

केंद्रीय विद्यालय संगठन , नई दिल्ली

KENDRIYA VIDYALAYA SANGATHAN, NEW DELHI



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एन.सी.ई.आर.टी. पाठ्यपुस्तक पर आधारित
BASED ON NCERT TEXT BOOK



संकलनकर्ता
डॉ रमाकांत उपाध्याय
प्रशिक्षण सहायक (जीव विज्ञान)

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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 महत्वपूर्ण 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

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CLASS XII (2023-24) (THEORY)**Time: 03 Hours****Max. Marks: 70**

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Total marks		70

Unit-VI Reproduction

Chapter-2: Sexual Reproduction in Flowering Plants Flower

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 upto 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 evidence for biological evolution (paleontology, comparative anatomy, embryology and molecular evidence); 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 and 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, biopiracy 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

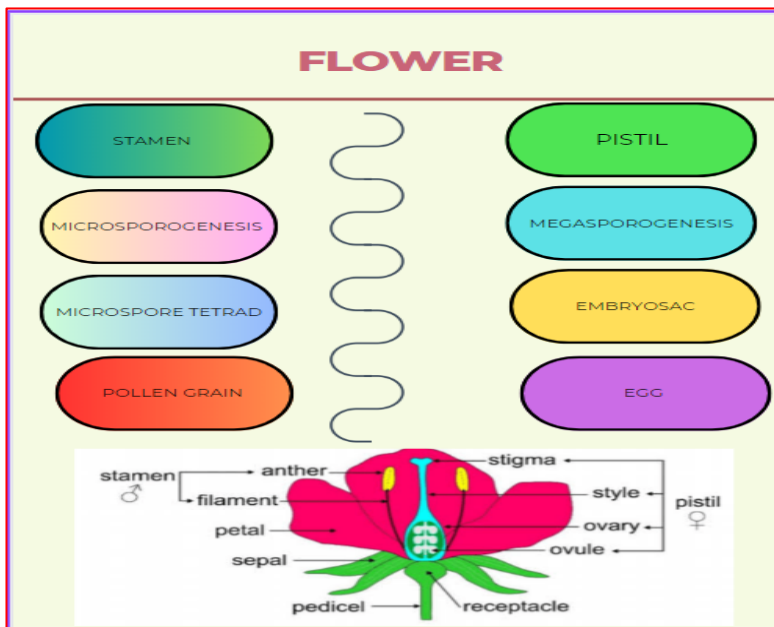
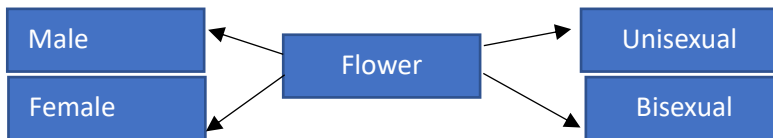
Ecosystems: Patterns, components; productivity and decomposition; energy flow; pyramids of number, biomass, energy (Topics excluded: Ecological Succession and Nutrient Cycles).

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

Flower	Reproductive part of a plant
Sporogenous tissue	Compactly arranged homogenous cells in the center of microsporangia, undergo meiosis (Microsporogenesis) to form tetrads of microspores
Germ pore	Apertures in the pollen grain, facilitate the exchange of gases and water, help in emerging of pollen tube
Autogamy	When pollination occurs between the same flower of the same plants
Egg apparatus	Consists of synergids and filiform apparatus, help in the entry of pollen tube into the embryo sac
Synergid	Present in the embryo sac, two in number
Filiform apparatus	Present in synergids, guider pollen tube entry into the embryo sac
Geitonogamy	Transfer of pollen grains from the anther to the stigma of another flower of the same plant
Xenogamy	Transfer of pollen grains from the anther to the stigma of a different plant
Triple fusion	Male gamete fuses with two polar nuclei to form the 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

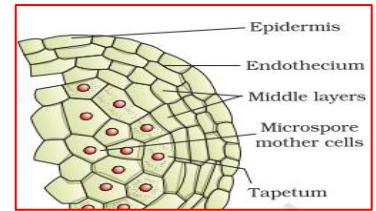


Pre-fertilization events

- It involves the formation of male and female gametes (gametogenesis) and gamete transfer.
- Gamete transfer- Bringing together male & female gamete

Male reproductive structure- Stamen

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



Microsporogenesis (formation of microspore)

- Microsporogenesis is the process in which sporogenous tissues in microsporangia form meiocytes (2n). The latter divide meiotically and form microspore tetrad (n).
- Each microspore matures into Pollen grains (male gametophyte)

Pollen grains

Inline (inner layer): it is composed of cellulose & pectin

Exine (outer layer): it is composed of sporopollenin.

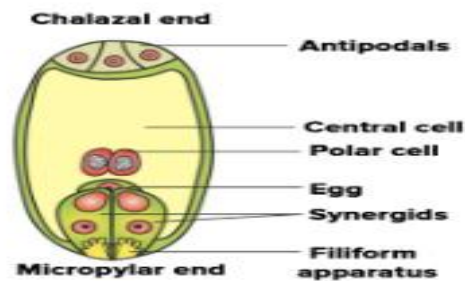
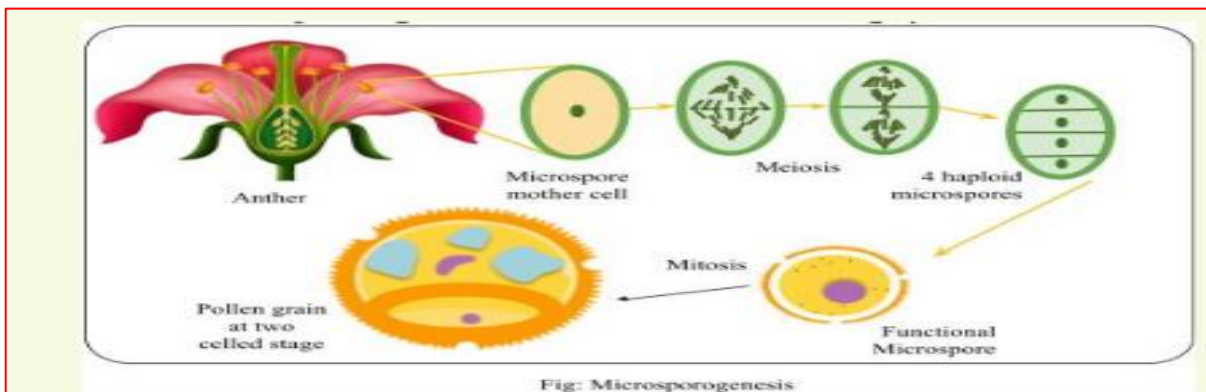
Female reproductive structure (Carpel)

- Carpel has stigma, style and ovary. The ovary encloses ovules (megasporangium) in it.
- Ovule consists of Funicle, Hilum, Integuments, Micropyle, Chalaza, Nucellus and embryo sac. The 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 undergoes meiosis and 4 haploid megaspores are formed (Megaspore tetrad).
- Only one of the megaspores develops into a female gametophyte (Monosporic development).



POLLINATION

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

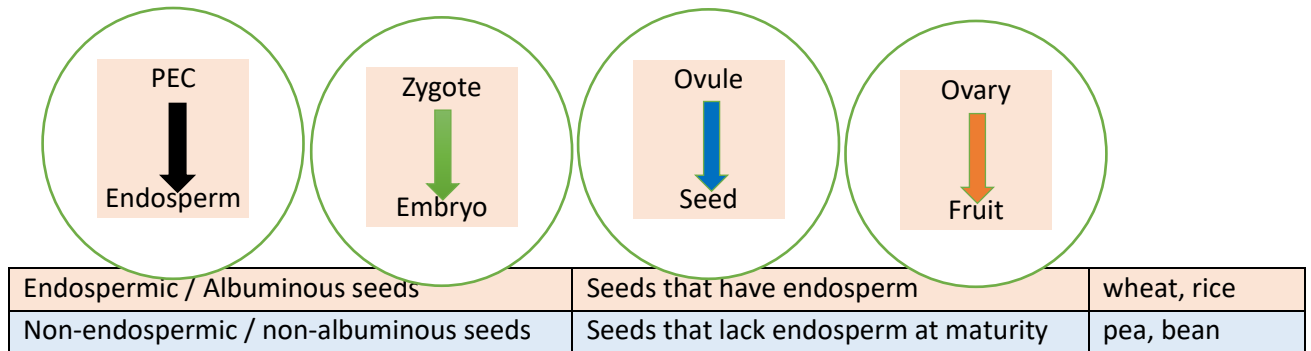
Adaptation in pollination

Wind	pollen grains are light, non-sticky, stamen well-exposed, large often-feathery stigma, often monolocular ovule, numerous flowers packed into an inflorescence.
Water	Pollen grains are long, ribbon like, and protected from wetting by a mucilaginous covering.
Insect	Flowers are large, colourful, fragrant and rich in nectar. When the flowers are small, several flowers are clustered into an inflorescence to make them conspicuous.

FERTILIZATION (Fusion of male and female gametes)

- Fusion of male gamete (in pollen) and female gamete (egg) in the embryosac.
- In some plants there are two male gametes. One fuses with an egg (syngamy) and the other fuses with two polar nuclei (triple fusion). This is known as double fertilization.

POST FERTILIZATION EVENT

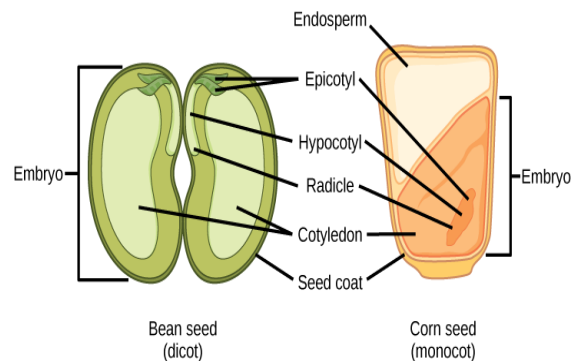


EMBRYO

- 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	The main axis of the embryo which divides it into different regions
Cotyledons	Food storage and nourishment
Epicotyl and hypocotyl	Part of the embryonal axis above and below the cotyledons respectively
Plumule a radicle	Stem tip and root tip respectively
Root cap	Covering of root tip



Structure of monocot embryo

Coleorrhiza	Sheath enclosing radicle & root cap
Coleoptile	Sheath enclosing plumule

OUT BREEDING DEVICES (to avoid inbreeding depression some plants develop devices to discourage self-pollination).

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

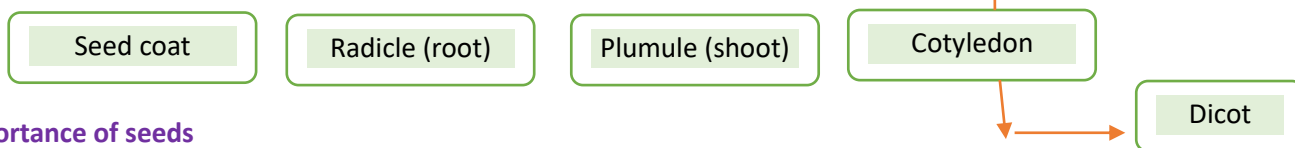
ARTIFICIAL HYBRIDIZATION

- Emasculation- removal of anther before attaining maturity
- Bagging- bagging of emasculated flower with a paper bag
- Dusting- removal of bag and dusting with desired pollen on the 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 can recognize Compatible or Incompatible pollen.
- Wrong pollen is rejected and stigma and style

SEED



Importance of seeds

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

APOMIXIS

- Formation of seed without fertilization is known as apomixis.
- Diploid nucellar cells divide and enter inside the 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- the occurrence of many embryos in value. E.g. Citrus, mango, etc.

IMPORTANT QUESTIONS

Very Short Answer Type Questions/ MCQ

- How many thecae are present in bilobed anther-**
a- One b- two c- three d- four
Ans: four
- In a bilobed anther one locule contains 100 pollen mother cells. Calculate the amount of pollen tetrad that the plant will form-**
a- 100 b- 200 c- 300 d- 400
Ans: $100 \times 4 = 400$
- Compare the role of the Tapetum and Sporogenous tissues in male flowers. -**
i- Tapetum: provide nourishment to developing pollen
ii- Sporogenous tissue: divide to form pollen grains.
a- Both a and b are correct
b- Both a and b are incorrect
c- Only a is correct
d- Only b is correct
- Identify the role of exine-**
a- Help in the formation of germ pore
b- Consists of intine
c- Helps in the formation of male gametes
d- All are incorrect
Ans: a
- How many male gametes are present in 3-celled stage pollen grains-**
a- 1 b- 2 c- 3 d- infinite
Ans: 2
- Mention one method by which pollen grains can be preserved.**
Ans: cryopreservation
- What is the Monosporic development of the embryo sac?**
Ans: only one megaspore is functional and develops into the female gametophyte or the embryo sac
- 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 the role of the 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 the embryo
Formation of endosperm cell

Short Answer Type Questions

1- Why geitonogamy do is considered genetically autogamy?

Ans: in this, the transfer of pollen to the stigma takes place from another flower to the same plant.

2- Write the pollination pattern in the – Vallisnaria, Hydrilla, Zostera, and water lily.

Ans: Valisnaria, Hydrilla, Zoostera- water pollination, Water lily- Insect pollination or wind pollination

3- Briefly explain the floral reward provided by the yucca plant.

Ans: Provide a safe place to lay eggs, provide nectar

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 the advantage of emasculation and bagging in artificial hybridization?

Ans: Emasculation is the removal of another before attaining maturity
Bagging is the covering of emasculated flowers with paper.
The advantage of both is that self-pollination can't occur i.e. prevention from inbreeding depression.

6- Write the name of different layers of the anther. Mention the role of any one of these.

Ans: epidermis, endothecium, middle layer, and Tapetum.
Tapetum provides nourishment to developing pollen.

7- If the ploidy on the egg is “n”, what will be the ploidy of the endosperm of the same plant? Why endosperm is supposed to have nutritive tissue?

Ans: ploidy of egg – haploid – n, Ploidy of endosperm- triploid- 3n, Endosperm provides nutrition to the developing embryo and therefore supposed as nutritive tissue.

8- What is the fate of floral parts after fertilization?

Ans: After fertilization the petals, stamens, style and stigma degenerate. Calyx sometimes degenerates or remains intact in dried form. Ovary becomes the fruit, ovules become seeds and the Ovary wall forms a pericarp.

9- Describe double fertilization in flowering plants. Also, mention the products of double fertilization.

Ans: Syngamy: One male gamete fuse with an egg to form a zygote which later develops into an 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 a new individual without fertilization. E.g. Turkey birds, a few lizards

Long Answer Types Questions

1- Compare adaptation in flowers showing different pollination patterns.

Wind	pollen grains are light, non-sticky, stamen well-exposed, large often-feathery stigma, often monolocular ovule, numerous flowers packed into an inflorescence.
Water	Pollen grains are long, ribbon like, and protected from wetting by a mucilaginous covering.
Insect	Flowers are large, colourful, fragrant, and rich in nectar. When the flowers are small, several flowers are clustered into an inflorescence to make them conspicuous.

2- Give the importance of outbreeding devices. How can be it achieved?

Ans: Outbreeding devices refer to plants' processes or mechanisms to avoid self-pollination and encourage cross-pollination. It can be achieved by

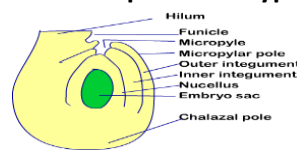
- i- Unisexual flower- in this only cross-pollination is possible.
- ii- Non-Synchronization in the release of pollen and stigma receptivity and vice versa.
- iii- Position of anther and stigma- anther and stigma are placed at different positions so that the pollen cannot come in contact with the stigma of the same flower
- iv- Self-incompatibility: This is a genetic mechanism that 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 them, diploid egg cell is formed without reduction division and develops into an embryo.
- ii- the embryo without fertilization-embryo sac and develop into the embryos

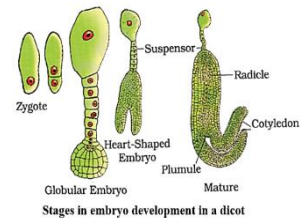
4- With a neatly labeled diagram, describe the parts of a typical angiosperm ovule.



Structure of Ovule

5- Explain the development of the 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 a 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.



UNIT VI – REPRODUCTION
CHAPTER 3 -HUMAN REPRODUCTION

Key Words

Scrotum	It is a pouch-like structure outside the abdominal cavity in which the testis are 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.
Seminiferous tubule	In each testicular lobule 1- 3 highly coiled seminiferous tubules in which sperms are produced.
Sertoli cells	Sertoli cells provide nutrition to the male germ cells.
Leydig cell	Present in interstitial space (regions outside the seminiferous tubules). It secretes testicular hormones called androgens
Urethral meatus	It is the external opening of the 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, prostate and paired bulbourethral glands
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 the seminiferous tubule.
Acrosome	Cap-like structure on sperm head. It contains 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 the egg.
Graafian follicle	Mature follicles formed during oogenesis. When it ruptures releases the secondary oocyte (ovum) and remaining part forms the corpus luteum.
Zona pellucida	The membrane on the secondary oocyte prevents polyspermy
Corpus luteum	After ovulation remaining parts of the Graafian follicle transform in the corpus luteum. It secretes progesterone hormone, which is essential for the maintenance of the endometrium.
Polar body	It is a small <u>haploid</u> cell that is formed during oogenesis. It can't be <u>fertilized</u> .
Cleavage	The mitotic division in the zygote is called cleavage.
Placenta	The chorionic villi and uterine tissue become interdigitated with each other and jointly form a structural and functional unit called the 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.
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 are generated by the placenta when the fetus is fully developed, at the time of parturition.

Gamete formation - spermatogenesis	Formation of spermatozoa
Oogenesis	Formation of ovum
Oocytes – Primary oocyte (2n)	Oogonia divide and arrest at meiotic prophase I
Secondary oocyte (n)	Formed from primary oocyte
Menstrual cycle – Menarche	Start of menstrual cycle
Menopause	Stop of menstrual cycle after age of 50 yrs
Zygote stages- Blastomere	2,4,8,16 celled stage
Blastocyst	Blastomere encysted in layers (trophoblast and inner cell mass)
Trophoblast	Outer layer of blastocyst, attached with endometrium
Inner cell mass	differentiated as the embryo
Birth hormones – Oxytocin	Uterine contraction
Relaxin	Widen cervix and helps in parturition (child birth)

Spermatogenesis and Oogenesis

Spermatogenesis

In the seminiferous tubule of testes, the male germ cells (Spermatogonia) divide mitotically to form a large number of Spermatogonia.

Spermatogonia undergo meiotic division to form primary spermatocytes.

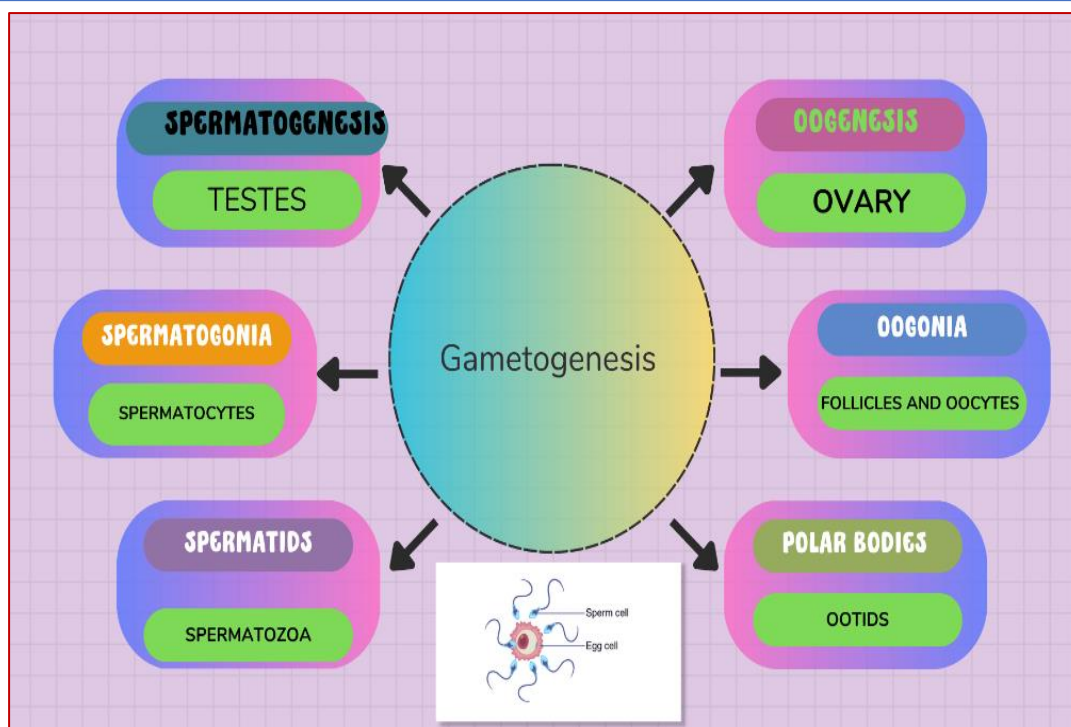
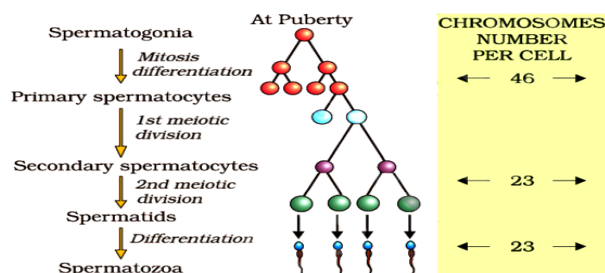
The latter form secondary spermatocytes, and finally four spermatids are formed.

Hormonal control

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

In the ovary some of the germinal epithelial cells divide by mitosis to produce a large number of Oogonia.

Oogonia multiply by mitosis and form primary oocytes.

Primary oocyte is surrounded by a layer of granulosa cells and is called primary follicle.

The primary follicles converted 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 corpus luteum.

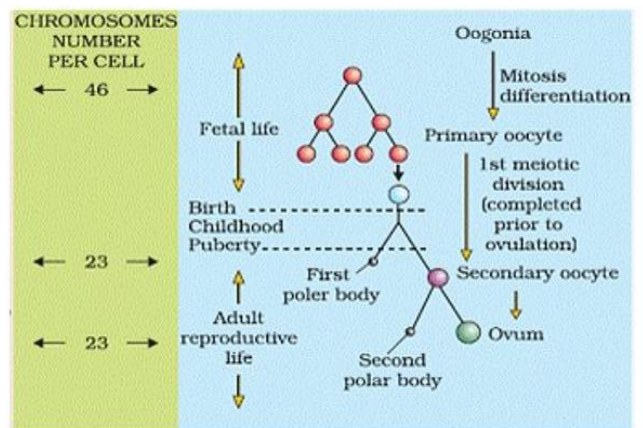
If a sperm can enter the secondary oocyte then secondary oocyte completes meiosis II and thus results in the formation of second polar body and an ovum.

Hormonal control

LH- acts on Graafian 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



• 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..

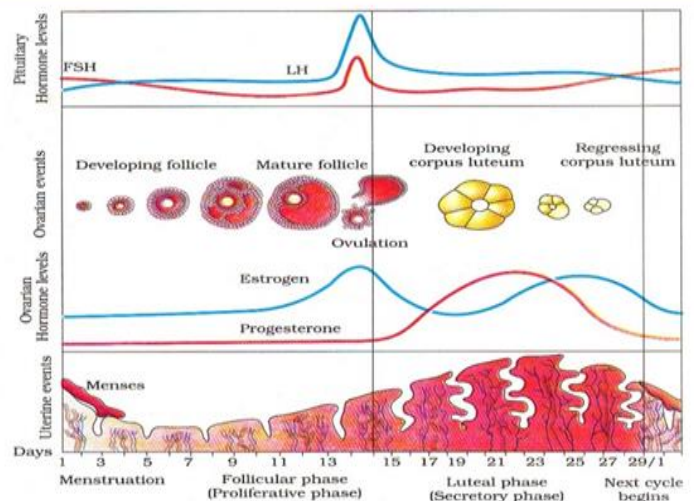
• Follicular phase

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

• Luteal phase

Graafian follicle ruptures and form yellow body called Corpus luteum.

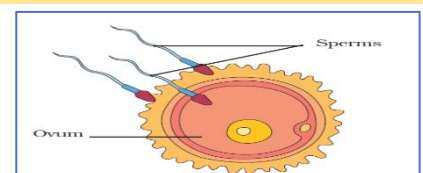
The corpus luteum secretes progesterone hormone which maintains the endometrium of uterus for implantation of the fertilized ovum.



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 and appearance of hair on the head
After 24 weeks (end of the second trimester)	The body is covered with fine hair, eyelids separate, and eyelashes are formed.
9 month	Foetus is fully developed

PARTURITION

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

Parturition: the process of delivery of the fetus.

Parturition is a neuroendocrine mechanism. The signals for parturition originate from the fully developed fetus 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 the 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 through the process called lactation.
- The milk produced during the initial few days of lactation is called colostrum which contains several antibodies essential to develop resistance for newly born babies.

IMPORTANT QUESTIONS

Very Short Answer Type Questions/ MCQ

1- LH surge is responsible for-

- a- Ovulation
- b- Spermatogenesis
- c- Oogenesis
- d- Fertilization

Ans: a.

2- Spermiogenesis is

- a- Transformation of spermatozoa into spermatids
- b- Transformation of spermatids into spermatozoa
- c- Both are incorrect
- d- A is correct while b is incorrect

Ans: B

3- What is the role of polar bodies-

- a- Maintain the number of chromosomes in the ootid
- b- Prevent polyspermy
- c- Release progesterone
- d- All of these

Ans: a

4- Despite the presence of So many sperms in the vicinity of an egg cell, only one sperm enters the ovum. Why?

Ans: Because when sperm comes in contact with the ovum (Zona pellucida) & induces changes in the membrane to block entry of other sperms

5- Define spermiogenesis. Where does it occur?

Ans: The transformation of non-motile spermatids into motile spermatozoa is called spermiogenesis. It occurs inside the seminiferous tubules of the testes.

6- Name the cells which produce testosterone. What is the function of this hormone?

Ans: Interstitial cells (Leydig's cells) of the testis secrete the testosterone hormone. Function. They control secondary sexual characters.

7- The Spermatogonia cell has 46 chromosomes in human males. Give the number of chromosomes in (a) Primary spermatocyte (b) Spermatid

Ans: (a) Primary spermatocyte – 46 (b) Spermatid- 23

8- How does colostrum provide initial protection against diseases in newborn infants? Give one reason.

Ans: Colostrum contains immunoglobulin which provides immunity to the infants.

9- Name the embryonic stage which gets implanted in the uterine wall of a human female.

Ans: blastocyst stage

10- 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.

11- Where are sperm stored in males?

Ans: Epididymis

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 the 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 the secondary oocyte is formed from the primary oocyte after meiosis-I – I division to produce ova in females during the stage of puberty.

2- Name the muscular and glandular layers 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.

The 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 the 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 layers 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 the placenta other than its endocrine function?

Ans: The placenta helps in the supply of nutrients and oxygen to the embryo, the elimination of excretory wastes and carbon dioxide produced by the embryo.

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

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

8- Differentiate between Sertoli cells and Leydig cells concerning 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 the seminiferous tubules of human females 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 the 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 pairs. 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 females by giving a 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 the vagina along with blood vessels and mucus.

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

c) Secretory Phase (about 12 days)- Corpus Luteum is formed from a 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 to Graffian follicle in the 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 oocytes.

The primary oocytes get surrounded by granulosa layers forming the primary follicle and then secondary follicles. The secondary follicle is transformed into a tertiary follicle characterized by an antrum (a fluid-filled cavity). The tertiary follicle matures into the Graafian follicle.

4- Give a schematic representation of spermatogenesis and oogenesis.

Ans: Fig 3.8, page 49, NCERT

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

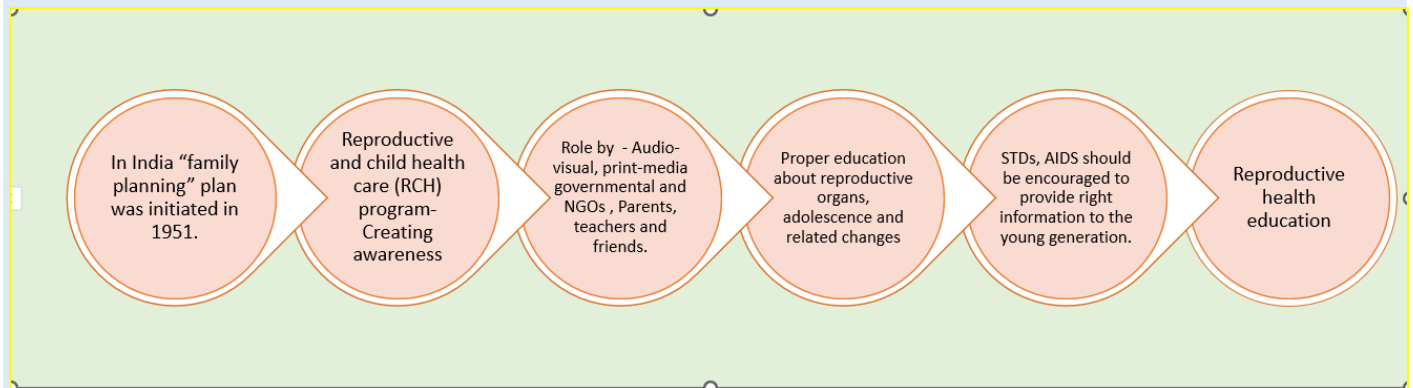
Ans:

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

CHAPTER- 4 REPRODUCTIVE HEALTH

WHO: reproductive health means total Well-being in all aspects of reproduction i.e. physical, emotional, behavioral and social.

REPRODUCTIVE HEALTH: PROBLEM AND STRATEGIES



Amniocentesis –

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

POPULATION EXPLOSION AND BIRTH CONTROL

MMR- Maternal mortality rate

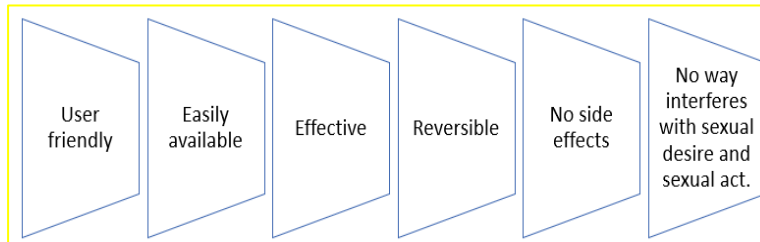
IMR- Infant mortality rate

CONTRACEPTIVE METHODS

Natural methods	work on the principle of avoiding chances of ovum and sperm 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	The male partner withdraws his penis from the vagina just before ejaculation 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 sperm are prevented from physically meeting with the help of barriers.
Condoms	Also, protect from STDs
Other examples of barrier methods	Diaphragms, cervical caps, and vaults.
IUDs	Inserted in the uterus through the vagina. IUDs increase phagocytosis of sperms within the uterus and the Cu ions released suppress sperm motility and the fertilizing capacity of sperms.
Non-medicated	Lippes loop
Copper releasing	CuT, Cu7, Multiload 375
Hormone releasing IUDs	Progestasert, LNG-20
Pills	
progestogens or progestogen-estrogen combinations	taken daily for a period of 21 days starting preferably within the first five days of the menstrual cycle. After a gap of 7 days (menses), it has to be repeated in the same pattern. Pills inhibit ovulation and implantation and 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 females. Saheli –the new oral contraceptive for 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 are also used. If used within 72 hours of coitus is very effective.
Surgical Methods/ Sterilization	
Vasectomy	in males, 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 the vagina.

An ideal contraceptive should be-



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 rid of unwanted pregnancy due to unprotected intercourse or failure of contraceptives used during coitus or rapes.
- It is relatively safe during the 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, Gonorrhoea, syphilis, genital herpes, chlamydia, trichomoniasis etc.
- Some infections like Hepatitis-B and HIV are also transmitted by sharing injection needles, surgical instruments with the 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 the disease.

INFERTILITY

Couples which are unable to reproduce children in despite of protected 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-

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

GIFT

ICSI

AI

IMPORTANT QUESTIONS

Very Short Answer Type Questions/ MCQ

1- Test tube baby implies which of the following techniques?

- a- IUT
- b- ICSI
- c- ZIFT
- d- All of these

Ans: C

2- Which of these can be used to cure infertility in couples where the male partner has a very low sperm count?

- (a) IUD
- (b) GIFT
- (c) IUI
- (d) None of these

Ans: C

3- Which part of the female is mainly involved in the tubectomy?

- a- Fallopian tube
- b- Endometrium
- c- Myometrium
- d- Vagina

Ans: A

4- Following statements are given regarding MTP.

- (i) MTPs are generally advised during the first trimester
- (ii) MTPs are used as a contraceptive method
- (iii) MTPs are always surgical
- (iv) MTPs require the assistance of qualified medical personnel

Choose the correct option.

- (a) (ii) and (iii)
- (b) (i) and (iii)
- (c) (i) and (iv)
- (d) (i) and (ii)

Ans: C

5- Sterilization techniques are generally very effective methods of contraception with the least side effects. Yet, this is the last option for the couples because

- (i) It is almost irreversible
- (ii) the misconception that it will reduce sexual urge

- (iii) it is a surgical procedure
- (iv) of lack of sufficient facilities in many parts of the country

Choose the correct option.

- (a) (i), (ii), (iii) and (iv)
- (i) and (iii)
- (b) (ii) and (iii)
- (c) (ii) and (iv)

Ans: A

6- 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 total Well-being in all aspects of reproduction i.e. physical, emotional, behavioral and social. A reproductively healthy society includes people having physically and functionally healthy reproductive organs. They have normal behavioral and emotional interactions in sex-related matters.

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

Ans: Amniocentesis

8- Which research institute develops the contraceptive pill “Saheli”?

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

9- Why tubectomy is considered a contraceptive method?

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

10- Which methods of contraception are also known as sterilization methods?

Ans: Tubectomy and Vasectomy

11- Expand ICSI.

Ans: Intra cytoplasmic sperm injection.

12- 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

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

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

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

Ans: Hepatitis, HIV-AIDS

15- How can a possible pregnancy due to rape or casual unprotected intercourse be 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 contraceptives 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 sperm

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

Ans- i- Avoid sex with unknown partners/ multiple partners. li-Always use a barrier method of contraceptive lii-Consult doctor in case of any symptom for early detection and treatment

4- Fill the a, b, c, d with the 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 reasons for sterility.

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

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

Ans: ZIFT (zygote intrafallopian transfer) – it is the 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 the detection of congenital disorder

Negative- used in sex determination and female foeticides

8- An infertile couple is advised to adopt a test tube baby programme. Describe two principles and procedures adapted to such technologies.

Ans: In-vitro fertilization (IVF): In this process, 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 an ovum, but can provide suitable conditions for the fertilization of the ovum, are provided with an ovum from a donor.

9- Describe the Lactational amenorrhea method of birth control.

Ans: Lactational Amenorrhea is a natural method of contraception. In lactating mothers there is a 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 the uterus and release copper ions which suppress sperm motility and fertilizing capacity of sperm.

(b) Hormone-releasing IUDs – Progestasert, LNG-20 -These make the uterus unsuitable for implantation and the cervix hostile to sperm.

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

The 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 rape. MTPs are also essential in cases where pregnancy could be harmful or even fatal to the mother/ foetus or both.

2- Some contraceptives can be taken orally. Give examples of such contraceptives and explain the 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 the 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 the 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 couples 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	The male partner withdraws his penis from the vagina just before ejaculation 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	Fitted in the uterus. Increases sperm phagocytosis, Cu ions suppress sperm motility and the fertilizing capacity of sperms. It also makes the uterus unsuitable for implantation and the cervix hostile to the sperm.
	Non-medicated -Lippes loop
	Copper releasing - CuT, Cu7, Multiload 375
	Hormone releasing - Progestasert, LNG-20
Injection	Progestogens alone or in combination with an 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, chlamydiosis, genital warts, trichomoniasis, and 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 the 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 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 be aware of myths and misconceptions. (b) For awareness about reproduction.
- (c) To be aware of 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

Keywords

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 a 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 the crossing of a hybrid with one of its parents or an individual genetically similar to its parent
Codominance	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 three alleles for a particular gene
Linkage	Tendency of closely situated genes to inherit together
Crossing over	It is an exchange of genetic material during sexual reproduction
Genotype	The specific combination of alleles for a given gene
Phenotype	An individual's observable traits
Punnet square	Square diagram is 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 gene
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 <i>autosome</i>
Chromosomal Disorders	A disorder due to a 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 that 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

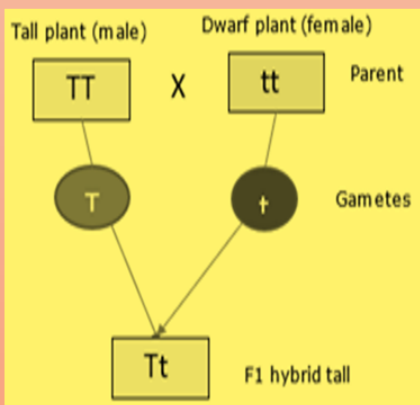
Contrasting characters observed by Mendel

Character	Dominant	Recessive
1. Stem length	Tall	Dwarf
2. Flower position	Axial	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

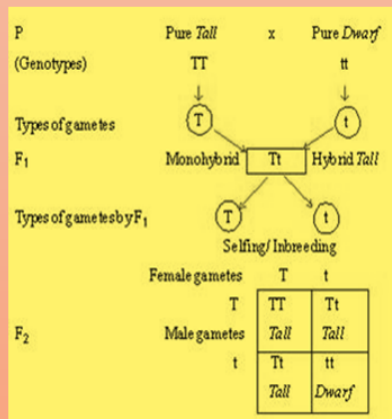
LAW OF DOMINANCE

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.



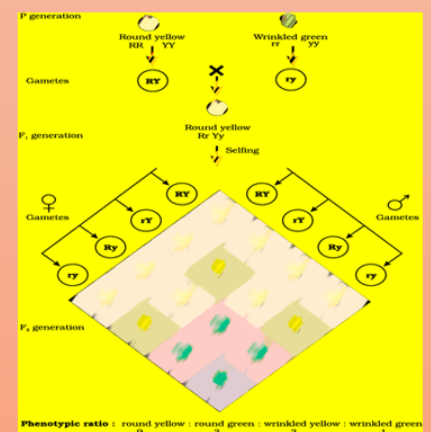
LAW OF SEGREGATION

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

the alleles of two (or more) different genes get sorted into gametes independently of one another.



Dihybrid Ratio

- Genotype ratio: -9:3:3:1
- Phenotypic ratio:- 9 Round yellow: 3 Round green: 3 Wrinkled yellow: 1 Wrinkled green

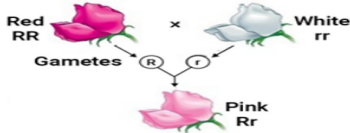
INCOMPLETE DOMINANCE/ CODOMINANCE/ MULTIPLE ALLELISM.

Incomplete Dominance

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

Ex. Pink flowers of Snapdragon or Antirrhinum

When plants with homozygous red flowers (RR) and homozygous white flowers (rr) are crossed the F1 offspring shows a pink colour flower (Rr).



Codominance

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.

Alleles	Blood group	Phenomenon
$I^A I^A, I^A i$	A	Dominance
$I^B I^B, I^B i$	B	Dominance
$I^A I^B$	AB	Co-dominance
ii	O	Recessive

HUMAN BLOOD GROUP SHOWS DOMINANCE, CO DOMINANCE AND MULTIPLE ALLELISM

Chromosomal theory of inheritance

Proposed by Walter Sutton & Theodore Boveri

Chromosomes occur in pair

Genes are located at specific locations on chromosomes.

Chromosomes as well as gene both occur in pairs.

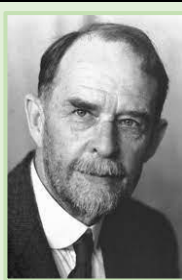
Homologous chromosomes separate during meiosis.

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 the linkage theory



Reason of working on *Drosophila*

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

LINKAGE and CROSSING OVER

Linkage

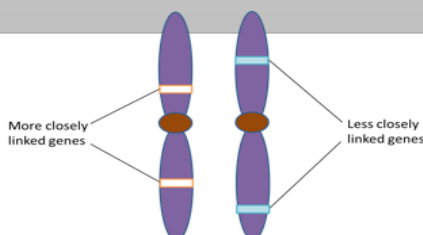
Linkage is the physical association of two or more genes on a chromosome.

Closely situated genes are more linked than distantly situated and they have a tendency to inherit together.

Linkage is responsible for the similarity of progenies to their parents.

Morgan 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



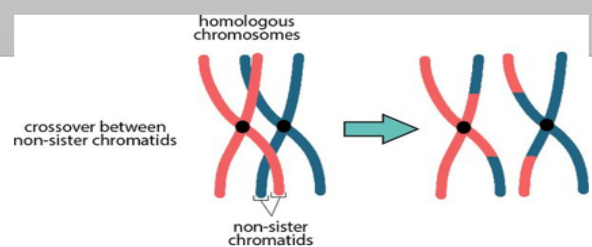
Crossing over and Recombination

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.

It 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 organisms.



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 and PLEIOTROPY

polygenic traits

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 a dominant trait and dark skin colour

aabbcc- this is recessive and light in light skin colour

Other examples are height and eye colour in humans

pleiotropy

In pleiotropy a single gene has multiple phenotypic expressions.

Example – Phenylketonuria disease is caused by mutation in the gene that codes for the enzyme phenyl alanine hydroxylase (single gene mutation).

This causes mental retardation and a reduction in hair and skin pigmentation

SEX DETERMINATION

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 the other 50 % of sperm did not receive it. **Henking** called this structure the **X body** (now it is called as X-chromosome).

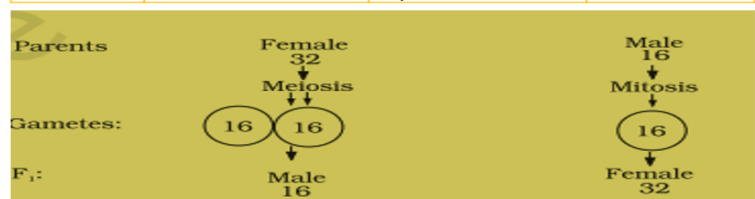
Sex Determination in Honey Bee

In honey bees, the male is haploid ($n=16$) while the female is diploid ($2n=32$).

Males (drones) develop by parthenogenesis from unfertilized eggs.

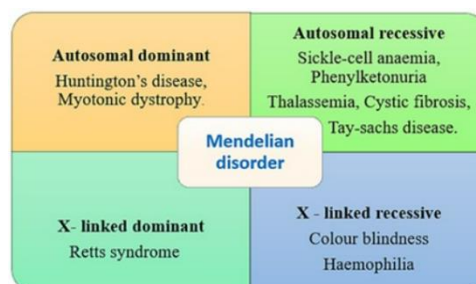
Females (worker bees) grow from fertilized eggs and are hence diploid.

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.



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 Blindness

sex-linked recessive disorder.
Unable to 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 ^c X ^c	Colourblind
X ^c Y	Colourblind
XX	Normal
XY	Normal
X ^c X	Carrier

Haemophilia

sex linked recessive disease.
permanent bleeding due to defect in blood clotting process
Queen Victoria shows a number of hemophilic descent as she was a carrier of the disease

Condition	Haemophilic or not
X ^h X ^h	Haemophilic
X ^h Y	Haemophilic
XX	Normal
X ^h X	Carrier

Thalassemia

Autosome-linked recessive disease.
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

Down's Syndrome

Caused due to trisomy of the chromosome no 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 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 45 with XO.
Features- sterile females with rudimentary ovaries, lack of other secondary sexual characters.

IMPORTANT QUESTIONS

VERY SHORT ANSWER QUESTIONS/ MCQ

- 1- Identify the name/ names of the scientists who rediscovered Mendel's work.
 - a- Hugo DeVries
 - b- Carl Correns
 - c- Tschermak
 - d- All of these
 Ans: D
- 2- What is the karyotype of Klinefelter's Syndrome and Turner's syndrome?
 - a- 45 XO
 - b- 47 XYY
 - c- 47 XXY
 - d- 45 XXY
 Ans: 47, XXY and 45 with XO
- 3- Which of the following represents the XO type of sex determination?
 - a- Grasshopper
 - b- Lizard
 - c- Huma
 - d- Earthworm
 Ans: Grasshopper
- 4- Write the Dihybrid cross ratio when self-cross is carried out between two heterozygous gametes.
 - a- 1:2:1
 - b- 9:3:3:1

c- 1:1:1:1

d- None of these

Ans: A

5- **For which types of reproduction Mendel's laws of inheritance are applicable?**

a- Asexual Reproduction

b- Sexual Reproduction

c- Both asexual and sexual reproduction

d- None of these

Ans: B

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

Ans: Henking, X-body

7- **What is the cross known as when the F1 progeny is crossed with a homozygous recessive parent? Write one advantage of such a cross.**

Ans: The cross is a test cross.

It is advantageous to determine the genotype of the parent plant.

8- **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.)

9- **What term is used in which there are extra set of chromosomes 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 ANSWER TYPE QUESTIONS

1- **In a plant $2n = 12$ and another plant $2n = 20$. What will be the ploidy of plants obtained by crossing 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 the law of dominance.**

Ans: The law of inheritance provides 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 the mother has blood group B, work out the genotypes of the parents and the possible genotypes of the offspring.**

Ans: Genotype of father $I^A I^A$

Genotype of mother $I^B I^O$

Genotype of child $I^O I^O$

♀ \ ♂		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 all

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 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 a 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 the sufferer of this syndrome.

Ans. Caused due to the presence of an additional copy of X chromosome resulting in 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 show 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 a student of Morgan. His contributions are-

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

ii- Established concept of the 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 the pea plant.

Ans: 5.7, page 79, NCERT

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

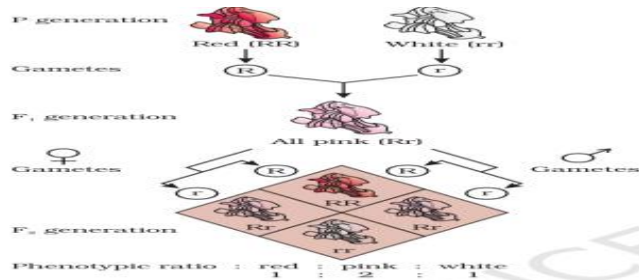
Ans: Recombination is the process of producing a new combination of genes by crossing over during meiosis. It is the characteristic feature of sexually reproducing organisms.

Applications:

- i- It causes variation in a population.
- ii- Variability leads to better adaptation and survival
- iii- With the 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?

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		
Genotypic ratio		: 1	: 1	: 1	: 1		

Ans:

- a- It is a dihybrid test cross
- b- It illustrates the Principle of independent assortment.

CHAPTER- 6

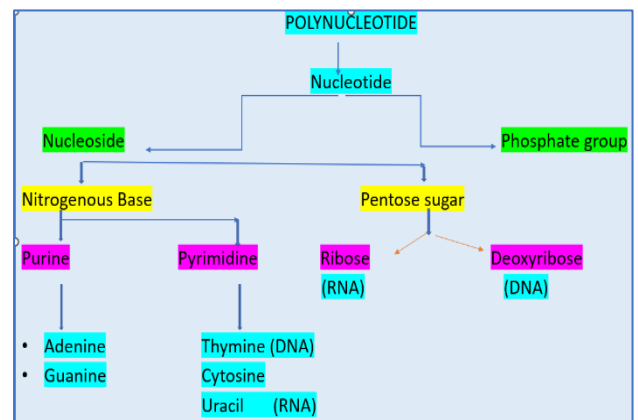
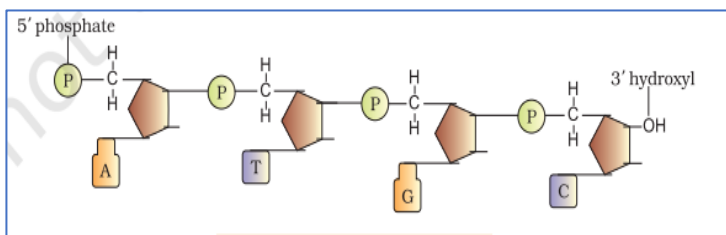
MOLECULAR BASIS OF INHERITANCE

Keywords

DNA	Deoxyribonucleic acid
RNA	Ribonucleic acid
Phosphodiester bond	The 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
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 chains.
- ✓ In polynucleotides the nucleotides are joined with a Phosphodiester bond.



DNA

- ✓ Friedrich Miescher in 1869 identify DNA as an acidic substance present in the nucleus and named it 'Nuclein'

Organism	Length of DNA
Bacteriophage $\phi \times 174$	5386 nucleotides
Bacteriophage lambda	48502 bp
Escherichia coli	4.6×10^6 bp
Human (haploid content)	3.3×10^9 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.

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'.

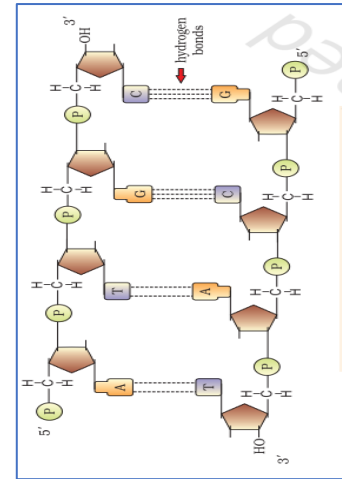
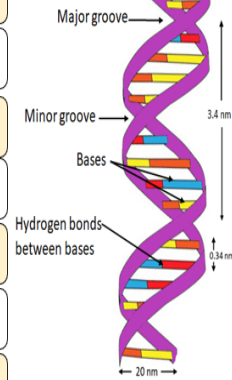
The nitrogenous bases are held by hydrogen bond in between two polynucleotide chain.

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

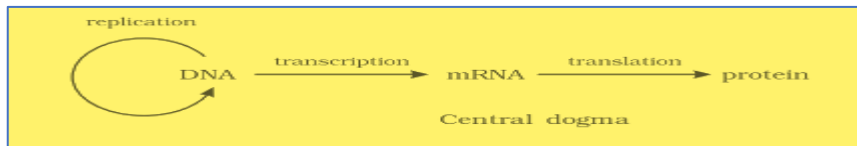
He found that in DNA, the ratios of adenine (A) to thymine (T) and guanine (G) to cytosine (C) are equal.

$A = T$ 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

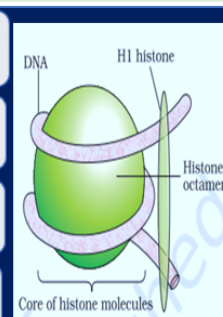
The process of tightly packing the DNA molecule to fit into the nucleus of a cell is known as Packaging of DNA Helix.

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- Proposed by** Frederick Griffith in 1928
- **Biochemical characterization of transforming principle-** proposed by Oswald Avery, Colin Macleod & Maclyn McCarty
- **Hershey-chase experiment-** proposed by Alfred Hershey and Martha Chase (1952)

Transformation Principle

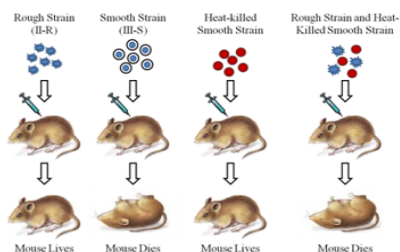
Griffith used mice & *Streptococcus pneumoniae*. *Streptococcus pneumoniae* has 2 strains:

- Smooth (S) strain (Virulent): Has polysaccharide mucus coat, cause pneumonia.
- Rough (R) strain (Non-virulent): No mucus coat, do not cause Pneumonia.

Experiment:

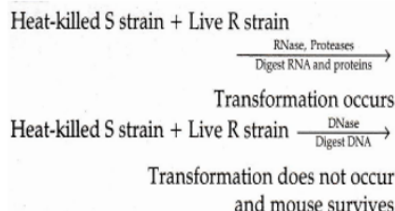
- S-strain → Inject into mice → Mice die
- R-strain → Inject into mice → Mice live
- S-strain (Heat killed) → Inject into mice → Mice live
- S-strain (Heat killed) + R-strain (live) → Inject into mice → Mice die

He concluded due to the transfer of genetic material some R-strain bacteria transformed into S strain (Virulent).



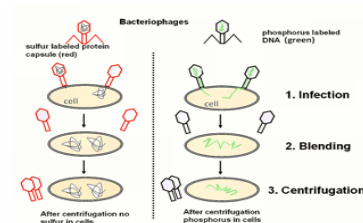
BIOCHEMICAL CHARACTERIZATION OF TRANSFORMING PRINCIPLE

- Oswald Avery, Colin Macleod & Maclyn McCarty 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 the transformation of R cells to S cells. They concluded that DNA is hereditary material.



Hershey and Martha Chase experiment

- Alfred Hershey and Martha Chase 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 the ^{32}P medium has radioactive DNA while those grown in the ^{35}S medium has labeled protein coat.
- They infect one group of bacteria with ^{32}P -labeled viruses and another group with ^{35}S -containing viruses.
- After blending and centrifugation they observed and concluded that bacteria infected with ^{32}P produce offspring labeled with ^{32}P while none of the progeny is radioactively labeled of ^{35}S labeled virus therefore DNA is the main genetic material



PROPERTIES OF GENETIC MATERIAL (DNA VERSUS RNA)

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

DNA is more stable than RNA because –

DNA is double-stranded	The mutation rate in RNA is more than in DNA
Thymine in DNA is less reactive than Uracil in RNA	The 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

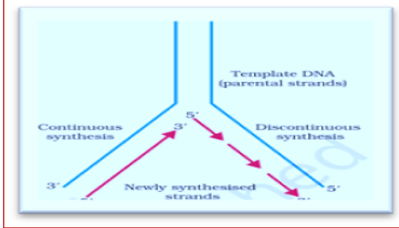
TYPES OF RNA

mRNA	It contains messages of DNA in the form of codons. Eukaryotic mRNA undergoes splicing before entering the translation process. Prokaryotic mRNA does not need to be processed.
rRNA	rRNA forms ribosomes along with protein. The ribosomes 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, TRANSCRIPTION AND TRANSLATION

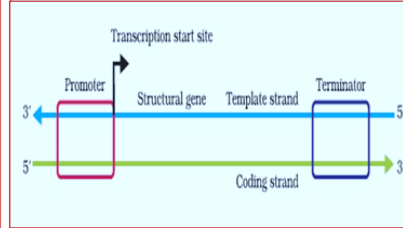
Replication

- DNA replication is the process by which DNA makes a copy of its own during S- the phase of cell division.
- Meselson and Stahl provide experimental proof of the semiconservative nature of a replication.
- Main enzyme for replication is DNA-dependent DNA polymerases.
- Replication starts within a small opening of the DNA helix (replication fork).
- The DNA-dependent DNA polymerases catalyze polymerization only in 5' to 3'.
- On one strand replication is in a continuous manner (leading strand) while on the other is in a discontinuous manner (lagging strand).
- The discontinuous strands (Okazaki fragments) are later joined by the enzyme DNA ligase.
- The DNA replication starts at a specific point known as Ori.



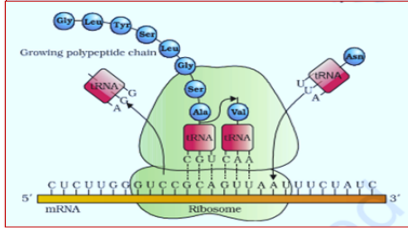
Transcription

- The process of copying genetic information from one strand of the DNA into RNA is termed a transcript.
- 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 –
 - A Promoter
 - The Structural gene
 - A Terminator
- Polymerization takes place only from the 5' end to the 3' end.
- The strand with 3' to 5' end polarity is known as the template strand and the other is known as the coding strand.
- Structural gene is the region which is transcribed is flanked with the promoter (towards 5' end; upstream) and terminator towards 3' end; downstream).
- Promoter provides a binding site for RNA polymerase while at the terminator the process of transcription stops.
- RNA polymerase binds to the promoter and initiates transcription (Initiation) with the of sigma factor. Polymerase uses nucleoside triphosphates as a substrate for polymerization.
- After completion of polymerization of the structural gene the factor (p) terminate the transcription process.



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 forms aminoacyl tRNA. The first amino acid is always methionine in a polypeptide sequence.
- Ribosomes provide a 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 the formation of the 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.



Complexities in Eukaryotic Transcription

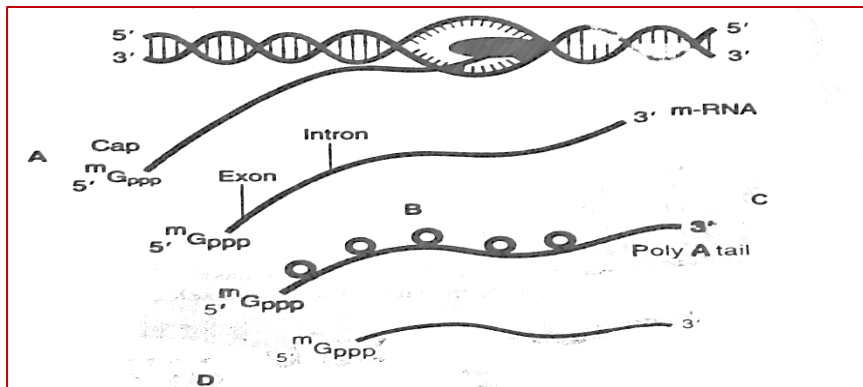
i- Three different RNA Polymerases

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 the sequence of codons on m RNA that contain information about amino acids.

The salient features of the genetic code are as follows:

- The codon is a **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 humans UUU would code for Phenylalanine. Some exceptions to this rule have been found in mitochondrial and protozoan codons.
- AUG has dual functions. It codes for **Methionine (met)** , and it also acts as an **initiator codon**.
- UAA, UAG, UGA are **stop terminator codons**.

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

REGULATION OF GENE EXPRESSION

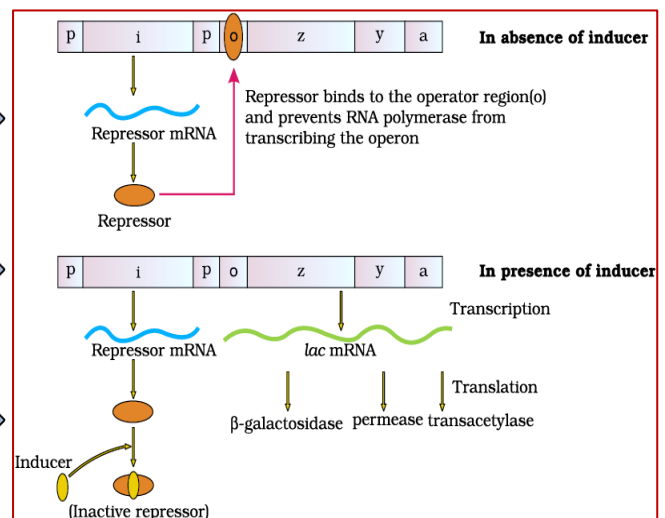
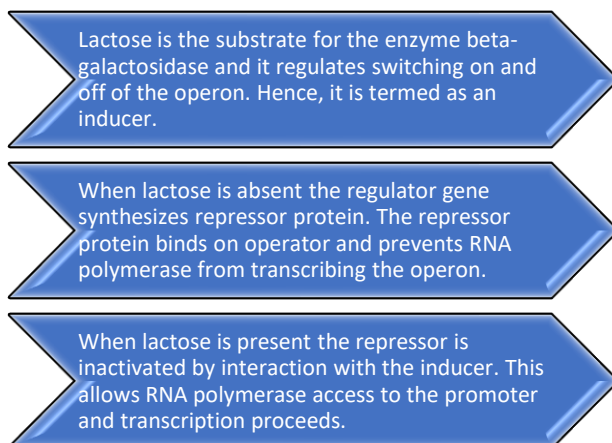
In eukaryotes, the regulation is controlled at-

- Transcriptional level (formation of primary transcript),
 - Processing level (regulation of splicing)
 - Transport of mRNA from nucleus to the cytoplasm,
 - 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 the binding site for the repressor
structural genes (z, y, a)	The z gene (beta-galactosidase (β -gal) –breakdown lactose into galactose and glucose. The 'y' gene (permease)- increases the permeability of the cell to β -galactosidase. The 'a' gene encodes a transacetylase.



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

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 THE HUMAN GENOME PROJECT

DNA FINGERPRINTING

- DNA fingerprinting is a technique of determining nucleotide sequences of certain areas (VNTRs) of DNA that are different in different individuals. DNA fingerprinting involves identifying differences in repetitive DNA.
- **Alec Jeffreys** develops the technique of DNA Fingerprinting. He used satellite DNA as a probe that shows a very high degree of polymorphism called as VNTRs (as Variable Number of Tandem Repeats)
- These sequences with a high degree of polymorphism form the basis of DNA fingerprinting.
- The repetitive DNA is 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 the genetic level) arises due to mutations.
- It is widely used in forensic science, paternity disputes, etc.

Steps of DNA Fingerprinting

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

IMPORTANT QUESTIONS

Very Short Answer Type Questions/ MCQ

1- By which method detection of hybridized DNA fragments is possible-

- a- Electrophoresis
- b- Southern blotting
- c- Northern blotting
- d- Autoradiography

Ans: D

2- Who invented methodologies of automatic DNA sequencing and Lac operon?

- a- Sanger
- b- Jeffry

- c- Nicholson
- d- Both a and b

Ans: D

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

- a- BAC
- b- YAC
- c- Both a and b
- d- None of these

Ans: C

4- What is the basic approach adopted as a methodology in HGP?

- a- ESTs
- b- Splicing
- c- Tagging
- d- Emasculation

Ans: A

5- met tRNA^{met} is an example of-

- a- AUG
- b- GUG
- c- Activated tRNA
- d- Activated mRNA

Ans: c

6- What are inducers in lac operon, give two examples of inducers.

Ans: inducer binds with repressor protein so that they can't bind on operator gene.

Example- Lactose and Allolactose

7- 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 an efficient translation process.

8- What are initiator tRNA? How many tRNAs are present in a cell for 20 different amino acids?

Ans: Initiator tRNA is for initiation of the translation process. It always carries methionine amino acid. There are 20 different tRNAs for 20 different amino acids.

9- What is the dual nature of codon AUG?

Ans: It codes for the amino acid methionine.

This is also known as the initiation codon responsible for the initiation of the translation process.

10- What is the role of the sigma factor and DNA ligase?

Ans: Sigma factor initiates the process of transcription

DNA ligase is to join adjacent nucleotides.

11- 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.

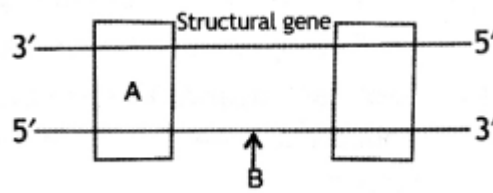
Ans: 3' UAUAGCAUCTAUUAGG 5'

**2- Three codons on mRNA are not recognized by tRNA during the translation process. Mention these codons?
Write the importance of these in protein synthesis.**

Ans: Stop codons- UAA, UAG and UGA

Help in termination of the 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 the 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 polyadenylate residue at 3' end.

5- List the features which must be present in 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 the role of the following-

Sigma factor, Rho factor, Release factor, Histone protein

Ans:

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

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

Ans: 1- If the strands code 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, and hence can easily express the characters.

RNA is 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 the ribosome reaches the Stop codons (UAA, UAG, and UGA) on mRNA, RF Protein (Release factor) binds on it and dissociates subunits of the ribosome, and the polypeptide is released in the cytoplasm.

10- List two essential roles of ribosomes during translation.

Ans: i- provide an attachment site for mRNA

ii) Provide the 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 labeled VNTR probe 6- Detection of hybridized DNA fragments by autoradiography

c- Paternity disputes can be solved by DNA fingerprinting

It is useful in the detection of crime and legal pursuits.

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

(i) **Unambiguous**

(ii) **Degenerate**

b- What is the significance of the 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 the Regulation of gene expression can be achieved in eukaryotes.

ii-What is the 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 the nucleus to the cytoplasm, translational level.

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

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

ii-Draw a double helical diagram of DNA showing phosphodiester bonds.

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

The DNA lacks a 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 features 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 percent) nucleotide bases are exactly the same in all people, The functions are unknown for over 50 percent of the discovered genes, and Less than 2 percent 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

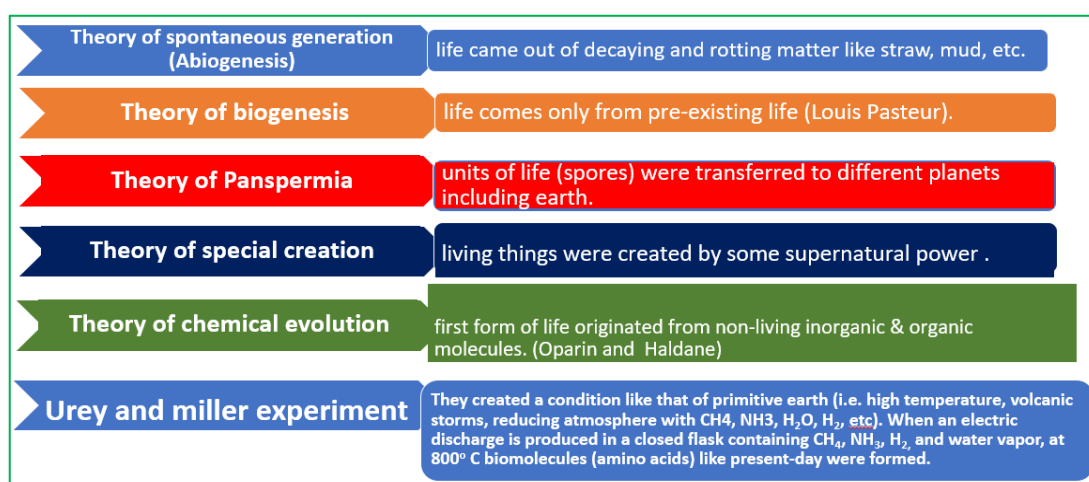
key words

Evolution	This 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 having similar appearances and performing 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	The process through which populations of living organisms adapt and change
Saltation	Single-step large mutation
mya	Million 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, CH₄, CO₂ & NH₃ released from molten mass covered the surface. The UV rays from the sun broke up water into Hydrogen and Oxygen and the lighter H₂ escaped. Oxygen is combined with ammonia and methane to form water, CO₂, etc. The ozone layer was formed. As it cooled, the water vapor fell as rain and formed oceans. Life appeared four billion years back.

THEORIES OF THE ORIGIN OF LIFE



EVIDENCE FOR EVOLUTION

1- **Fossils:** Fossils are remnants of life forms found in rocks (earth's 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 analyzing fossils in different sedimentary rock layers.

2- **Morphological & Anatomical evidence**

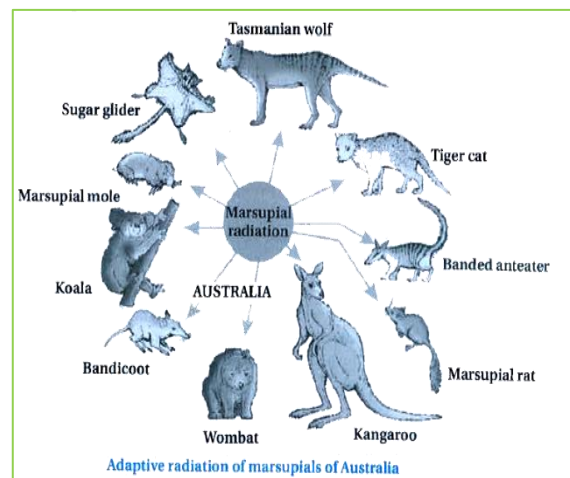
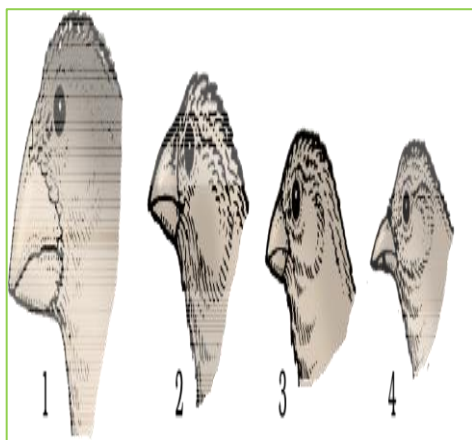
Homologous organs	These organs have similar structures and origins but different functions. The origin of homologous organs is due to Divergent evolution. Homology indicates common ancestry.	The human hand, Whale's flippers Bat's wing & Cheetah's foot humerus, radius, ulna, carpals, metacarpals & phalanges
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		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



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

MUTATION

- **Hugo de Vries** proposed the Mutation Theory of evolution.
- He conducted experiments in 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.

Equation:

- Sum total of all the allelic frequencies = 1

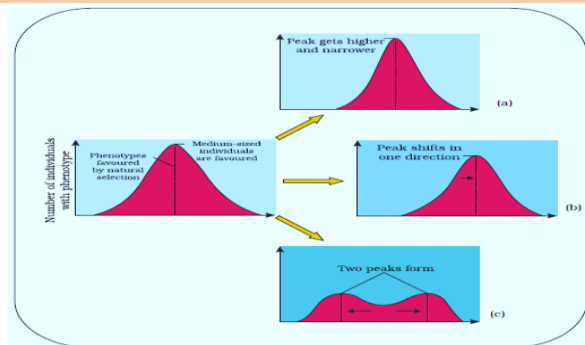
$$p^2 + 2pq + q^2 = 1$$

Factors affecting Hardy-Weinberg equilibrium

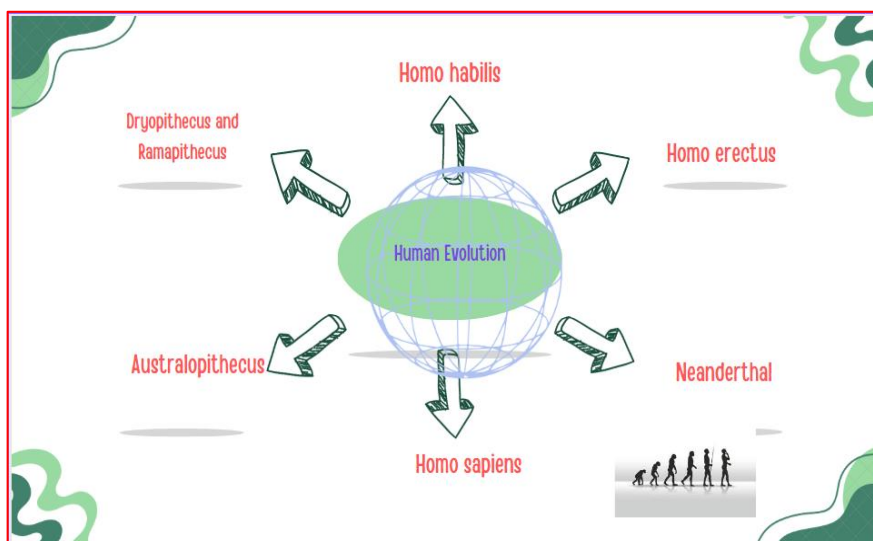
Gene Migration	Genetic drift	Mutation	Genetic recombination	Natural selection
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Types of Natural selection:

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 (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 and 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.
Prehistoric 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/ MCQ

1- Who used pre-sterilized flasks and yeast to disprove the theory of abiogenesis-

- a- Pasteur
- b- Darwin
- c- Lamarck
- d- Morgan

Ans: Louis Pasteur

2- What was the observation of Ernst Heckel regarding evidence of the origin of life?

- a- Embryological support for evolution
- b- Finches
- c- Homology
- d- Convergent evolution

Ans: A

3- What is the basis of the Darwinian theory of evolution?

- a- Natural selection
- b- Branching Descent
- c- Mutation
- d- Both a and b

Ans: D

4- $(p+q)^2 = p^2 + 2pq + q^2 = 1$ represents an equation used in

- a- Population genetics
- b- Cytogenetics
- c- bioinformatics
- d- Anthropology

Answer: A

5- The abiogenesis theory of origin supports

- a- spontaneous generation
- b- origin of life from blue-green algae
- c- origin of life is due to pre-existing organisms
- d- Organic evolution is due to chemical reactions.

Ans: A

6- 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.

7- Which scientist come to the same conclusion as Darwin?

Ans: Alfred Wallace (worked in the Malay Archipelago)

8- Give two examples of adaptive radiation.

Ans: Darwin finches, Australian marsupials.

9- 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.

10- 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.

11- 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 show the same ancestor.

12- 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 of 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 or 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- $p^2 + 2pq + q^2 = 1$ where p and q are allelic frequencies

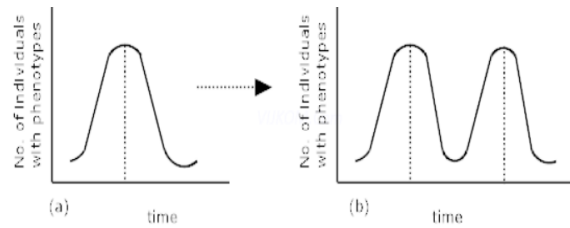
Factors affecting are - Genetic drift, Mutation, Gene flow, Genetic Recombination, Natural Selection

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 to bury 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

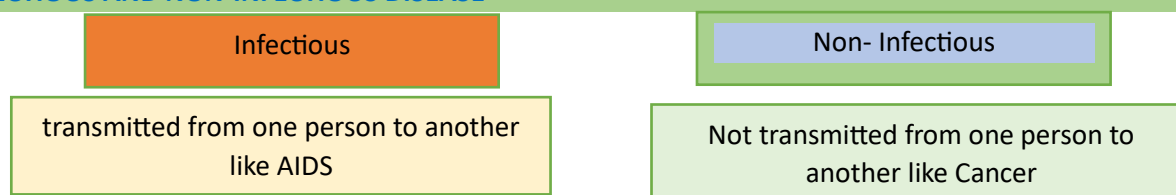
Keywords

Health	complete physical, mental and social well-being
Disease	Abnormal 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 secreted by virus-infected cells and protect non-infected cells
Primary response	The encounter of body pathogen for the first time
Allergy	The exaggerated immune response to certain antigens presents 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



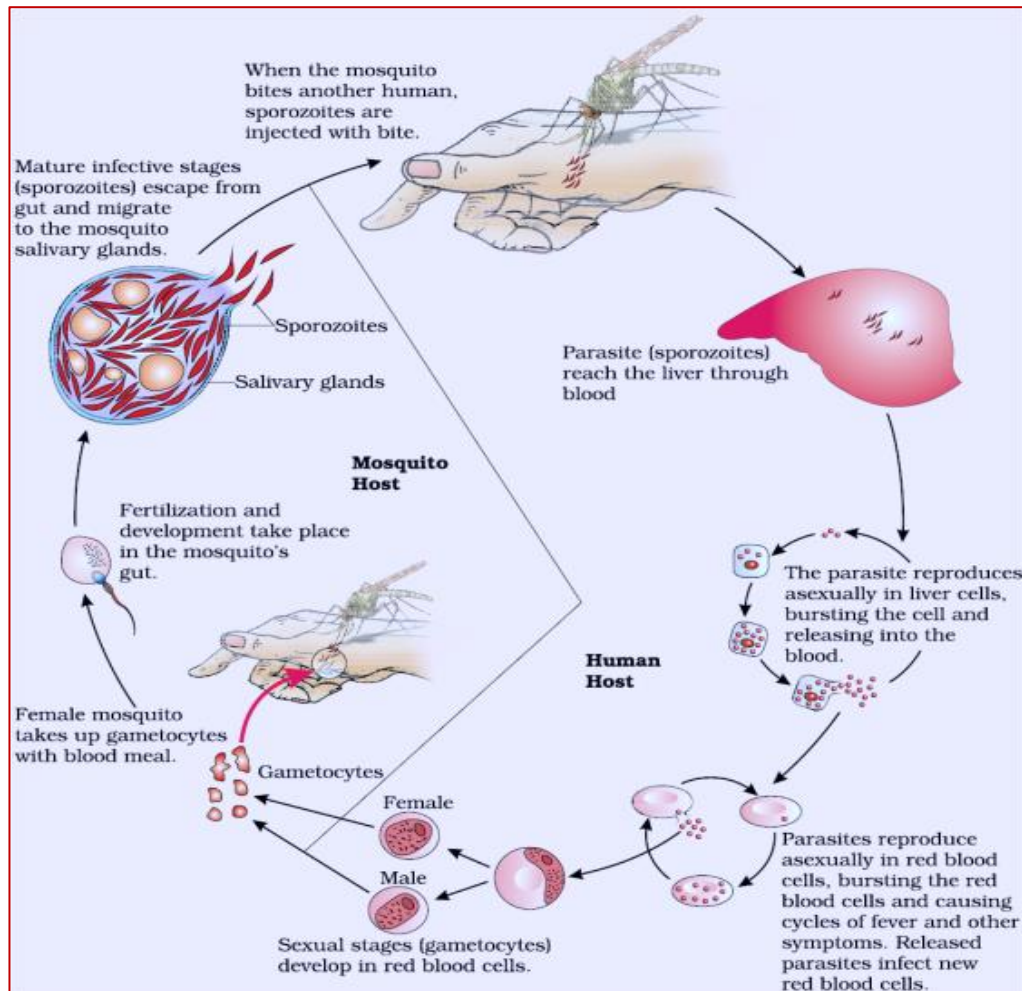
COMMON DISEASES IN HUMAN

Typhoid	<i>Salmonella typhi</i>	Test- Widal Test Intestinal perforation Sustain high fever (39-40 ° C), weakness, stomach pain, constipation, headache and loss of appetite
Pneumonia	<i>Streptococcus pneumoniae</i> <i>Haemophilus influenzae</i>	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)	<i>Entamoeba histolytica</i>	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	<i>Wuchereria (W. bancrofti and W. malayi)</i>	Infect lymphatic vessels Chronic inflammation of the organs like lower limbs and genitals.
Ringworms	Microsporum,	The appearance of dry, scaly lesions on various parts of the body such as skin, nails and scalp

	Trichophyton Epidermophyton	
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

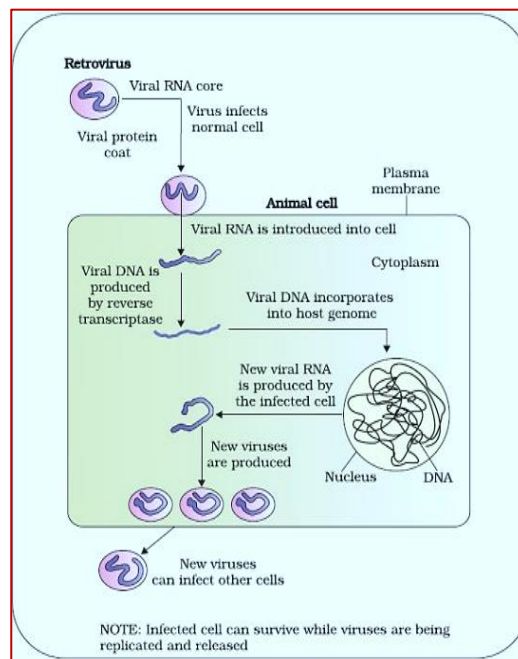
MALARIA

- 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 an infected female Anopheles mosquito.
- The parasites in the liver cells and then rupture the RBCs.
- The rupture of RBCs results in the formation of hemozoin, 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, undergo further development, and again form sporozoite.
- The sporozoites are stored in their salivary glands.



AIDS (Acquired Immuno Deficiency Syndrome)

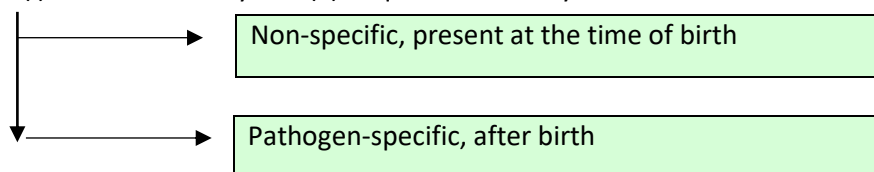
- Pathogen –HIV a retrovirus (RNA-containing virus)
- Transmission- occurs by (a) sexual contact with the infected person, (b) by transfusion of contaminated blood (c) by sharing infected needles (d) from the infected mother to her child through the placenta.
- After infection, the virus enters macrophages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



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.

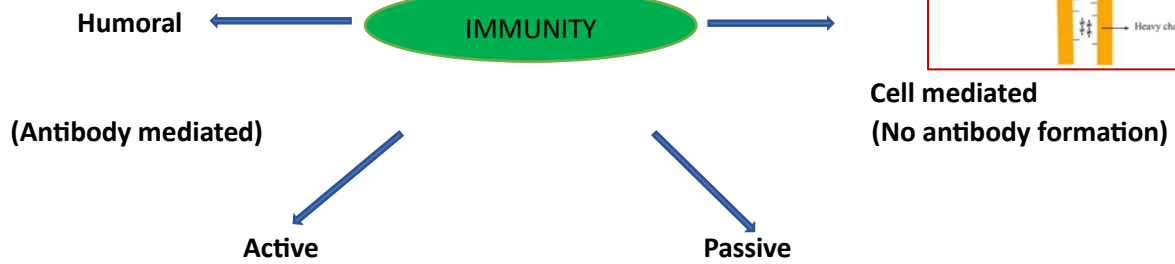
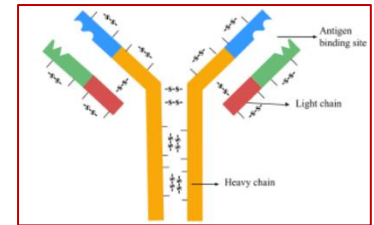
The primary and secondary immune responses are carried out with the help of two special types of lymphocytes present in our blood- (i) B-lymphocytes and (ii) T lymphocytes.

B lymphocyte- they produce Antibodies (immunoglobulin) 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



Active Immunity – 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) is introduced into the body.

The antibodies produced in the body against these antigens would neutralize the pathogenic agents during actual infection.

The vaccines also generate memory – B and T-cells that recognize the pathogen quickly on subsequent exposure and overwhelm the invaders with a massive production of antibodies.

IMMUNIZATION

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

Allergies

- The immune system's exaggerated response to certain antigens (allergens) present in the environment is called allergy. Common allergens are - pollen grains, mites in dust, animal dander etc.
- Allergic reactions are due to chemicals like histamine and serotonin released from the mast cells.
- Antibody IgE is 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 abnormality in which the immune response starts rejecting its own body cell or self-cells and molecules e.g. Rheumatoid Arthritis. Such diseases are known as an auto-immune diseases.

CANCER

In this, some of the body's cells grow uncontrollably

It shows uncontrolled proliferation of cells without any differentiation.

Contact inhibition- Process that inhibits a normal cell's uncontrolled growth due to its contact with the surrounding cells. Cancerous cells lost this property

Tumour- Large mass of cells formed due to the repeated division of cancerous cells

Benign tumors- Remain confined to their original location, do not spread to other body parts, 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 another parts by the body fluids is called metastasis.

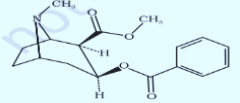
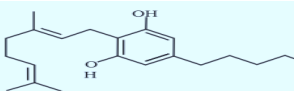
Carcinogens (cancer-causing agents)

Chemicals	nicotine
Biological Oncogenic viruses	These are cancer-causing viruses is called oncogenic viruses. They have genes called viral oncogenes.
ionizing radiation	X-rays and γ -rays
Non-ionizing radiations	UV-rays

Diagnosis- Biopsy and histopathological studies of the tissue and blood and bone marrow tests for increased cell counts in the case of leukaemia, 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 α -interferon

DRUGS AND ALCOHOL ABUSE

Drug	Common name and source	Effect
Opoids 	Heroin (smack) Source - Latex of poppy (<i>Papaver somniferum</i>)	Bind to specific opioid receptors present in our CNS and gastrointestinal tract. Heroin is a depressant and slows down body functions
Cannabinoids 	Examples- marijuana, hashish, charas and ganja. Obtained from <i>Cannabis sativa</i> .	Interact with cannabinoid receptors present principally in the brain. Effects on the cardiovascular system of the body.
Coca alkaloid	coke or crack Obtained from coca plant <i>Erythroxylum coca</i> .	interferes with the transport of the neurotransmitter dopamine. It acts on CNS producing a sense of euphoria and may cause hallucinations.
Nicotine	Tobacco	Stimulates adrenal gland raises blood pressure and increase heart rate
Barbiturates, Amphetamines, Benzodiazepines, and lysergic acid diethyl amides (LSD), are 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 the 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 the regular dose of drugs/alcohol is abruptly discontinued.

IMPORTANT QUESTIONS

Very Short Answer Type Questions/ MCQ

1- Antibodies present in colostrum that protect the new-born from certain diseases are of

- a- IgG type
- b- IgA type
- c- IgD type
- d- IgE type.

Ans: B

2- Malignant malaria is caused by which pathogen?

- a- Plasmodium falciparum
- b- Plasmodium vivax
- c- Plasmodium malignancies
- d- None of these

Ans: A

3- Chemically interferons are-

- a- Carbohydrates
- b- Glycosides
- c- Peptides
- d- Lipoproteins

Ans: C

4- Which of the following is not lymphoid tissue?

- a- Spleen
- b- Tonsils
- c- Liver
- d- Thymus

Ans: C

5- Ig E is released during-

- a- Allergy
- b- Colostrum secretion
- c- Tear formation
- d- None of these

Ans: A

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

**Ans: Widal test for typhoid
Biopsy- Cancer**

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

Ans: interferon is secreted by the virus-infected cell. Interferons are proteins.

8- Name the infective stage of the malaria parasite in humans. In which organ of the mosquito is situated?

Ans: Sporozoite. Situated in mosquito salivary gland

9- The malaria parasite requires two hosts to complete its life cycle. Identify the host where the following events take place-

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

Ans: (i) Human (ii) Mosquito

10- Name any four types of immunoglobulin present in the human immune system.

Ans: IgA, IgM, IgE, IgG

11- Provide two means of passive immunity through which the fetus and newly born baby get protected from infection.

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

12- Identify the type of immunoglobins in the following-

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

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

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

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

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

Ans: Barbiturates, Amphetamines

Short Answer Type Question

1- Give a detailed account of factors that 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) Lifestyle including food and water we take

2- Explain the 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 a primary response which is of low intensity. Subsequent encounter with the same pathogen shows a quick and highly intensified secondary or anamnestic response. This is because in primary response antibodies are formed which have the property of memory.

4- (i) Draw the structure of immunoglobulin.

(ii) Why immunoglobins are called H_2L_2 molecules.

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

(ii) Because it contains two heavy chains (H_2) and two light chains (L_2) of polypeptide

5- (i) What is an allergy?

(ii) Name two factors that are responsible for allergy in our body.

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

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

(ii) Histamine and serotonin

(iii) Anti-histamine, adrenalin

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

Ans: Macrophages are called HIV factories. After entering 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 leukemia, X ray, Monoclonal antibodies test

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

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

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

Ans: (i) Dengue and Chikungunya

(ii) Microsporium, Trichophyton

(iii) Streptococcus pneumoniae or Haemophilus influenzae

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

Ans: (i) Benign tumour - tumour remains confined to the place of origin or affected organ. The rate of growth of tumors is low.

(ii) Malignant tumor- it invades surrounding tissue & spreads throughout the body. The rate of growth of the tumor is rapid

Malignancy is lethal as it spreads all over the 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 the different mechanisms by which innate immunity protects the human body since birth.

Ans: Physical barriers - Skin prevents entry of the micro-organisms. Mucus coating of the epithelium lining the respiratory, gastrointestinal and urogenital tracts also helps in trapping microbes entering our body

Physiological barriers- Acid in the stomach, saliva in the mouth, tears from the eyes—all prevent microbial growth.

Cellular barriers- Leukocytes (WBC) like polymorpho-nuclear leukocytes (PMNL-neutrophils) and monocytes and natural killers 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 the red blood cells of the human body for their life cycle. Based on the statement answer the following questions-

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

(ii) Name the disease and its causative agent.

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

Ans. (i) due to the release of chemical hemozoin 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 do addiction and dependence differ from each other? What are the 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 the regular dose of drugs/alcohol is abruptly discontinued.

Withdrawal syndrome occurs if the regular dose of drugs/alcohol is abruptly discontinued. This is characterized 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 the humoral immune system work when our body is infected?

Ans: Humoral immunity is also called antibody-mediated immunity.

In this Immunoglobins (antibodies) are developed from B- lymphocytes.

These antibodies (B-cell) have receptors on their surface that recognize a specific antigen.

The antibody binds to the antigen- forming an antigen-antibody complex which is later digested by phagocytic cells like macrophages.

5- By observing the diagram answer the flowing questions-

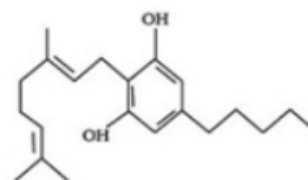
(i) Mention the group of drugs this structure represents.

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

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

(iv) Which part of the 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 is called lactic acid bacteria (LAB). The LAB produces lactic acid which coagulates and partially digests the milk proteins. This results in the formation of curd. Curd is rich in vitamin B12 and it checks the disease-causing microbes in the stomach.
Fermentation property – Microorganisms are widely used in the formation of dosa, idli, and bread. The puffed-up appearance of dough is due to the production of CO ₂ gas.
In bread formation, baker's yeast (<i>Saccharomyces cerevisiae</i>) is used.
The fermentation of palm sap is used to make traditional drinks like a toddy.
In cheese formation, specific microbes are used-
The large holes in 'Swiss cheese' are due to the production of a large amount of CO ₂ by a bacterium named <i>Propionibacterium sharmanii</i> .
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 (<i>Saccharomyces cerevisiae</i>) 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 the 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
<i>Fungus</i>	<i>Aspergillus niger</i>	Citric acid
<i>Bacterium</i>	<i>Acetobacter aceti</i>	Acetic acid
<i>Bacterium</i>	<i>Clostridium butylicum</i>	Butyric acid

<i>Bacterium</i>	Lactobacillus	Lactic acid
<i>Yeast</i>	Saccharomyces cerevisiae	Ethanol
<i>Lipases are used in detergent formulations and are helpful in removing oily stains from the laundry.</i>		
<i>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.</i>		
Product	Microorganism	Use
<i>Streptokinase</i>	Streptococcus	clot buster
<i>Cyclosporin A</i>	Trichoderma polysporum	immunosuppressive agent
<i>Statins</i>	Monascus purpureus	Blood-cholesterol-lowering agents.

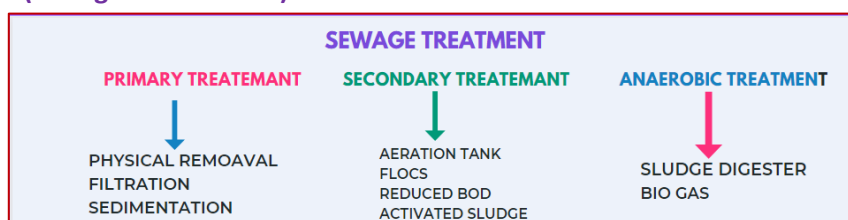
MICROBES IN SEWAGE TREATMENT

This municipal wastewater is also called sewage. Sewage) contains a 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 the 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 is 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 THE PRODUCTION OF BIOGAS

- Biogas is (containing methane) produced by the microbial activity of methanogen on cow dung and cellulosic waste. Cow dung is a 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 the slurry of dung is fed.
- The Biogas plant has A floating cover placed over the slurry (which keeps on rising as the gas is produced in the tank) and 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

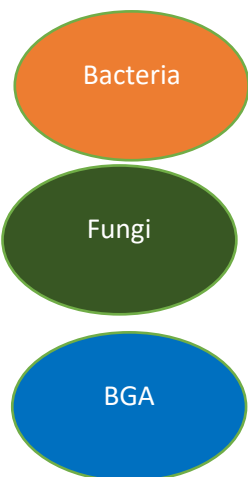
Biocontrol refers to the control of pests by microorganisms.

- 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 biocontrol 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.



Rhizobium in the root nodule of leguminous plants fixes atmospheric nitrogen into organic forms, which is used by the plant as a nutrient. Azospirillum and Azotobacter are also used as nitrogen-enriching biofertilizers.

Many species of fungus form a symbiotic association with the roots of plants (Mycorrhiza). e.g.- Genus Glomus form mycorrhiza. The fungal mycelium absorbs phosphorus from the soil and passes it to the plant. Such plants also show resistance to root-borne pathogens and 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/ MCQ

1- Nostoc is economically very important due to its following feature-

- N₂ fixing bacteria
- N₂ fixing cyanobacteria
- Mycorrhizae
- None of these

Ans: B

2- Bacillus thuringiensis is widely used as:

- Insecticide
- Weedicides
- Rodenticide
- None of the above

Ans: A

3- Which one is used as a biocontrol agent-

- Bacillus
- NPV
- Trichoderma
- All of these

Ans: D

4- Full potential of Penicillin is established by which scientist?

- Ernest Chain
- Howard Florey

- c. Both A and B
- d. Only A

Ans: C

5- What is common in penicillin and ampicillin-

- a. Antibiotic
- b. Antibody
- c. Immunoglobulin
- d. Antiseptic

Ans: A

6- Which organism is involved in curd formation? Mention the process of curd formation.

Ans: Lactic acid bacteria are used in the formation of curd.

The LAB produces lactic acid which coagulates and partially digests the milk proteins.

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

Ans: the large holes in 'Swiss cheese' are due to the production of a large amount of CO₂ by a bacterium named Propionibacterium sharmanii.

8- Write the scientific name of baker's yeast and brewer's yeast.

Ans: Saccharomyces cerevisiae

9- What Nucleopolyhedra viruses (NPV) are being used nowadays?

Ans: NPV is used as a biocontrol agent for insect control

10- Name a biological product that is used to remove stains from clothes.

Ans: Lipase

11- List an immune immunosuppressive agent and also, mention the name of the source organisms.

Ans: Cyclosporin A, source organism: Trichoderma polysporum

12- Why bottled juice looks clearer than homemade juice.

Ans: Proteases and pectinases are used which digest pectin and make juice clearer.

13- Why is the secondary treatment of water in sewage treatment plants called biological treatment?

Ans: In this treatment Organic wastes of sewage water are decomposed by certain microorganisms in the presence of water.

14- 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 the sewage treatment plant.

Ans: BOD refers to the amount of 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, the more is polluted.

2- Alexander Fleming observed that in the 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 the 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, and 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 the soil and passes it to the plant. Such plants also show resistance to root-borne pathogens and tolerance to salinity and drought.

5- From which organism we can obtain a 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 Floccs are formed during sewage treatment. Mention its application.

- Ans: Floccs are mesh-like structures containing aerobic bacteria and fungal mycelium.
- These are forms in aerobic tanks when organic matter is abundant.
- Floccs 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 the secondary level during biological treatment floccs reduces BOD significantly.

8- A farmer is advised to add a culture of microorganisms in the soil before sowing the crop. Name two microorganisms that can be helpful for farmers. How are 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 plants as a 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 – CH₄ , CO₂ , H₂.

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 floccs. These microbes consume the organic matter in the effluent. This significantly reduces the BOD.

•Once the BOD of sewage is reduced significantly, the effluent is then passed into a settling tank where the bacterial 'floccs' 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 the use of biocontrol 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 beings. 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 the following ways-

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

5- Various bioactive molecules and chemicals are produced from microorganisms by using modern technology. Give a brief account of 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

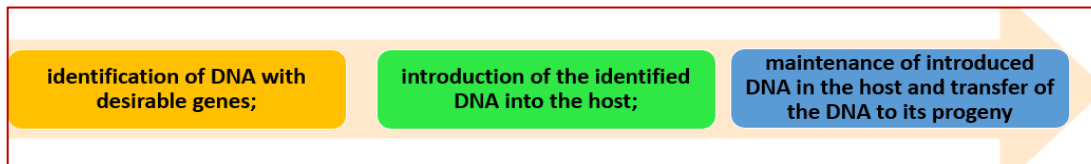
Biotechnology	'The integration of natural science and organisms, cells, parts thereof, and molecular analogues for products and services.
<i>Recombinant DNA</i>	Desired DNA + Vector DNA
<i>Origin of replication</i>	which is responsible for initiating replication
<i>Plasmid</i>	autonomously replicating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

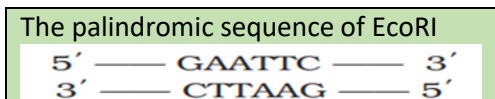
Three basic steps in genetically modifying an organism-



TOOLS OF RECOMBINANT DNA TECHNOLOGY

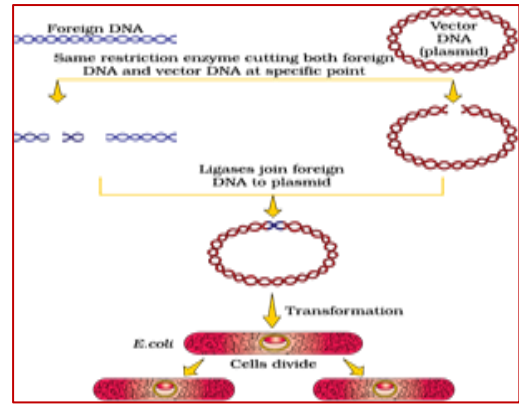
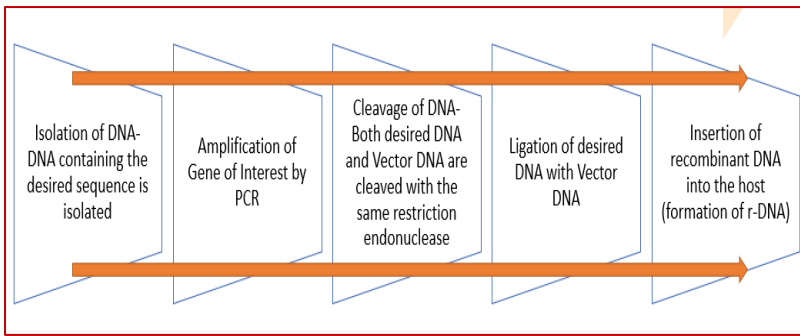
Restriction enzymes

- 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 –



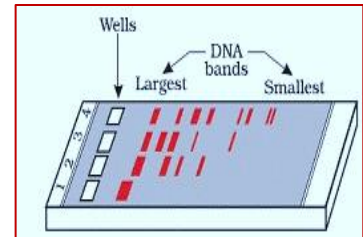
E	Genus, Escherichia
co	Species, coli
R	Strain
I	Order of isolation

PROCESS OF r-DNA FORMATION



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 results 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 (beta-galactosidase). Such bacterial colonies don't produce any colour.

Vectors for cloning genes in plants and animals

Agrobacterium tumefaciens – 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, creates 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
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Isolation of the Genetic Material (DNA)

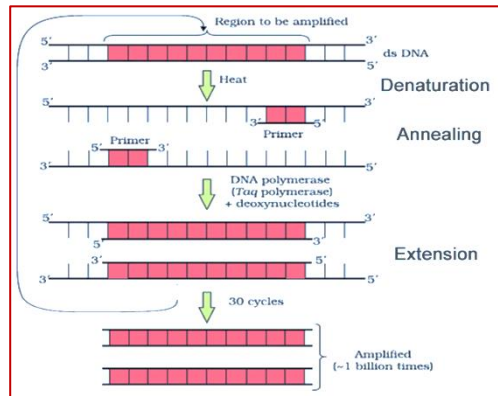
Chemical	Used for	Chemical	Used for
Lysozyme	To break the bacterial cell wall.	Cellulase	To break the plant cell wall
Chitinase	To break the fungal cell wall.	Ribonuclease	Removes RNA
Protease	Removes proteins (histones associated with DNA).	Chilled ethanol	Precipitate DNA

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 temperatures.

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

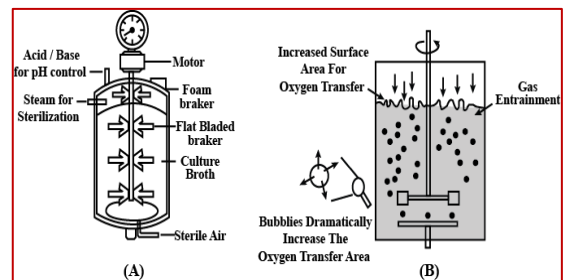


BIOREACTOR

- 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-

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	Sparged stirred-tank bioreactor- sterile air is sparged through the reactor
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IMPORTANT QUESTIONS

Very Short Answer Type Questions

- The cutting of DNA at a specific location became possible with –**
 - Restriction enzymes
 - Ligases
 - Both a and b
 - None of these

Ans: b
- Electrophoresis is a technique used in laboratories in order to separate**
 - DNA
 - Lipoprotein
 - Lactose
 - All of these

Ans: a
- The role of antibiotics in genetic engineering is chiefly as-**
 - Ori C
 - Selectable markers

- c. Both a and b
- d. None of these

Ans: b

4- _____ joins two DNA fragments together via a phosphodiester bond between two nucleotides.

- a. DNA Polymerase
- b. Primase
- c. DNA Ligase
- d. DNA topoisomerase

Ans: c

5- Site of origin controls replication in circular plasmid DNA

- a- Ori
- b- Selectable marker
- c- rop
- d- all of these

Ans: a

6- Selectable markers define biotechnology as given by the European Federation of Biotechnology (EFB).

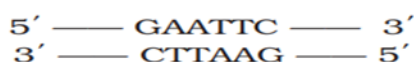
Ans: 'The integration of natural science and organisms, cells, parts thereof, and molecular analogues for products and services.

7- Why alien DNA is linked with the origin of the 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.

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

Ans:



9- 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 seaweed.

10- Which dye is used to visualize DNA bands on electrophoresis?

Ans: Ethidium bromide-stained gel exposed to UV light

11- Give examples of any four antibiotics which are used as selectable markers in the cloning vector.

Ans: ampicillin, chloramphenicol, tetracycline or kanamycin

12- 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.

13- Why are proteases added while isolating the DNA?

Ans: to remove histone proteins from DNA

14- What is T- DNA? Write about its importance in genetic engineering.

Ans: it is a piece of DNA of Agrobacterium tumefaciens. T-DNA transform normal plant cells into a tumour cell.

15- 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 the 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 fragments.
 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 cells and chitinase for the fungal cell.
 (ii) Cellulase is used to break plant cell walls, 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 the polymerase chain reaction.**
(ii) Which enzyme is used for PCR and why?
(iii) What is the source of that enzyme?
 Ans: (i) the correct steps are
- Denaturation- separation of ds DNA into ss DNA at high temperature (92°C).
 - 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 the 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

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.)

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-

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.
- 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 and chemical 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 / MCQ

1- Genetically engineered bacteria have been used in commercial production of

- Thymine
- Testosterone
- Human insulin
- All of these

Ans: c

2- Biopiracy is

- Unauthorized use without permission
- Authorized use without permission
- None of these
- All of these

Ans: a

- 3- The process of RNA interference has been used in the development of plants resistant to _
a. RNAi b- DNAi c- Insertional inactivation d-None of these

Ans: a

- 4- ELISA is based on-
a. Ag- IFN interaction
b. Ag- Ab interaction
c. DNA- RNA interaction
d. mRNA – DNA interaction

Ans: b

- 5- How human protein (α -1-antitrypsin) is used in the medical field.

- a. To treat diabetic
b. To remove clot
c. Immunosuppressive agent
d. To treat emphysema

Ans: d

- 6- 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

- 7- Which organism badly affects the crop of tobacco?

Ans: Nematode-*Meloidogyne incognita*

- 8- 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.

Ans: to treat emphysema

- 9- 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.

- 10- By giving one example clarify that GMOs enhance the nutritional value of food.

Ans: Golden rice, i.e., Vitamin 'A' enriched rice.

- 11- Which vector is used to create a pest-resistant tobacco plant?

Ans: Agrobacterium vectors

- 12- Specify one consequence of adenosine deaminase (ADA) deficiency.

Ans: adenosine deaminase (ADA) is crucial for the immune system to function

- 13- 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-sense 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

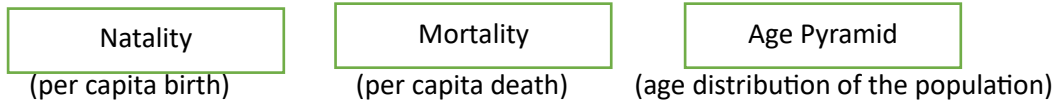
- To study the effect of genes on normal physiology and development
- To study diseases like cancer, cystic fibrosis, rheumatoid arthritis and Alzheimer's
- To obtain biological products. E.g. human protein (α -1-antitrypsin)
- For study of Vaccine and chemical testing and safety

Chapter-13 Organisms and Populations

POPULATIONS

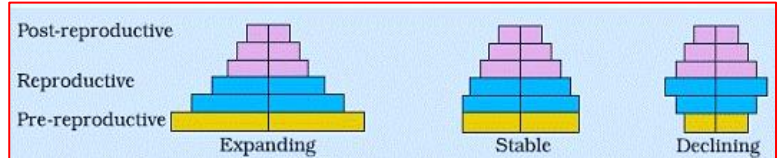
A population is a group of organisms of one species that can interbreed and live in a particular geographical area.

POPULATION ATTRIBUTES



Age pyramid may be the following types:-

- Expanding
- Stable
- 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 (Nativity and immigration) contribute to an increase in population density and two (mortality and emigration) to a decrease.

Nativity (B) – It is the number of births during a given period in the population.

Mortality (D) - is the number of deaths in the population during a given period.

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.

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

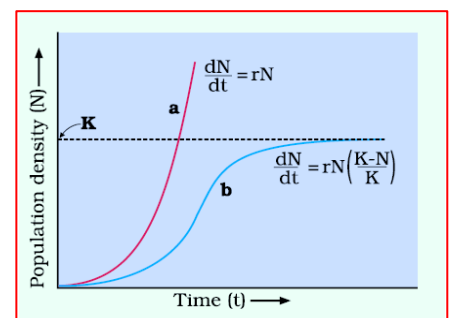
$$N_{t+1} = N_t + [(B + I) - (D + E)]$$

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-

$$\begin{aligned} dN/dt &= (b - d) \times N \\ \text{Let } (b-d) &= r, \\ \text{then } dN/dt &= rN \\ r &= \text{'intrinsic rate of natural increase'} \end{aligned}$$



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

$$N = N_0 e^{rt}$$

(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).

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

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

- The logistic growth curve 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:

POPULATION INTERACTIONS

PREDATION

- Predators feed on prey and by doing so they act as 'conduits' for energy transfer across trophic levels and keep prey populations under control.
- In the 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 1920s) spread very rapidly into millions of hectares of rangeland. It can be controlled only after introducing the 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.

- Interspecific competition: competition between two different species
- 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 *Chthamalus* 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 behavioral differences in their foraging activities.

PARASITISM

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

Ectoparasite: feeds on the external surface of the host. Examples – head lice on humans, ticks on dogs, *Cuscuta*

Endoparasite: Take shelter within the body of the host organism. Examples – Liver fluke, Plasmodium

Parasites 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 another bird (e.g. crow) and lets that other bird to incubate them.

COMMENSALISM

In this one species benefit 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 an 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 a female bee

AMENSALISM

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

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

IMPORTANT QUESTIONS

Very Short Answer Type Questions

1- **Penicillium placed with streptococcus will show which type of population interaction?**

- a. Commensalism
- b. Amensalism
- c. Parasitism
- d. None of these

Ans: b

2- **An orchid growing as an epiphyte on a mango branch shows which type of population interaction?**

- a. Commensalism
- b. Amensalism
- c. Parasitism
- d. None of these

Ans: a

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

- a. Commensalism
- b. Amensalism
- c. Parasitism
- d. None of these

Ans: c

4- **Sea anemone, and clown fish show-**

- a. Commensalism
- b. Amensalism
- c. Parasitism
- d. None of these

Ans: a

5- **In this one bird (e.g. cuckoo) lays its eggs in the nest of another bird (e.g. crow) and lets that other bird to incubate them**

- a. Commensalism
- b. Amensalism
- c. Brood Parasitism
- d. None of these

Ans: c

6- Define competitive release in reference to the population interaction.

Ans: Competitive release is the mechanism in which the species expands its distribution range when the competitor species is removed.

7- What is emigration? How does it affect population density?

Ans: It is the outward movement of some individuals of the species from a local population during the time period under consideration.

It decreases the population density.

8- What are two parameters by which population can be measured?

Ans: Biomass and Number

9- Name the orchid plant which undergoes sexual deceit phenomenon.

Ans: Mediterranean orchid Ophrys

10- The given age of pyramid represents –

Ans: stable population



11- Why do certain exotic species (like Parthenium in India) become too much invasive in certain geographical areas?

Ans: because those areas do not have natural predators of weed

12- In which specific condition 'J-shaped' population growth curve may be observed?

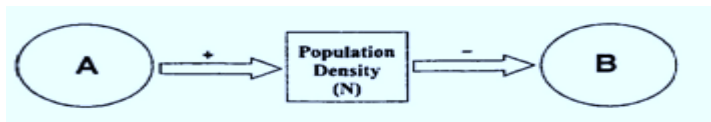
Ans: when there are unlimited natural resources available, and no competition takes place.

Short answer Type questions

1- 8 individuals in a laboratory population of 80 fruit flies 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 defense 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 mechanisms 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 act as 'conduits' for energy transfer across trophic levels and keep prey populations under control. In the 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's 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 help 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 declining.

(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 policymakers in planning for the future.

(iii) Fig 13.4, page 227, NCERT

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

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

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

Ans: (i) Fig 13.6 page 230 NCERT

(ii) $N_t = N_0 e^{rt}$

N_t = Population density after time t

N_0 = 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 the impacts of any biotic or abiotic factor on population growth.

4- What is 'sexual deceit'? Explain by giving a 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 the different types of interaction in a habitat? Explain with the help of chart.

Ans: fig 13.1, page 232, NCERT

Chapter-14 Ecosystem

Ecosystem

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

Ecosystem- Structure and Functions Ecosystem

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

Components of ecosystem

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

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

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

Productivity	The rate of biomass production is called productivity. Unit - $\text{gm}^{-2} \text{yr}^{-1}$ or $(\text{kcal m}^{-2}) \text{yr}^{-1}$ 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})	<p>GPP- It is the rate of production of organic matter during photosynthesis.</p> <p>GPP minus respiration losses (R), is the net primary productivity (NPP).</p> <p>NPP = GPP - R</p> <p>NPP- is the available biomass for the consumption to heterotrophs</p> <p>Secondary productivity is defined as the rate of formation of new organic matter by consumers.</p>
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Decomposition

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

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

Fragmentation of Detritus	Detritivores (e.g., earthworms) 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 the soil

Factors affecting rate of Decomposition

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

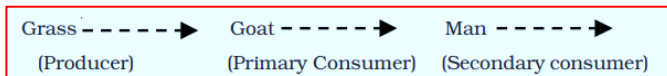
Energy Flow

- All living organisms are dependent on 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 the synthesis of food by plants.
- Transfer of energy follows the **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 the trophic level. E.g. producer, herbivore, primary carnivore, secondary carnivore



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

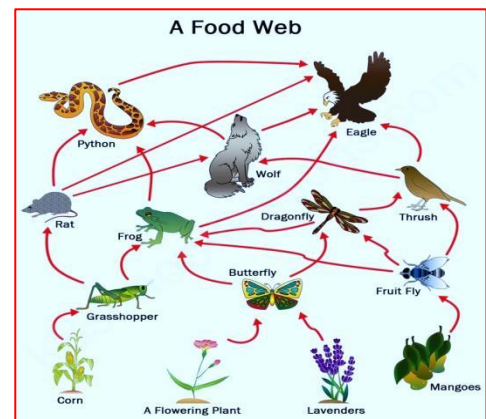
GFC	Energy flows from producers to consumers.
DFC	Begins with dead organic matter. It is made up of saprotrophs/ decomposers (heterotrophic organisms like fungi and bacteria).

Food web

The natural interconnection of the 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 a more stable ecosystem

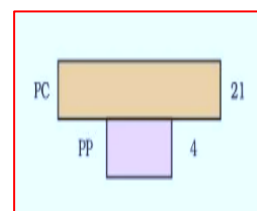
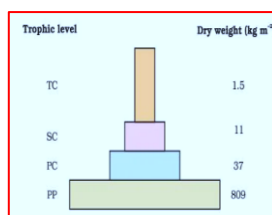
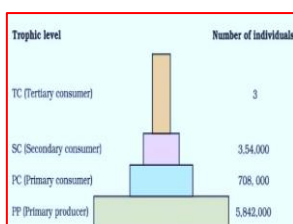


Ecological Pyramids

- 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	<ul style="list-style-type: none"> • Represent the number of individuals per unit area at various trophic levels with a producer at the base. • It is generally upright. • A pyramid of numbers in the case of a big tree is generally inverted because the number of insects feeding on that tree generally exceeds in number.
Pyramids of biomass	<ul style="list-style-type: none"> • Represent the biomass in various trophic levels. • The pyramid of mass is upright except in the aquatic food chain involving short-lived plankton. • A pyramid of biomass in the sea is generally inverted.
Pyramids of energy	<ul style="list-style-type: none"> • Give s graphic representation of the amount of energy trapped by different trophic levels per unit area. • It is always upright, and 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- Which one is an example of a manmade ecosystem.

- a- Aquarium
- b- Crop field
- c- Aquaculture pond
- d- All of these

Ans: d

2- During ecological succession

- a. Speciation in the new area
- b. The gradual and predictable change in species composition occurs in a given area
- c. Reduction of a pioneer community
- d. Bare land with no vegetation

Ans: b

3- Energy transfer takes place from one trophic level to another –

- a- 10 % b- 20 % c- 50 % d- depends on the trophic level

Ans: A

4- Which of the following is called as a detritivore?

- a. An animal feeding on an animal
- b. A plant feeding on an insect
- c. An animal feeding on insect
- d. An animal feeding on decaying organic matter

Ans: d

5- Root hairs are absent in-

- a. Xerophytes
- b. Hydrophytes
- c. Lithophytes
- d. Mesophytes

Ans: b

6- Why decomposition occurs at a faster rate in the tropics?

Ans: high humidity and temperature favour the rapid rate of decomposition

7- How do decomposers like fungi obtain their food?

Ans: Decomposers release their enzymes to decompose dead and decaying remains of plants and animals absorb the simple inorganic substances.

8- Name the trophic level occupied by secondary consumers & tertiary consumers.

Ans. Third trophic level by secondary consumer and fourth trophic level by tertiary consumer

9- What is the shape of the pyramid of biomass in the sea? Why?

Ans: Inverted, because the biomass of fishes is too much as compared 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 the top vertical strata of a forest, shrubs are the second and grasses occupy the bottom layers.

2- What are the four basic functional components of an ecosystem?

Ans: (i) Productivity; (ii) Decomposition; (iii) Energy flow (iv) Nutrient cycling.

3- Give two examples of autotrophic components in the food chain of the aquatic ecosystem.

Ans: phytoplankton, some algae

4- Which metabolic process causes a 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: The flow of energy in an ecosystem is unidirectional.

The Sun is the ultimate source of energy. It is used in the photosynthesis process to make food in autotrophs. This energy is transferred from autotrophs to the next trophic level. Only 10% of energy is transferred to next trophic level, the 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., earthworms) 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 the soil.

2- Provide a diagrammatic representation of the decomposition cycle in a terrestrial ecosystem.

Ans: Fig. 14.1 page 244, NCERT

3- What is meant by the ecological pyramid? Distinguish between upright & inverted pyramids. Explain with the help of a diagram.

Ans: The graphic representation of the trophic structure of a food chain is known as the ecological pyramid.

In the upright pyramid, the number or biomass of producers is more in comparison to consumers in an ecosystem.

In an inverted pyramid, the number/biomass of producers is less as compared to consumers.

Fig. 14.4 (a, b, c) page 248 NCERT

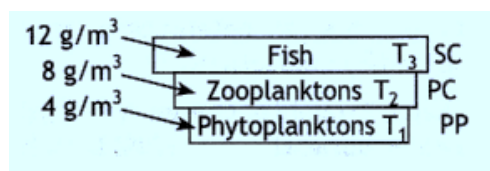
4- (i) How does the rate of decomposition affected by abiotic factors in an ecosystem?

(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 the following types-

i) Primary consumers - herbivores e.g. deer, cow

ii) Secondary consumers – feed on primary consumers like cats, fox

iii) Tertiary consumers- feed on secondary consumers like Lion

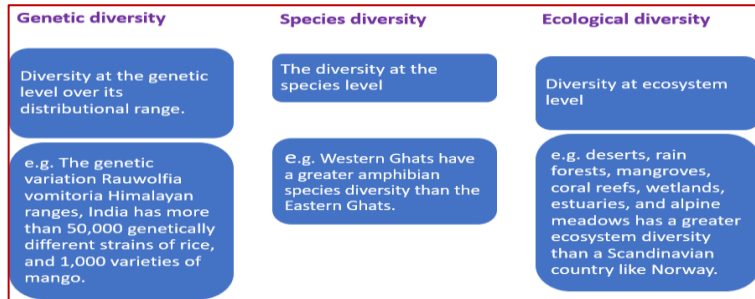
Decomposers: - Decompose dead and decaying objects like fungi, bacteria

Chapter-15 Biodiversity and its Conservation

BIODIVERSITY

- Biodiversity term is popularized by **Edward Wilson**.
- Biodiversity is the sum total of flora and fauna in a geographical area.

TYPES OF BIODIVERSITY



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

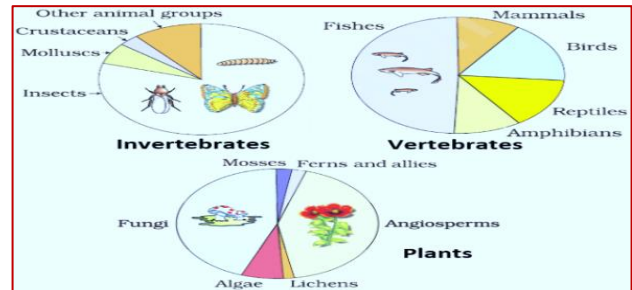
Robert May proposed the global species diversity at about 7 million. More than 70% of all the species are animals. Insects are more than 70% of total animals

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 the 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 results in higher productivity.

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 rivet of an airplane 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 the Red List which reported the 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 major

Habitat loss and fragmentation- Loss of habitats due to various human activities
Over-exploitation- Many species extinctions in the last 500 years were due to overexploitation by humans. For example- Steller's sea cow, passenger pigeon.
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.
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.

Quartet' (The four causes)

BIODIVERSITY CONSERVATION

Reason for conservation

Narrowly utilitarian	Biodiversity provides direct economic benefits from nature like food, firewood, fibers, medicinal plants, industrial products, etc
Broadly Utilitarian	Biodiversity plays a major role in ecosystem services like the production of Oxygen during photosynthesis, pollination without a natural pollinator, and 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	Ex situ (off-site) conservation
<ul style="list-style-type: none"> * conserving species in their natural habitats and environment * Ex- biosphere reserves, national parks, wildlife sanctuaries, sacred groves 	<ul style="list-style-type: none"> * Animals and plants are taken out of their natural habitat and placed in special settings to protect them. * Ex- Zoological parks, Botanical Gardens, wildlife safari parks and 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 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- **Identify the ex-situ conservation by which gametes of threatened species can be preserved.**
 - a- Zoological Park
 - b- Wildlife sanctuary
 - c- Sacred grooves
 - d- Cryopreservation

ANS: D
- 2- **Ramsar sites designed of international importance are-**
 - a- Oceans
 - b- Aquatic bodies
 - c- Wetlands
 - d- All of these

Ans: c
- 3- **Aravalli Hills are well known for**
 - a- Religious site
 - b- ASI sites
 - c- Mangrove
 - d- Sacred grooves

Ans: d
- 4- **Examples of onsite biodiversity conservations are**
 - a- biosphere reserves
 - b- national parks
 - c- wildlife sanctuaries
 - d- all of these

Ans: d
- 5- **western ghats have more amphibians than eastern ghat represents-**
 - a- species diversity
 - b- genetic diversity
 - c- ecological diversity
 - d- global diversity

Ans: a
- 6- **List some important conventions held at the international level for biodiversity conservation.**

Ans: The Earth Summit- Rio de Janeiro in 1992, World Summit - Johannesburg, South Africa in 2002
- 7- **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.
- 8- **Give an example of any two alien species that become a threat to indigenous plant species.**

Ans: Parthenium, water hyacinth (Eichhornia)

9- 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 bear

(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 about 40000 species of plants, 1,25,000 species of insects, 3000 species of fishes, 427 of amphibians, 378 of reptiles, 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) Rauwolfia vomitoria in different Himalaya range

(iv) Thousands of 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.

Ethical- for conserving biodiversity relates to what we own to millions of plants, animals and microbes species with whom we share this planet.

(ii) Over-exploitation- Many species extinctions in the last 500 years were due to overexploitation by humans. For example- Steller's Sea cow, passenger pigeon.

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.

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.

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