum	immunosuppressive agent
Statins	Monascus purpureus	Blood-cholesterol lowering agents.

CHAPTER 11
BIOTECHNOLOGY: PRINCIPLES AND PROCESSES

Key words

Biotechnology	'The integration of natural science and organisms, cells, parts thereof, and molecular analogues for products and services.
Recombinant DNA	Desired DNA + Vector DNA
Origin of replication	which is responsible for initiating replication
Plasmid	autonomously replicating circular extra-chromosomal DNA
Restriction enzymes	Cut DNA at specific locations
Vector	Transfer DNA/r-DNA to the host
Cloning	Obtaining multiple copies of r-DNA
Exonucleases	Exonucleases remove nucleotides from the ends of the DNA
Endonucleases	Cuts at a specific position in palindromic sequence within the DNA
Palindromic sequences	The same reading frame on opposite polarity strand of DNA
ampR , tet R	Ampicillin and Tetracycline resistant gene
DNA ligases	Ligate adjacent nucleotides
Electrophoresis	Separation of charged particles under influence of electric current.
Elution	Obtaining DNA from agarose gel
Downstream processing	It is the separation and purification of the product.

PRINCIPLES OF BIOTECHNOLOGY

- Genetic engineering: Techniques to alter the chemistry of genetic material (DNA and RNA).
- Bioprocess engineering: Maintenance of sterile (microbial contamination-free) conditions to enable the growth of only the desired microbe/eukaryotic cell in large quantities for the manufacture of biotechnological products like antibiotics, vaccines, enzymes, etc.

Three basic steps in genetically modifying an organism-

- identification of DNA with desirable genes;
- introduction of the identified DNA into the host;
- maintenance of introduced DNA in the host and transfer of the DNA to its progeny

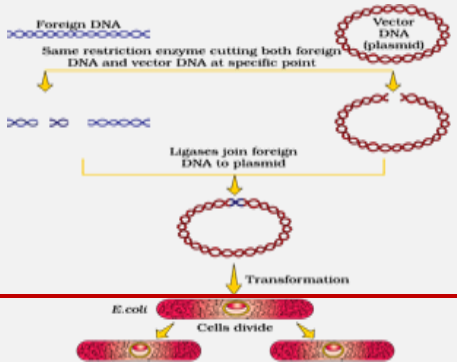
TOOLS OF RECOMBINANT DNA TECHNOLOGY

Restriction enzymes

- A restriction enzyme is a type of nuclease enzyme that cleaves DNA at specific sites, producing DNA fragments with a known sequence.
- The nuclease enzyme may be – exonucleases and endonucleases.
- Example of restriction endonuclease- Eco RI
- Nomenclature of restriction endonuclease -
- Palindromic sequence of EcoRI

E	Genus, Escherichia
co	Species, coli
R	Strain
I	Order of isolation

5′ —— GAATTC —— 3′
3′ —— CTTAAG —— 5′

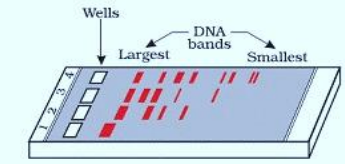


PROCESS OF R-DNA FORMATION

- Isolation of DNA- DNA containing the desired sequence is isolated
- Amplification of Gene of Interest by PCR
- Cleavage of DNA- Both desired DNA and Vector DNA are cleaved with the same restriction endonuclease
- Ligation of desired DNA with Vector DNA
- Insertion of recombinant DNA into the host (formation of r-DNA)

Electrophoresis

- This technique is used to separate cleaved DNA sequences as bands based on their size.
- The DNA samples are loaded into wells on an agarose gel.
- When electricity is passed, being negatively charged the DNA molecules move toward the positive charge end.
- DNA fragments can be visualized by using Ethidium bromide under UV lamp.



CLONING VECTORS

Cloning vectors are utilized to insert desired DNA into another host cell and create multiple copies of the same. The main properties of cloning vectors are-

1- **Origin of replication (ori):** This is responsible for replication. This sequence is also responsible for controlling the copy number of the linked DNA.
2- **Selectable marker:** It helps in identifying and eliminating non-transformants. These may be chemical markers (ampicillin, chloramphenicol, tetracycline, or kanamycin) and phenotypic marker (beta-galactosidase).
3- **Cloning sites:** It is the site where desired DNA is inserted into the vector.

Selection of transformants and recombinants

- Selectable markers help in the identification of transformants and non- transformants.
- The gene of interest is ligated in one of the selectable markers (e.g., antibiotic-resistant gene). This result in insertional inactivation. The inactivated sequence lost its property. This method is used to select transformants and recombinants.
- Insertional inactivation is also carried out with the phenotypic marker gene (bet galactosidase). Such bacterial colonies don't produce any colour.

4- Vectors for cloning genes in plants and animals

Agrobacterium tumifaciens – This plant pathogen is now used as a cloning vector.
Retroviruses – these are used as vectors in animals.

Competent Host (For Transformation with Recombinant DNA)

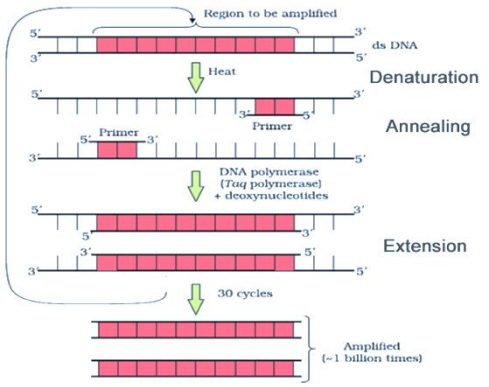
Method	Explanation
Divalent cation	Treating a cell with a specific concentration of a divalent cation, such as calcium, increases the cell's efficiency to take DNA.
Heat and shock	incubating the host cell under heat and then ice, create pores on the wall through which DNA enters the bacterium.
Micro-injection	r- DNA is directly injected into the nucleus of an animal cell
Biolistic/ Gene gun method	plant cells are bombarded with high-velocity micro-particles of gold or tungsten coated with DNA.
Disarmed pathogen vectors	Infect host cell and transfer r- DNA into them

Isolation of the Genetic Material (DNA)

Chemical	Used for	Chemical	Used for
Lysozyme	To break the bacterial cell wall.	Cellulase	To break the plant cell wall
Chitinase	To break the fungal cell wall.	Ribonuclease	Removes RNA
Protease	Removes proteins (histones associated with DNA).	Chilled ethanol	Precipitate DNA

Amplification of Gene of Interest using PCR-

- Artificial method (invitro) of DNA cloning.
- The specific enzyme Taq Polymerase a type of DNA Polymerase used is isolated from Thermus aquaticus bacteria. The enzyme can withstand very high temperature.



Steps involved in PCR –

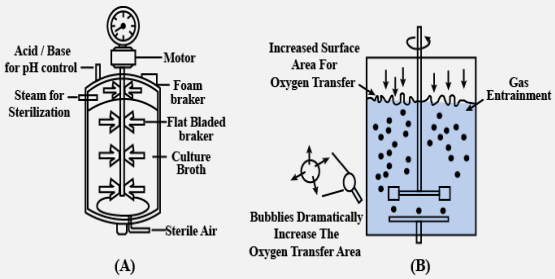
- Denaturation: At high temp. DNA molecule denatures.
- Annealing: At low temp. the primers are attached to the DNA molecule.
- Extension: Taq DNA polymerase the DNA strand by adding dNTPs

BIOREACTOR

- It is the cylindrical vessel of large volumes (100-1000 litres) in which culture can be processed to obtain desired products by using downstream processing.
- In bioreactors, r-hosts are provided with optimal conditions (nutrient, temperature, pH, substrate, salts, vitamins, oxygen) for culture recombinant cells.

Bioreactors are of two types-

1- Simple stirred tank bioreactor- cylindrical or with a curved base to facilitate the mixing of the reactor contents and the stirrer facilitates even mixing and oxygen availability throughout the bioreactor.
2- Sparged stirred-tank bioreactor- sterile air is sparged through the reactor.



IMPORTANT QUESTIONS

Very Short Answer Type Questions

1- **Define biotechnology as given by the European Federation of Biotechnology (EFB).**
Ans: 'The integration of natural science and organisms, cells, parts thereof, and molecular analogues for products and services.

2- **Why alien DNA is linked with the origin of replication sequence?**
Ans: Alien DNA is linked with the origin of replication, so that, this alien piece of DNA can replicate and multiply itself in the host organism.

3- **Write the recognition sequence/ cleavage site of Eco RI.**

Ans: 

4- **Nowadays says which matrix is used in gel electrophoresis? From which source one can get gel used in electrophoresis?**
Ans: Nowadays the most commonly used matrix is agarose. The main source of this is seaweeds.

5- **Which dye is used to visualize DNA bands on electrophoresis?**
Ans: Ethidium bromide-stained gel exposed to UV light

6- **Give examples of any four antibiotics which are used as selectable markers in the cloning vector.**
Ans: ampicillin, chloramphenicol, tetracycline or kanamycin

7- **Why it is considered that a single recognition site in a vector is better than multiple recognition?**
Ans: The presence of more than one recognition site within the vector will generate several fragments, which will complicate gene cloning.

8- **Why are proteases added while isolating the DNA?**
Ans: to remove histone proteins from DNA

9- **What is T- DNA? Write its importance in genetic engineering.**
Ans: it is a piece of DNA of Agrobacterium tumifaciens. T-DNA transform normal plant cells into tumour cell.

10- **Name one widely used artificial vector and one natural vector used to make GMOs.**
Ans: pBR322, Retrovirus

Short Answer Type Questions

1- **Write nomenclature method of restriction endonuclease EcoRI.**
Ans: E -Genus, Escherichia, co - Species, coli, R- Strain, I- Order of isolation

2- **Explain the one advantage of using Agrobacterium in genetic engineering?**
Ans: Agrobacterium tumefaciens is a bacterial plant pathogen. It infects plants and causes crown gall disease. This disease is induced by Ti plasmid (tumour-inducing plasmid). The Ti plasmid incorporates T-DNA into the host plant cell.

3- **What are two core techniques that enabled the birth of modern biotechnology.**
Ans: Genetic engineering: Techniques to alter the chemistry of genetic material (DNA and RNA).
Bioprocess engineering: Maintenance of sterile (microbial contamination-free) for optimal growth of desired microbes.

4- **What do you understand by the term selectable marker? Give two examples of selectable markers.**
Ans: A selectable marker is a gene which is used in the selection of transformants and recombinants.
Example: phenotypic marker (antibiotic resistant gene like ampR, tetR) and genotypic marker (beta-galactosidase)

5- **List three basic steps required in the creation of GMOs (genetically modifying an organism).**
Ans: (i) identification of DNA with desirable genes;
(ii) introduction of the identified DNA into the host;
(iii) maintenance of introduced DNA in the host and transfer of the DNA to its progeny.

6- **Draw a typical agarose gel electrophoresis showing migration of DNA fragments and label any four parts.**

Ans: Fig11.3, page 198, NCERT

7- **What are restriction enzymes? From where one can isolate it? How many linear DNA fragments will be produced when a circular plasmid is digested with a restriction enzyme having two sites?**

Ans: Restriction enzymes are a type of nuclease enzyme that can cut DNA fragment.
One can isolate it mainly from bacteria and a few other microorganisms.
Four fragments will produce.

8- **Who constructs the recombinant DNA? Which organism does he use for this purpose?**

Ans: Cohen and H. Boyer constructed the first r- DNA using antibiotic resistance genes present on the plasmid.
He used the bacterium Salmonella typhimurium.

9- **What features make plasmid a good cloning vector?**

Ans: Plasmids are low molecular weight extrachromosomal genetic material, it has an origin of replication centre, self-replication, have cleavage site for restriction endonucleases, selectable markers and are easily available.

10- **(i) Name the enzymes that are used for the isolation of DNA from bacterial and fungal cells for rDNA technology.**
(ii) Why is enzyme cellulase used for isolating genetic material from plant cells and not from animal cells?

Ans: (i) Lysozyme for bacterial cell and chitinase for the fungal cell.
(ii) Cellulase is used to break plant cell wall, animal cells lack a cell wall therefore cellulose will not work on animal cells.

Long Answer Type Questions

1- **(i) Explain the correct sequential step of polymerase chain reaction.**
(ii) Which enzyme is used for PCR and why?
(iii) What s the source of that enzyme?

Ans: (i) the correct steps are

- Denaturation- separation of ds DNA into ss DNA at high temperature (92℃).
- Annealing- attachment of primers towards 3' end of both strands.
- Extension- To polymerization on primer to form new ds DNA.

(ii) Enzyme used is Taq DNA Polymerase.
(iii) Source of the enzyme is bacteria Thermus aquaticus.

2- **What is Bioreactor? What are the advantages of Stirred tank Bioreactor? Show diagrammatically a simple Stirred tank Bioreactor?**

Ans: Bioreactors are large vessels in which raw materials are biologically converted into specific biological products.
Stirred tank Bioreactor provides optimal conditions (temp., pH etc), it also has an agitation system, and foam control system for better growth.
Fig. 11.7 (a), page 204, NCERT

3- **Diagrammatically represent the steps in the formation of recombinant DNA by the action of restriction endonuclease enzyme – EcoRI.**

Ans: Fig. 11.1 page 196 NCERT

4- **What is genetic engineering? Explain briefly the different steps involved in genetic engineering technology.**

Ans: Genetic engineering is a technique of modification/alteration of the genome and its application for human welfare.

Steps:

- Isolation of genetic material containing the desired gene.
- Cleavage of the sequence of DNA containing the gene of interest and vector gene with the same restriction endonuclease.
- Amplification of gene using PCR.
- Formation of r- DNA by ligating vector DNA and gene of interest
- Using gene transfer technology transfer of r- DNA into the host cell.

5- Explain any four methods of vector-less gene transfer and one method which involve vectors.

Ans:

Method	**Explanation**
Vector less Method	
Divalent cation	Treating a cell with a specific concentration of a divalent cation, such as calcium, increases the cell's efficiency to take DNA.
Heat and shock	incubating the host cell under heat and then ice, create pores on the wall through which DNA enters the bacterium.
Micro-injection	r- DNA is directly injected into the nucleus of an animal cell
Biolistic/ Gene gun method	plant cells are bombarded with high-velocity micro-particles of gold or tungsten coated with DNA.
Vector mediated	
Disarmed pathogen	Infect host cell and transfer r- DNA into them

CHAPTER 12
BIOTECHNOLOGY AND ITS APPLICATION

KEYWORDS

GMOs	Genetically modified organisms these are genetically modified living organisms like plants, animals and microorganisms.
Biopesticide	The pesticide of biological origin
PCR	Polymerase chain reaction
ELISA	Enzyme-linked immunosorbent assay
Bt	Bacillus thuringiensis
Transposons	These are mobile genetic elements that replicate via an RNA intermediate.
Biopiracy	Use of bioresources with proper authentication

Biotechnology has many applications, including biopharmaceuticals, therapeutics, diagnostics, genetically modified crops, processed food, bioremediation, waste treatment and energy production.

Three critical research areas of Biotechnology:

- Providing the best catalyst in the form of an improved organism usually a microbe or enzyme.
- Creating optimal conditions through engineering for a catalyst to act.
- Downstream processing technologies to purify the protein/organic compound.

APPLICATION IN AGRICULTURE

- Agro-chemical-based agriculture: It uses fertilizers & pesticides
- Organic agriculture
- Genetically engineered crop-based agriculture

ADVANTAGES OF GENETIC MODIFICATION IN PLANTS:

- It makes crops more tolerant to abiotic stresses (cold, drought, salt, heat etc.).
- Pest-resistant crops reduce the use of chemical pesticides.
- It reduces post-harvest losses.
- It increases plant mineral usage efficiency (it prevents soil fertility's early exhaustion).
- It enhances the nutritional value of food. E.g. Golden rice (Vitamin A enriched rice).
- To create tailor-made plants to supply alternative resources (starches, fuels, pharmaceuticals etc.) to industries.

PEST RESISTANT PLANTS

- They act as bio-pesticide.
- It reduces the need for insecticides.
- E.g. Bt cotton, Bt corn, rice, tomato, potato, soybean, etc.

Bt Cotton:

- Some strains of bacteria Bacillus thuringiensis have proteins that kill insects like coleopterans (beetles), lepidopterans (tobacco budworm, armyworm) & dipterans (flies, mosquitoes).
- B. thuringiensis forms Bt toxin. Bt toxin is a crystalline insecticidal protein,
- When an insect ingests the toxin, it becomes active due to alkaline pH in the midgut of the insect and creating pores. This causes the death of the insect.

- Bt toxin genes were isolated from bacteria B. thuringiensis and incorporated into crop plants such as cotton by using genetic engineering.

CRY Genes

Cry genes code Bt toxin. Cry genes are of the following types-

cryIAc & cryIIAb	control cotton bollworms
cryIAb	controls corn borer

NEMATODE RESISTANCE IN TOBACCO PLANTS

RNAi (RNA Interference)/ RNA Silencing

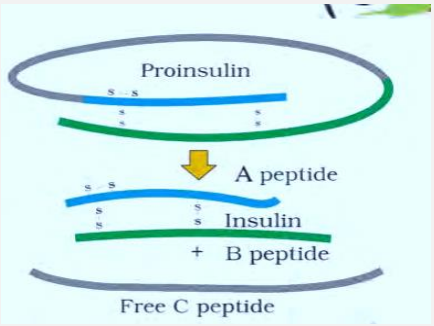
- Nematode - Meloidogyne incognita
- Plant- Tobacco
- Vector used- Agrobacterium
- A nematode infects the roots of tobacco plants.
- The process of RNA interference (RNAi) involves silencing of a specific mRNA due to a complementary dsRNA (double-stranded m RNA) molecule that binds to and prevents translation of the mRNA, also referred to as RNA silencing.
- The source of this complementary RNA could be from infection by viruses having RNA genomes or transposons.
- Using Agrobacterium vectors, nematode-specific genes were introduced into the host plant such that it produced both sense and anti-sense RNA in the host cells.
- Two RNA's being complementary to each other forming a dsRNA that initiated RNAi and thus, silenced the specific mRNA of the nematode.

ADVANTAGES OF GENETIC MODIFICATION IN PLANTS:

- It makes crops more tolerant to abiotic stresses (cold, drought, salt, heat etc.).
- Pest-resistant crops reduce the use of chemical pesticides.
- It reduces post-harvest losses.
- It increases plant mineral usage efficiency (it prevents soil fertility's early exhaustion).
- It enhances the nutritional value of food. E.g. Golden rice (Vitamin A enriched rice).
- To create tailor-made plants to supply alternative resources (starches, fuels, pharma etc)

APPLICATIONS IN MEDICINE

Genetically Engineered Insulin



- Insulin from the pancreas of animals (cattle & pigs) causes allergy or other types of reactions to the foreign protein.
- Human insulin consists of two short polypeptide chains (chain A & chain B) that are linked by disulphide bridges.
- Another chain C peptide is removed during the maturation process
- In 1983, Eli Lilly (an American company) prepared two DNA sequences corresponding to A & B chains of human insulin and introduced them in plasmids of E. coli to produce insulin chains.
- Chains A & B were combined by creating disulphide bonds to form human insulin (Humulin).

GENE THERAPY

- Gene therapy is a method that allows the correction of a faulty gene by a correct and functional gene.
- First evidence - 1990 to a 4-year-old girl with adenosine deaminase (ADA) deficiency which is caused due to the deletion of the gene for adenosine deaminase. ADA enzyme is crucial for the immune system to function.
- Lymphocyte culture - Lymphocytes from the blood of the patient are grown in a culture outside the body and a functional ADA cDNA (using a retroviral vector) is then introduced into these lymphocytes using a retroviral vector which is returned to the patient. It is not a permanent method as lymphocytes are not immortal.
- Enzyme replacement- in this functional ADA is given to the patient by injection. This required periodic infusion of injection.
- Bone marrow transplantation- If the ADA gene from marrow cells is introduced into cells at early embryonic stages, it could be a permanent cure.

MOLECULAR DIAGNOSIS

PCR (Polymerase Chain Reaction)	A very low concentration of a bacteria or virus can be detected by amplification of their nucleic acid by PCR. To detect HIV in suspected patients. To detect gene mutations in suspected cancer patients.
ELISA (Enzyme-Linked Immuno-Sorbent Assay)	It is based on antigen-antibody interaction. To detect HIV- AIDS
Autoradiography	To find out mutated genes

STEM CELL TECHNOLOGY

Stem Cells are present in the inner cell mass of the embryo, and bone marrow. It has the ability to develop in all types of tissues and organs. These cells are also involved in the development, growth, and repair of the organism. These properties are used to treat many diseases such as heart disease, kidney disease, type-I diabetes, arthritis, muscular dystrophy, etc.

TRANSGENIC ANIMALS

Transgenic animals are animals with a modified genome. Their genome has been manipulated by using genetic engineering technology.

Examples: Transgenic plant- Bt Cotton, Bt brinjal

Transgenic animals – rats, rabbits, pigs, sheep, cows and fish

Benefits of transgenic animals:

- To study Normal physiology and development
- To study diseases
- To obtain biological products. E.g. human protein (α-1-antitrypsin) used to treat emphysema, transgenic cow, Rosie, produced human protein-enriched milk (2.4 grams per litre).
- Testing for vaccine safety
- Chemical safety testing

ETHICAL ISSUES- Ethical standards are required to evaluate the morality of all human activities, and to validate GM research. For this purpose, Govt of India established GEAC (Genetic Engineering Approval Committee).

BIO-PIRACY: It is use of bio-resources by multinational companies and other organizations without proper authorisation from the countries and people concerned without compensatory payment developed and used by farmers and indigenous people of a country.

Important Question

Very short answer type questions

1- **Cry gene is extensively used in genetic engineering to develop transgenic plants like cotton. Name the source organism from which one can get the cry gene.**
Ans: Bacillus thuringiensis

2- **Which organism badly affects the crop of tobacco.**
Ans: Nematode-*Meloidogyne incognita*

3- **Human proinsulin has three polypeptide chains. Name all these chains and which chain is not present in mature insulin.**
Ans: chain A, B and C. Chain C are not present in mature insulin.

4- **Expand ELISA and mention the principle on which it is based.**
Ans: Enzyme-Linked Immuno-sorbent Assay
It is based on antigen-antibody interaction

5- **How human protein (α-1-antitrypsin) is used in the medical field.**
Ans: to treat emphysema

6- **What is GEAC? Write its role.**
Ans: GEAC (Genetic Engineering Approval Committee), which will make decisions regarding the validity of GM research and the safety of introducing GM organisms to public services.

7- **By giving one example clarify that GMOs enhance the nutritional value of food.**
Ans: Golden rice, i.e., Vitamin 'A' enriched rice.

8- **Which vector is used to create a pest-resistant tobacco plant?**
Ans: Agrobacterium vectors

9- **Specify one consequence of adenosine deaminase (ADA) deficiency.**
Ans: adenosine deaminase (ADA) is crucial for the immune system to function

10- **Write any two roles of PCR in molecular diagnosis technique.**
Ans: HIV detection, identification of mutated gene.

Short answer type questions

1- **How is a probe used in molecular diagnostics?**
Ans: A probe is a ss DNA or RNA used to search for its complementary sequence in a sample genome.
By the process of hybridization and autoradiography, the probes can be identified.

2- **What is biopiracy?**
Ans: use of bio-resources by multinational companies and other organisations without proper authorisation from the countries and people concerned without compensatory payment.

3- **Developed nations are exploiting the bioresources of under-industrialised nations. Justify the statement with a suitable example.**
Ans: 27 varieties of Basmati are grown in India. There is a reference to Basmati in ancient texts, folklore and poetry, as it has been for centuries. In 1997, an American company got patent rights on Basmati rice through the US Patent and Trademark Office. This allowed the company to sell a 'new' variety of Basmati, in the US and abroad.

4- **Transgenic animals can be used in various ways. How could be a transgenic mouse helpful?**

Ans: Transgenic mice are developed for testing the safety of vaccines before they are used on humans. example: polio vaccine.

5- **How crystal protein acts in Bt Cotton?**

Ans: Cry gene of Bacillus thuringiensis is introduced in the cotton plant to form insect resistant plant. When insects feed on the cotton plant the inactive crystal protein becomes active due to the alkaline pH in the midgut of insects. The protein creates pores in the midgut and ultimately insects die.

6- **Give two examples of biological products obtained by using genetic engineering?**

Ans: human protein (α-1-antitrypsin) is used to treat emphysema. Rosie cow produced 2.4 g/ The milk contained the human alpha-lactalbumin and was nutritionally a more balanced product for human babies than natural cow-milk

Long Answer Type Questions

1- **Plants bacteria, fungi and animals whose genes have been altered by manipulation are called Genetically Modified Organisms (GMO). GM plants have been useful in many ways. Give at least five examples in support of the statement**.

Ans:

- made crops more tolerant to abiotic stresses (cold, drought, salt, heat).
- reduced reliance on chemical pesticides (pest-resistant crops).
- helped to reduce post-harvest losses.
- increased efficiency of mineral usage by plants
- enhanced nutritional value of food, e.g., golden rice, i.e., Vitamin 'A' enriched rice

2- **What are the advantages of insulin obtained from genetic engineering? Explain the process of its formation.**

Ans: Insulin obtained from genetic engineering is cast effective and shows no adverse effect on the body.

Insulin has polypeptide chains A and B.

The chain A and B is synthesized in the different host using r—DNA technology.

These chains are isolated and joined with the help of a disulphide bond.

3- **Explain different processes of Gene Therapy.**

Ans: • Lymphocyte culture - Lymphocytes from the blood of the patient are grown in a culture outside the body and a functional ADA cDNA (using a retroviral vector) is then introduced into these lymphocytes using a retroviral vector which is returned to the patient. It is not a permanent method as lymphocytes are not immortal.

•Enzyme replacement- in this functional ADA is given to the patient by injection. This required periodic infusion of injection.

•Bone marrow transplantation- If the ADA gene from marrow cells is introduced into cells at early embryonic stages, it could be a permanent cure.

4- **What is RNA Silencing? How is this strategy used to create pest-resistant plants?**

Ans: RNA silencing involves silencing specific mRNA. This causes a stoppage of translation.

This is achieved in the bacco plant against nematode Meloidogyne incognita.

In RNAi complementary ds RNA is produced against specific mRNA.

Using the Agrobacterium vector, nematode-specific genes were introduced into the host plant.

The introduction of DNA was such that it produced both sense &anti-dense RNA in the host cell.

These two RNA's being complementary to each other formed a ds RNA that initiated RNAi.

5- What are transgenic animals? Enlist any four reasons for their production.

Ans: Transgenic animals or GMOs are those organisms whose genetic material has been altered by using genetic engineering techniques.

Reason of their production

- To study the effect of genes on normal physiology and development
- To study diseases like cancer, cystic fibrosis, rheumatoid arthritis and Alzheimer's
- To obtain biological products. E.g. human protein (α-1-antitrypsin)
- For study of Vaccine and chemical testing and safety

Chapter-13
Organisms and Populations

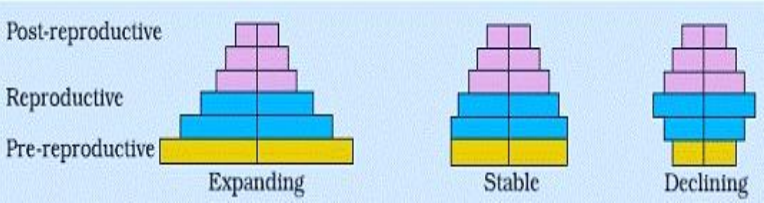
POPULATIONS

Population is a group of organisms of one species that can interbreed and live in a particular geographical area.

POPULATION ATTRIBUTES

- The birth rate (Natality) and death rates (Mortality) are referred as per capita births or deaths respectively.
- Sex ratio is another attributes of population. An individual may be male or female but population has sex ratio.
- Age pyramid: If the age distribution is plotted for the population, the resulting structure is called age pyramids.

Age pyramid may be following types:-
(i) Expending
(ii) Stable
(iii) Declining



POPULATION GROWTH

- Population density is the average number of individuals in a population per unit of area
- Density of a population in a given habitat during a given period, fluctuates due to changes in four basic processes, two of which (Natality and immigration) contribute to an increase in population density and two (mortality and emigration) to a decrease.

(i) Natality (B) –It is the number of births during a given period in the population.
(ii) Mortality (D) - is the number of deaths in the population during a given period.
(iii) Immigration (I) - is the number of individuals of the same species that have come into the habitat from elsewhere during the time period under consideration.
(iv) Emigration (E) - is the number of individuals of the population who left the habitat and gone elsewhere during the time period under consideration.
If N is the population density at time t, then its density at time t +1 is

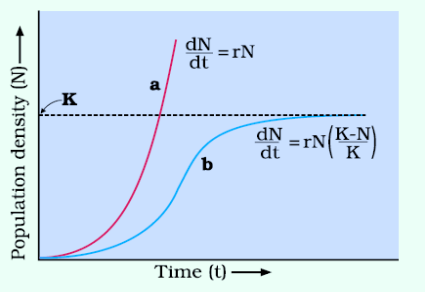
$$N_{t+1} = N_t + [(B + I) – (D + E)]$$

GROWTH MODELS

(i) Exponential growth

- It can occur if natural resources are unlimited and there is no completion between species.
- Increase or decrease in N during a unit time period t (dN/dt) will be-3

$dN/dt = (b – d) \times N$
Let (b–d) = r,
then $dN/dt = rN$
r = 'intrinsic rate of natural increase



- 'r' is very useful in assessing impacts of any biotic or abiotic factor on population growth.
- Another formula for exponential population grows is-

$N = No^{ert}$

(ii) Logistic growth

- In nature the resources are limited and this leads to competition between individuals.
- Since resources for growth for most animal populations are finite and become limiting sooner or later, the logistic growth model is considered a more realistic one.
- In nature, a given habitat has enough resources to support a maximum possible number, beyond which no further growth is possible; this is called as carrying capacity (K).
- The logistic growth cure has- lag phase (initial phase), phases of acceleration and deceleration and finally an asymptote, when the population density reaches the carrying capacity.
- A plot of N in relation to time (t) results in a sigmoid curve. This type of population growth is called
- Verhulst-Pearl Logistic Growth and is described by the following equation:

$$dN/dt = rN\left(\frac{K-N}{K}\right)$$

Where N = Population density at time t
r = Intrinsic rate of natural increase
K = Carrying capacity

POPULATION INTERACTIONS

All animals, plants and microbes in a biological community interact with each other. These interactions may be beneficial, detrimental or neutral to one of species or both.

Following table represent the details of population interactions occur in the nature-

PREDATION

- Predators feed on prey and by doing so they acts 'conduits' for energy transfer across trophic levels and keep prey populations under control. In absence of natural predators the prey species could achieve very high population densities and cause ecosystem instability. Predators also help in maintaining species diversity in a community, by reducing the intensity of competition among competing prey species.
- The prickly pear cactus introduced into Australia (in 1920's) spread very rapidly into millions of hectares of rangeland. It can be controlled only after introducing natural predator moth of that cactus

- In the rocky intertidal communities (American Pacific Coast) when predator starfish were removed from an enclosed intertidal area, more than 10 species of invertebrates became extinct within a year, because of interspecific competition.
- Prey species have evolved various defenses to lessen the impact of predation-
  Animals: Camouflage in frogs, highly distasteful Monarch butterfly
  Plants: Thorns (Acacia, Cactus, highly poisonous cardiac glycosides (Calotropis), alkaloids (nicotine, caffeine, quinine, strychnine, opium, etc.)

COMPETITION

Competition is best defined as a process in which the fitness of one species (measured in terms of its 'r' the intrinsic rate of increase) is significantly lower in the presence of another species.

(i) Interspecific competition: competition between two different species
(ii) Intraspecific competition: competition between two same species

- South American lakes, visiting flamingoes and resident fishes compete for their common food, the zooplankton in the lake.
- The Abingdon tortoise in Galapagos Islands became extinct within a decade after goats were introduced on the island, apparently due to the greater browsing efficiency of the goats.
- Connell's elegant field experiments showed that on the rocky sea coasts of Scotland, the larger and competitively superior barnacle Balanus dominates the intertidal area, and excludes the smaller barnacle Chathamalus from that zone.
- Gause's 'Competitive Exclusion Principle' – it states that two closely related species competing for the same resources cannot co-exist indefinitely and the competitively inferior one will be eliminated eventually.
- Resource partitioning- if two species compete for the same resource, they could avoid competition by choosing, for instance, different times for feeding or different foraging patterns. **MacArthur** showed that five closely related species of warblers living on the same tree were able to avoid competition and co-exist due to behavioural differences in their foraging activities.

PARASITISM

It is the interaction where one species (parasite) depends on the other species (host) for food and shelter, host is harmed.

- Ectoparasite: feed on external surface of host. Example – head lice on humans, ticks on dogs, Cuscuta
- Endoparasite: Take shelter within the body of the host organism. Example – Liver fluke, Plasmodium

Parasite evolved special adaptations

- Loss of unnecessary sense organs, presence of adhesive organs or suckers to cling on to the host, loss of digestive system and high reproductive capacity.

Brood parasitism- In this one bird (e.g. cuckoo) lays its eggs in the nest of other birds (e.g. crow) and let that other bird to incubate them.

COMMENSALISM

In this one species benefits and the other is neither harmed nor benefited.

- Examples: An orchid growing as an epiphyte on a mango branch, Barnacles growing on the back of a whale, the cattle egret and grazing cattle, Sea anemone and clown fish

MUTUALISM

It is interaction in which both the interacting species are benefited

- Examples: Lichen (fungi and algae), Mycorrhiza (fungi and roots of higher plants), Pollination of plants by insects, Mediterranean orchid- sexual deceit for pollination- appears as female bee.

AMENSALISM

In this one species is harmed and the other species is neither harmed nor benefited.

- Example. Fungus Penicillium secrete Penicillin which kill the bacteria but there is no benefit to fungus

IMPORTANT QUESTIONS

Very Short Answer Type Questions

1- **Define competitive release in reference to population interaction.**
Ans: Competitive release is the mechanism in which the species expands its distribution range when the competitor species is removed.

2- **What is emigration? How does it affect population density?**
Ans: It is outward movement of some individuals of the species from a local population during the time period under consideration.
It decreases the population density.

3- **What are two parameters by which population can be measured?**
Ans: Biomass and Number

4- **Name the orchid plant which undergoes sexual deceit phenomenon?**
Ans: Mediterranean orchid Ophrys

5- **The given age of pyramid represents**  –
Ans: stable population

6- **Penicillium placed with streptococcus will show which type of population interaction?**
Ans: Amensalism

7- **Why do certain exotic species (like Parthenium in India) become too much invasive in certain geographical area?**
Ans: because those areas do not have natural predators of weed

8- **In which specific condition 'J shaped' population growth curve may be observed?**
Ans: when there is unlimited natural resources are available, and no competition takes place.

9- If '+' sign is positive interaction and '-' sign is detrimental, then which type of population interaction will be shown by '+' '-'
Ans: Parasitism

10- **An orchid growing as an epiphyte on a mango branch shows which type of population interaction?**
Ans: Commensalism

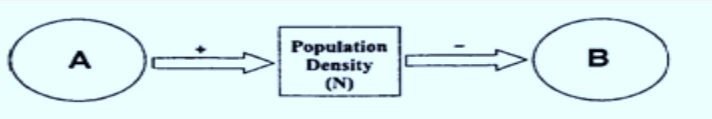
Short answer Type questions

1- **8 individual in a laboratory population of 80 fruit fly died in a week. Calculate the death rate.**

Ans: Death rate= no of individual die/ total number

= 8/80 = 10

2- Fill the 'a' and 'b' with appropriate population attributes-

Ans: A= 

Natality or Immigration B= Mortality or Emigration

3- Give an example for each of these:

a) Chemical defence agent b) Predator animal c) Migratory animal d) Camouflaged animal

Ans: a- alkaloids b- Lion c- Bird d- Frog

4- Mention the attributes which a population has but not an individual organism.

Ans: Natality, Mortality, Sex ratio, age groups.

5- List any two examples of defense mechanism in plants against herbivorous predators?

Ans. i) Thorn in acacia.

ii) Cardiac glycosides in Calotropis

Long Answer Type Questions

1- (i) Discuss the role of predators in an ecosystem.

(ii) What is brood parasitism? Give an example

Answer: (i) Predators feed on prey and by doing so they acts 'conduits' for energy transfer across trophic levels and keep prey populations under control. In absence of natural predators the prey species could achieve very high population densities and cause ecosystem instability. Predators also help in maintaining species diversity in a community, by reducing the intensity of competition among competing prey species.

(iii) Phenomenon in which one (parasitic) bird species lays its eggs in the nest of another bird species. Cuckoo lays her egg in crow nest.

2- (i)How does age distribution help in the study of the population?

(ii)How does an age pyramid, for the human population at a given point of time helps the policymakers in planning the future?

(iii) Draw the different types of age pyramid.

Ans: (i)The relative abundance of the organisms of various age groups in the population is called the age distribution of the population. Age may be grouped into pre reproductive, post reproductive and reproductive

With regard to age distribution, there are three kinds of populations:

Expanding, stable and decline.

(ii)The shape of the age pyramid reflects the growth status of the population. Thus age pyramid for the human population at a given time helps the policymakers in planning for the future.

(iii) Fig 13.4, page 227, NCERT

3- (i)Compare exponential and logistic growth curve by giving diagram only.

(ii) Write mathematical equation to determine population density in logistic growth.

(iii) Mention the significance of 'r' value.

Ans: (i) Fig 13.6 page 230 NCERT

(ii) Nt = N 0 ert

Nt = Population density after time t

N0 = Population density at time zero

r = intrinsic rate of natural increase

e = the base of natural logarithms (2.71828)

(iii)'r' is very useful in assessing impacts of any biotic or abiotic factor on population growth.

4- What is 'sexual deceit'? Explain by giving suitable example.

Ans: one petal of orchid flower resembles as female bee in size, colour and marking.

The male bee is attracted to what it perceives as a female, 'pseudocopulates' with the flower, During this bee is dusted with pollen from the flower.

When this same bee 'pseudocopulates' with another flower, it transfers pollen to it and thus, pollinates the flower.

5- What are different types of interaction in a habitat? Explain with the help of chart.

Ans: fig 13.1, page 232, NCERT

Chapter-14
Ecosystem

Ecosystem

Ecosystem is the functional unit of nature where living organisms (biotic component) interact among themselves and also with the surroundings physical environment(Abiotic component).

Ecosystem- Structure and Functions Ecosystem

Terrestrial ecosystem	forest, grassland , desert
Aquatic ecosystem	ponds, lake, river estuary

Components of ecosystem

Biotic	Non-living component	Light, Water, Soil, atmospheric gases etc
Abiotic	Living component	Producer, consumer, decomposers

The components of ecosystem that are seen as functional unit are-

(i)Productivity (ii) Decomposition (iii) Energy flow (iv) Nutrient cycling

Productivity	The rate of biomass production is called productivity. Unit -gm^{-2} yr^{-1} or (kcal m^{-2}) yr^{-1} Primary production is the amount of biomass or organic matter produced per unit area over a time period by plants during photosynthesis. Unit - (gm^{-2}) or energy (kcal m^{-2})	GPP- It is the rate of production of organic matter during photosynthesis. GPP minus respiration losses (R), is the net primary productivity (NPP). NPP = GPP - R NPP- is the available biomass for the consumption to heterotrophs Secondary productivity is defined as the rate of formation of new organic matter by consumers.

Decomposition

- Breakdown of complex organic matter into inorganic substances like carbon dioxide, water and nutrients is called decomposition.
- Detritus- Dead plants remains and dead remains of animals.

Steps of Decomposition- Fragmentation, leaching, catabolism, humification and mineralization

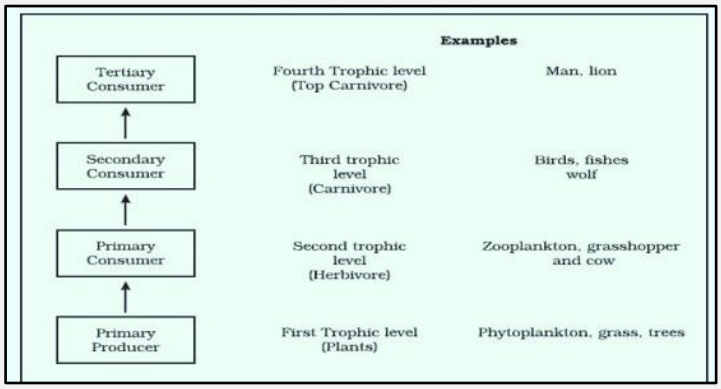
Fragmentation of Detritus	Detritivores (e.g., earthworm) break down detritus into smaller particles. This process is called fragmentation
Leaching	Water-soluble inorganic nutrients go down into the soil horizon and get precipitated as unavailable salts.
Catabolism	Bacterial and fungal enzymes degrade detritus into simpler inorganic substances
Humification	Accumulation of a dark coloured amorphous substance called humus
Mineralization	Degradation of humus microbes and release of inorganic nutrients in soil

Factors affecting rate of Decomposition

Chemical composition	Decomposition rate will be slow when detritus is rich in lignin and chitin and rate increases when detritus is rich in nitrogen and water soluble substances like sugars.
Climatic conditions	Warm and moist environment favour decomposition and low temperature and anaerobiosis inhibit decomposition.

Energy Flow

- All living organisms are dependent for their food on producers, directly or indirectly.
- There is a unidirectional flow of energy from the sun to producers and then to consumers.
- Photosynthetically active radiation (PAR) is responsible for synthesis of food by plants.
- Transfer of energy follows 10 percent law that is only 10 percent of the energy is transferred to each trophic level from the lower trophic level.



Food chain

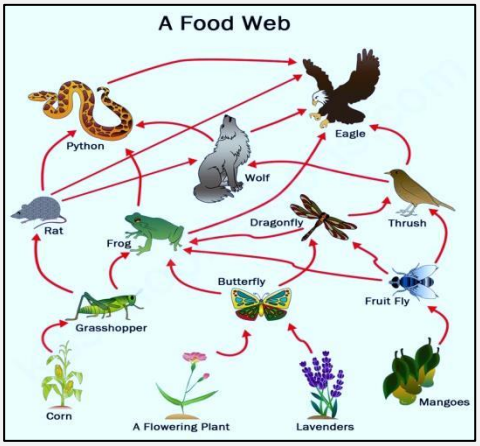
- Consumers obtain their food from autotrophs (plants).
- Food chain is the flow of energy from one trophic level to another trophic level.
- Trophic level: Based on the source of their nutrition or food, organisms occupy a specific place in the food chain that is known as trophic level. E.g. producer, herbivore, primary carnivore, secondary carnivore

Grass ⟶ Goat ⟶ Man ⟶
(Producer) (Primary Consumer) (Secondary consumer)

- Food chains are of two types- Grazing food chain (GFC) and detritus food chain (DFC)

GFC	Energy flows from producers to consumers.
DFC	Begins with dead organic matter. It is made up of saprotrophs/ decomposers (heterotrophic organisms like fungi and bacteria).

Food web



Natural interconnection of food chain forms the food web.

Significance of food web:

(1) Food webs permit alternative foods.

(2) They ensure a better chance of survival of an organism, in case any of its food sources happens to be scarce

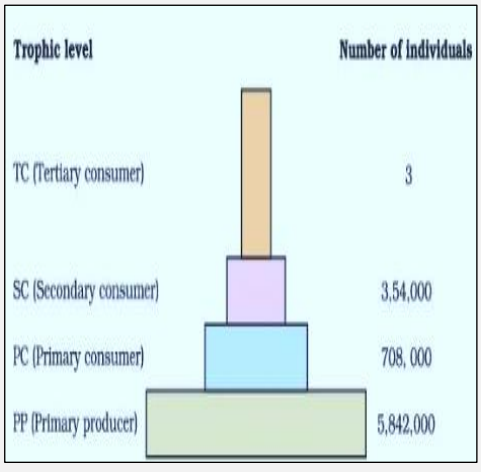
(3) More complex food web means more stable ecosystem

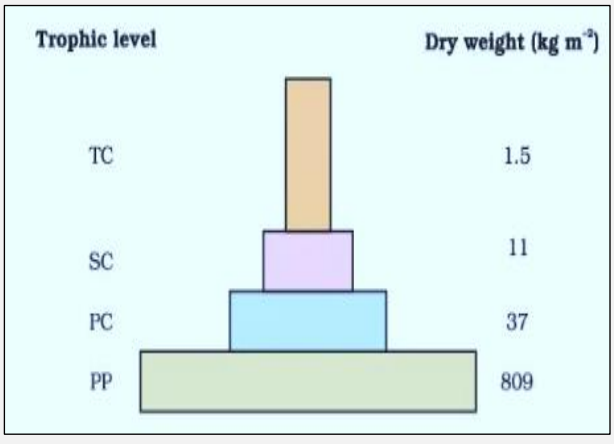
Ecological Pyramids

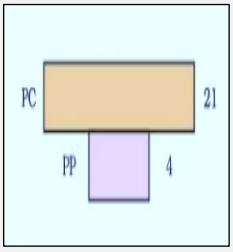
- Pyramid is the graphical representation of an ecological parameter (number, biomass, energy) sequence wise in various trophic levels of a food chain with producers at the base and herbivores in the middle and carnivores at the top tiers.
- It can be upright, inverted, or spindle shaped.

Three common ecological pyramids are

Pyramids of number	Represent the number of individuals per unit area at various trophic levels with producer at base. It is generally upright. A pyramid of number in case of a big tree is generally inverted because number of insects feeding on that tree generally exceeds in number.
Pyramids of biomass	Represent the biomass in various trophic levels. Pyramid of mass is upright except in aquatic food chain involving short lived plankton. A pyramid of biomass in sea is generally inverted.
Pyramids of energy	Give s graphic representation of amount of energy trapped by different trophic levels per unit area. Pyramid of energy is always upright, can never be inverted, because when energy flows from a particular trophic level to the next trophic level, some energy is always lost as heat at each step e.g in feeding, digestion, assimilation and respiration







IMPORTANT QUESTIONS

Very Short Answer Type Questions

1- **Give two examples of manmade ecosystem.**
Ans: Crop fields, Aquarium

2- **Why decomposition occurs at a faster rate in the tropics?**
Ans: high humidity and temperature favour the rapid rate of decomposition

3- **How do decomposers like fungi obtain their food?**
Ans: Decomposers release their enzymes to decompose dead and decaying remains of pants and animal absorb the simple inorganic substances.

4- **Name the trophic level occupied by secondary consumers & tertiary consumers?**
Ans. Third trophic level by secondary consumer and fourth trophic level by tertiary consumer

5- **What is the shape of pyramid of biomass in sea? Why?**
Ans: Inverted, because biomass of fishes are too much as compare to very smaller phytoplankton.

Sort answer types questions

1- **Describe stratification by citing three examples.**
Ans: Vertical distribution of different species occupying different levels is called stratification. For example, trees occupy top vertical strata a forest, shrubs the second and grasses occupy the bottom layers.

2- **What are four basic functional components of an ecosystem?**
Ans: (i) Productivity; (ii) Decomposition; (iii) Energy flow (iv) Nutrient cycling.

3- **Give two examples of autotrophic component in food chain of aquatic ecosystem.**
Ans: phytoplankton, some algae

4- **Which metabolic process causes reduction in gross primary productivity? Explain**
Ans: A considerable amount of GPP is utilized by plants in respiration.
Gross primary productivity minus respiration losses (R), is the net primary productivity (NPP). GPP – R = NPP

5- **Give an account of energy flow in an ecosystem**.
Ans: Flow of energy in an ecosystem is unidirectional.
The Sun is ultimate source of energy. It is used in photosynthesis process to make food in autotrophs. This energy is transferred from autotrophs to next trophic level. Only 10% of energy is transferred to next trophic level, rest amount is lost as heat.

Very Long Answer Type Questions

1- **Describe steps in the process of decomposition of detritus in DFC (detritus food chain).**
Ans: Fragmentation of Detritus - Detritivores (e.g., earthworm) break down detritus into smaller particles.
Leaching- Water-soluble inorganic nutrients go down into the soil horizon and get precipitated as unavailable salts.
Catabolism- Bacterial and fungal enzymes degrade detritus into simpler inorganic substances
Humification- Accumulation of a dark coloured amorphous substance called humus

Mineralization- Degradation of humus microbes and release of inorganic nutrients in soil.

2- **Provide diagrammatic representation of decomposition cycle in a terrestrial ecosystem.**

Ans: Fig. 14.1 page 244, NCERT

3- **What is meant by ecological pyramid? Distinguish between upright & inverted pyramids? Explain with the help of diagram.**

Ans: The graphic representation of the trophic structure of a food chain is known as ecological pyramid.

In upright pyramid the number or biomass of producers is more in compare to consumers in an ecosystem.

In inverted pyramid the number / biomass of producer is less as compare to consumers.

Fig. 14.4 (a, b, c) page 248 NCERT

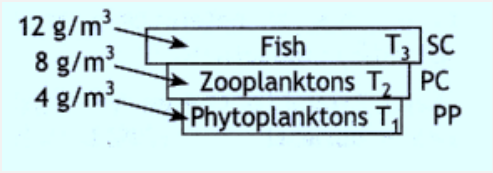
4- (**i)How does rate of decomposition affected by abiotic factors in an ecosystem?**

(ii) Construct a pyramid of biomass starting with phytoplankton.

Ans: (i) Decomposition rate will be slow when detritus is rich in lignin and chitin and rate increases when detritus is rich in nitrogen and water soluble substances like sugars.

Warm and moist environment favour decomposition and low temperature and anaerobiosis inhibit decomposition.

(ii)



5- **Describe the components of an ecosystem?**

Ans: i) Abiotic components – Inorganic substances (P, N, K, C, H etc.) b) Organic substances (Protein, carbohydrates, lipids), Climatic (water, air, soil, temperature etc.)

ii) Abiotic components-

Producers (make their own food like plants)

Consumers (Depend on producers for food. Consumers are of following types-

i) Primary consumers - herbivores e.g. deer, cow

ii) Secondary consumers – feed on primary consumers like cat, fox

iii) Tertiary consumers- feed on secondary consumers like Lion

Decomposers: - Decompose dead and decaying objects like fungi, bacteria

Chapter-15
Biodiversity and its Conservation

Content

Biodiversity-Concept, patterns, importance; loss of biodiversity; biodiversity conservation; hotspots, endangered organisms, extinction, Red Data Book, Sacred Groves, biosphere reserves, national parks, wildlife, sanctuaries and Ramsar sites

BIODIVERSITY

- Biodiversity term is popularized by the Edward Wilson.
- Biodiversity is sum total of flora and fauna in a geographical area.

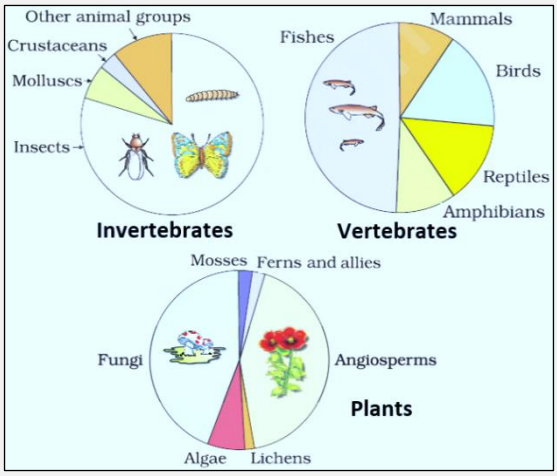
TYPES OF BIODIVERSITY

Genetic diversity	Diversity at the genetic level over its distributional range. e.g. The genetic variation Rauwolfia vomitoria Himalayan ranges, India has more than 50,000 genetically different strains of rice, and 1,000 varieties of mango.
Species diversity	The diversity at the species level e.g. Western Ghats have a greater amphibian species diversity than the Eastern Ghats.
Ecological diversity	Diversity at ecosystem level e.g. deserts, rain forests, mangroves, coral reefs, wetlands, estuaries, and alpine meadows has a greater ecosystem diversity than a Scandinavian country like Norway.

How Many Species are there on Earth and How Many in India?

Some facts

According to the IUCN (2004), the total number of plant and animal species described so far is slightly more than 1.5 million
Robert May proposed the global species diversity at about 7 million. More than 70 % of all the species are animals. Insects are more than 70 % of total animals
Plants comprise about 22%.
The number of fungi species in the world is more than the combined total of the species of fishes, amphibians, reptiles and mammals.
India has only 2.4 % of the world's land area but its biodiversity is 8.1 %. India is one of the 12 mega diversity countries of the world.
Nearly 45,000 species of plants and twice as many of animals have been recorded from India.
May's global estimates say that only 22 % of the total species have been recorded so far.



PATTERNS OF BIODIVERSITY

a) Latitudinal gradients

- Species diversity decreases as we move away from the equator towards the poles.

Country	location	Bird species
Colombia	near the equator	1,400
New York	41° N	105
Greenland	at 71° N	56
India	Mostly tropical	1200

- Biodiversity in amazon forest (South America) as the greatest biodiversity on earth.

Plant	40000	Mammal	427
Fish	3000	Reptile	378
Bird	1300	Invertebrate	125000

Tropics harbor more species than temperate or polar areas.

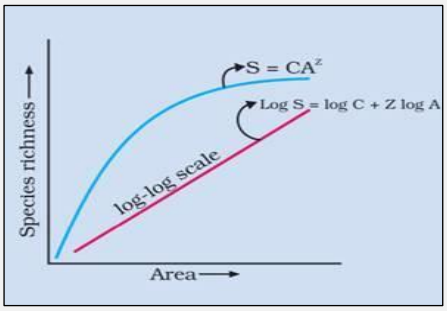
- Tropical latitudes have remained relatively undisturbed for millions of years.
- Tropical environments are less seasonal and more constant and predictable.
- More solar energy available in the tropics that results in higher productivity.

b) Species-Area relationships

Alexander von Humboldt observed that within a region species richness increased with increasing explored area, but only up to a limit.

On a logarithmic scale, the relationship is a straight line described by the equation

log S = log C + Z log A



Where, S= species, A= Area, Z= slope of the line, C =Y- intercept.

Rivet popper hypothesis

- Proposed by Paul Ehrlich
- He proposed that every rivets of an aeroplane is like species of an ecosystem. Loss of rivets (key species that perform major ecosystem functions) may cause loss of ecosystem as well as biodiversity.

LOSS OF BIODIVERSITY

- IUCN (International Union for Conservation of Nature) documented Red List which reported extinction of 784 species (including 338 vertebrates, 359 invertebrates and 87 plants) in the last 500 years.
- Example of recent extinction: the dodo (Mauritius), quagga (Africa), thylacine (Australia), Steller's Sea Cow (Russia) and three subspecies (Bali, Javan, Caspian) of tiger.

CONSEQUENCES OF BIODIVERSITY LOSS-

- Decline in plant production
- Lowered resistance to environmental perturbations, drought, and flood.
- Increased variability in ecosystem processes such as productivity, water use, and pest and disease cycles.

CAUSES OF BIODIVERSITY LOSSES

'The Evil Quartet' (The four major causes)

1) Habitat loss and fragmentation- Loss of habitats due to various human activities

2) Over-exploitation- Many species extinctions in the last 500 years were due to overexploitation by humans. For example- Steller's sea cow, passenger pigeon.

3) Alien species invasions- Some of alien species turn invasive and cause decline or extinction of indigenous species. E.g. The Nile perch introduced into Lake Victoria in east Africa led eventually to the extinction of more than 200 species of cichlid fish in the lake. Invasive weeds species like carrot grass (parthenium), Lantana and water hyacinth causing threats to indigenous species.

4) Co-extinctions- when a species becomes extinct, the plant and animal species associated with it also become extinct. When a host fish species becomes extinct, its unique assemblage of parasites also becomes extinct.

BIODIVERSITY CONSERVATION

Reason for conservation

- The narrowly utilitarian- Biodiversity provides direct economic benefits from nature like food, firewood, fibres, medicinal plants, industrial products etc.
- The Broadly Utilitarian- Biodiversity plays a major role in ecosystem services like productions of Oxygen, pollination without natural pollinator, pleasure from nature are priceless.
- Ethical- for conserving biodiversity relates to what we own to millions of plants, animals and microbes species with whom we share this planet.

HOW DO WE CONSERVE BIODIVERSITY?

In situ (on site) conservation	conserving species in their natural habitats and environment biosphere reserves, national parks, wildlife sanctuaries, sacred groves
Ex situ (off site) conservation	Animals and plants are taken out from their natural habitat and placed in special setting when they be protected and given special care. Zoological parks, Botanical Gardens and wildlife safari parks, Cryopreservation

HOT SPOTS

- Biodiversity hotspots are the regions with very high levels of species richness and high degree of endemism.
- Three hotspots – Western Ghats and Sri Lanka, Indo-Burma and Himalaya

SACRED GROVES

- Socially, culturally, or religiously important place, protected by local people.
- Examples- Khasi and Jaintia Hills (Meghalaya), Aravalli Hills (Rajasthan)

CONVENTIONS ON BIODIVERSITY

- The Earth Summit- Rio de Janeiro in 1992
- World Summit - Johannesburg, South Africa in 2002

RAMSAR SITE

- Ramsar Sites are wetland sites designed of international importance under the Ramsar convention.

- These wetlands are protected under strict guidelines of the Ramsar Convention on Wetlands.

➢ The main objectives of the Ramsar Convention are:

- To ensure the wise use of all their wetlands. The wise use of wetlands means; maintaining the ecological character of a wetland.
- designate appropriate wetlands for the list of Wetlands of International Importance (the "Ramsar List") and to guarantee their effective management.
- To cooperate worldwide on transboundary wetlands, shared wetland systems and shared species.

➢ India currently has 54 sites designated as Ramsar sites.

IMPORTANT QUESTIONS

Very Short Answer Questions

1- **Name the method of ex situ conservation by which gametes of threatened species can be preserved**.
Ans: Cryopreservation

2- **List some important conventions held at international level for biodiversity conservation.**
Ans: The Earth Summit- Rio de Janeiro in 1992, World Summit - Johannesburg, South Africa in 2002

3- **Make your statement in favor of India as a major mega biodiversity country.**
Ans: India has only 2.4 % of the world's land area but its biodiversity is 8.1 %. Therefore India is in one of the 12 mega diversity countries of the world.

4- **Give example of any two alien species that become threat to indigenous plant species.**
Ans: Parthenium, water hyacinth (Eichornia)

5- **How exotic species differ from endemic species.**
Ans: Exotic species are derived into a geographical area from any other geographical area. Endemic species are native species restricted to a particular geographical area.

Short Answer Type Questions

1- (**i) Hot spots of biodiversity show high degree of endemism. Explain the statement.**
(ii) Give three examples of hot spots.
Ans: (i) species confined to a region and not found anywhere else. Example: Polar beer
(ii) Western Ghats and Sri Lanka, Indo-Burma and Himalaya

2- **It is very difficult to study the pattern of biodiversity of prokaryotes. Give reason.**
Ans: The problem is that conventional taxonomic methods are not suitable for identifying microbial species and many species are simply not culturable under laboratory conditions.

3- **What are evil quarters responsible for loss of biodiversity?**
Ans- Habitat loss, over exploitation, Alien species invasion, co-extinction

4- **Give four examples of recent extinction due to biodiversity loss and over exploitation.**
Ans: Example of recent extinction: the dodo, quagga, thylacine, Steller's Sea Cow

5- **Explain co-extinction and its consequence with a suitable example**.

Ans: Co-extinction refers to the disappearance of species with extinction of another species of plant or animal.

E.g. Plant-pollinator mutualism, In absence of pollinators the plant cannot survive.

6- **What could have triggered mass extinctions of species in the past?**

Ans: Glaciation, melting of snow, the eruption of large volcanoes, earthquakes, movement of continents, large meteorites falling on the earth, drought, etc.

7- **Describe sixth extinction. How it is different from previous episodes? What is major concern of ecologist about sixth extinction?**

Ans: In past five episode of mass extinction takes place. In present sixth Extinction' is in progress.

The current species extinction rates are estimated to be 100 to 1,000 times faster than in the pre-human times.

Ecologists warn that if the present trends continue, nearly half of all the species on earth might be wiped out within the next 100 years

8- **"Amazonian rain forest in south America has the greatest bio-diversity on earth". Justify the statement.**

Ans: Amazonian rain forest in south America has the greatest biodiversity on earth; it harbors about40000 species of plants, 1,25,000 species of insects, 3000 species of fishes, 427 of amphibians, 378 ofreptiles, 1300 of birds & 427 of mammals.

9- **Provide examples of the followings –**

(i)Over exploitation (ii) Alien species invasion (iii) Co extinction

Ans: (i) extinction of Steller's sea cow, passenger pigeon

(ii) Alien species invasion- Nile perch introduced into Lake Victoria (East Africa) causes extinction more than 200 species of cichlid fish in the lake.

(iii) Co extinction- plant-pollinator mutualism where extinction of one invariably leads to the extinction of the other.

10- **What is the special about tropics that might account for their greater biodiversity?**

Ans: (i) Tropical latitudes have remained relatively undisturbed for millions of years.

(ii) Tropical environments are less seasonal and more constant and predictable.

(iii) More solar energy available in the tropics that results in higher productivity.

Very Long Answer Type Questions

1- **Identify the type of biodiversity with the help following statements**

(i) Variation in number Amphibians of eastern ghat and western ghat

(ii) Alpine meadow has greater ecosystem diversity than Scandinavian country

(iii) Rauwlofia vomitaria in different Himalaya range

(iv) Thousands species of Rice

(v) Desert, coral reefs and mangroves in Indian sub-continent

Ans: (i) species diversity (ii) and (v) ecological diversity (iii) and (iv) (genetic diversity

2- **(i) Represent global biodiversity of plants, invertebrates and vertebrates by giving suitable pie charts**.

(ii) As per IUCN data how many species were become extinct in recent past?

Ans: (i) fig 15.1 , [page 260 NCERT

(ii) 784 species (including 338 vertebrates, 359 invertebrates and 87 plants)

3- Who proposed Species-Area relationships? Explain by giving graphical representation.

Ans: Species area relationship was given by Alexander Von Humboldt

According to this within a region species richness increased with increasing explored area, but only up to a limit.

On a logarithmic scale, the relationship is a straight line described by the equation

$\log S = \log C + Z \log A$

Where, S= species, A= Area, Z= slope of the line, C =Y- intercept.

Fig. 15.2, page 262 NCERT

4- (i) Why is there a need to conserve biodiversity?

(ii) Name and explain any two ways that are responsible for the loss of biodiversity.

Ans: (i) The narrowly utilitarian- Biodiversity provides direct economic benefits from nature like food, firewood, fibres, medicinal plants, industrial products etc.

The Broadly Utilitarian- Biodiversity plays a major role in ecosystem services like productions of Oxygen during photosynthesis, pollination without natural pollinator, pleasure from nature are priceless.

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5- What are the different approaches for biodiversity conservation in India?

Ans: There are two major approaches for conservation of biodiversity:-

i) In-situ conservation - it is protecting of the endangered species in the natural habitat.

Biosphere Reserves, National park, wildlife Sanctuaries, Sacred Grooves are example of In-situ conservation

India has 14 biosphere reserves, 90 national parks and 448 wildlife sanctuaries.

ii) Ex- situ Conservation- It is the process of protecting of the species rearing them under human care. It includes Botanical garden, zoological park. Cryopreservation is the modern method of ex-situ preservation where gametes can be stored at very low temperature for long time.