BIOLOGY

STUDENT SUPPORT MATERIAL

केन्द्रीय विद्यालय संगठन

CLASS XII

TERM I 2021-22

केन्द्रीय विद्यालय संगठन, एर्नाकुलम क्षेत्र

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Message

I feel immense pleasure to publish the study material for class XII (BIOLOGY). This support material is prepared incorporating all the recent changes in curriculum and assessment process made by CBSE. I am sure it will definitely be of great help to class XII students of all Kendriya Vidyalayas.

Getting acquainted with the latest changes will help students to prepare well for the board examination and enable students to face case based and Multiple-Choice Questions with confidence. This support material has been prepared by a team of dedicated and veteran teachers with expertise in their respective subjects.

The Support material contains all the important aspects required by the students- the design of question paper, term wise split up syllabus, summary of all the chapters, Sample question papers, problem solving and Case study questions.

I hope that this Support Material will be used by students and teachers as well and will prove to be a good tool for quick revision.

I would like to express my sincere gratitude to the In- charge principal and all the teachers who have relentlessly worked for the preparation of this study material. Their enormous contribution in making this project successful is praiseworthy.

Meticulous planning blended with hard work, effective time management and sincerity will help the students to reach the pinnacle of success.

Wish you all the best

(R Senthil Kumar)

Mr. T Vijayan
Principal
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BIOLOGY

(Code No. 044)

COURSE STRUCTURE CLASS XII

(2021 - 22)

EVALUATION SCHEME		
Theory		
Units	Term – I	Marks
VI	Reproduction: Chapter - 2, 3 and 4	15
VII	Genetics and Evolution: Chapter – 5 and 6	20
Units	Term - II	Marks
VIII	Biology and Human Welfare: Chapter – 8 and 10	14
IX	Biotechnology and its Applications: Chapter – 11 and 12	11
X	Ecology and Environment: Chapter – 13 and 15	10
Total Theory (Term – I and Term – II)		70
Practicals Term – I		15
Practicals Term – II		15
Total		100

THEORY

TERM I

Unit-VI Reproduction

Chapter-2: Sexual Reproduction in Flowering Plants

Flower structure; development of male and female gametophytes; pollination - types, agencies and examples; outbreeding devices; pollen-pistil interaction; double fertilization; post fertilization event- 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; fertilisation, 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 human being, 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.

TERM II

Unit-VIII Biology and Human Welfare

Chapter-8: Human Health and Diseases

Pathogens; parasites causing human disease (malaria, dengue,Chikungunya, filariasis, ascariasis, typhoid, pneumonia common cold, amoebiasis, ringworm) 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 biocontrol 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 Application

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

Organisms and environment: Habitat and niche, population and ecological adaptations; population interactions - mutualism, competition, predation, parasitism; population attributes - growth, birth rate and death rate, age distribution.

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.

PRACTICALS

Max. Marks: 15 for each Term

Evaluation Scheme			
	TERM - I	TERM - II	MARKS
Part A			
One Major Experiment	Experiment No. – 1	Experiment No. - 3	4
One Minor Experiment	Experiment No. - 2	Experiment No. – 4, 5	3
Part B			
Spotting (3 Spots of 1 mark each)	B.1, 2, 3, 4, 5	B.6, 7, 8	3
Practical Record + Investigatory Project & Record + Viva Voce			5
Total			15

Practicals should be conducted alongside the concepts taught in theory classes.

A. List of Experiments

TERM - I:

1. Isolate DNA from available plant material such as spinach, green pea seeds, papaya, etc.
2. Prepare a temporary mount to observe pollen germination.

TERM - II:

1. Prepare a temporary mount of onion root tip to study mitosis.
2. Collect water from two different water bodies around you and study them for pH, clarity and presence of any living organism.
3. Collect and study soil from at least two different sites and study them for texture, moisture content, pH and water holding capacity. Correlate with the kinds of plants found in them.

B. Study/observation of the following (Spotting)

TERM - I:

B.1 Flowers adapted to pollination by different agencies (wind, insects, birds).

B.2 Identification of stages of gamete development, i.e., T.S. of testis and T.S. of ovary through permanent slides (from grasshopper/mice).

B.3 Meiosis in onion bud cell or grasshopper testis through permanent slides.

B.4 T.S. of blastula through permanent slides (Mammalian).

B.5 Prepared pedigree charts of any one of the genetic traits such as rolling of tongue, blood groups, ear lobes, widow's peak and color blindness.

TERM – II:

B.6 Common disease - causing organisms like *Ascaris, Entamoeba, Plasmodium*, any fungus causing ringworm through permanent slides, models or virtual images. Comment on symptoms of diseases that they cause.

B.7 Two plants and two animals (models/virtual images) found in xeric conditions. Comment upon their morphological adaptations.

B.8 Two plants and two animals (models/virtual images) found in aquatic conditions. Comment upon their morphological adaptations.

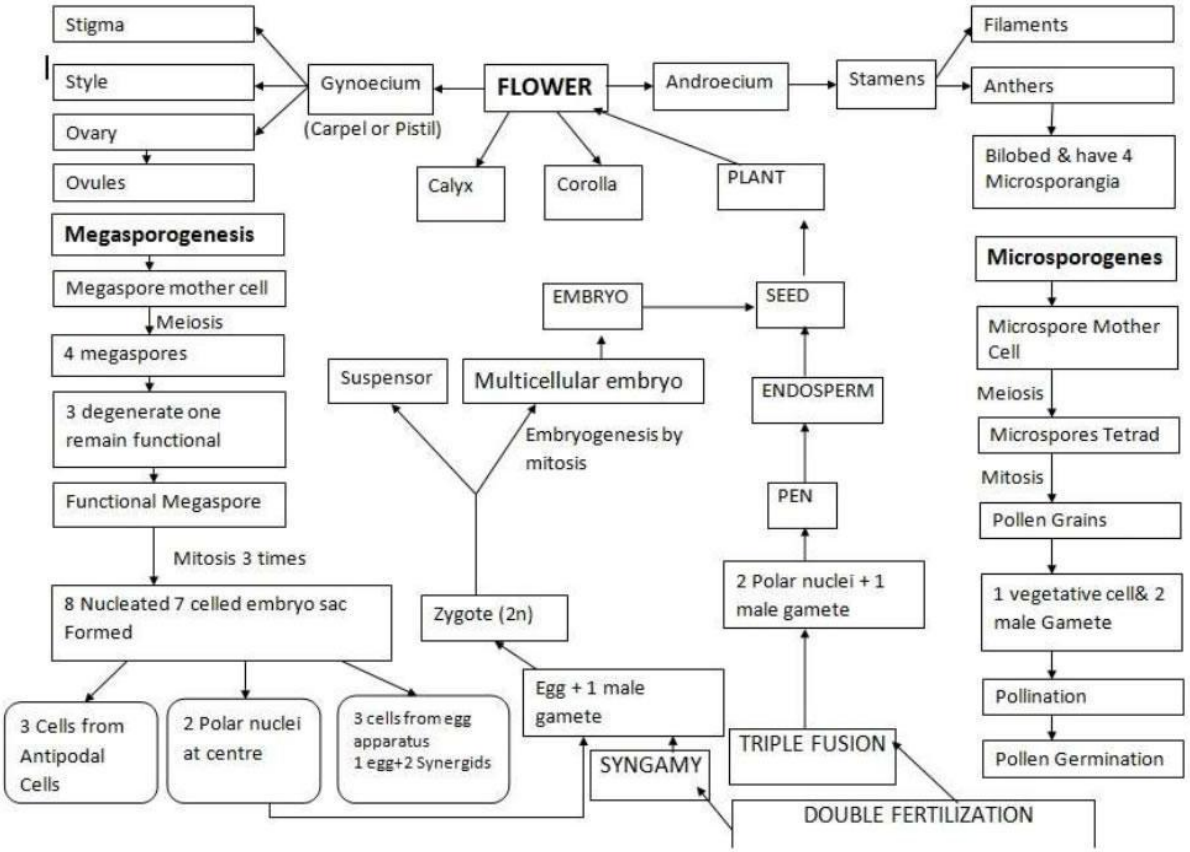
SPLIT UP SYLLABUS

XII – BIOLOGY

SL NO.	CHAPTER	PERIODS	MONTH
1	Sexual Reproduction in Flowering Plants	12	April-June
2	Human Reproduction	11	July
3	Reproductive Health	4	July
4	Principles of inheritance and Variation	16	August
5	Molecular basis of inheritance	17	September
6	Human Health and Diseases	7	October
7	Microbes in Human Welfare	6	October
8	Biotechnology - Principles and Processes	11	November
9	Biotechnology and its Application	10	December
10	Organisms and Populations	5	January
11	Biodiversity and its Conservation	4	January

SEXUAL REPRODUCTION IN FLOWERING PLANTS

SUMMARY



Sexual reproduction is the process of fusion of haploid gametes, resulting in the production of a diploid zygote, which ultimately develops into a new organism. All flowering plants show sexual reproduction.

Flowers

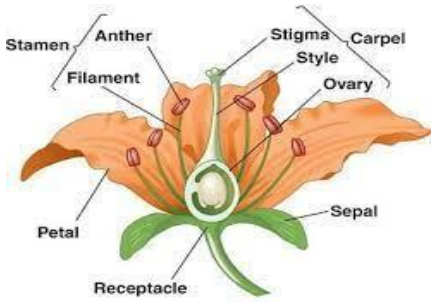
Site of sexual reproduction in flowering plants.

Parts of a flower:

A flower has following parts arranged in four whorls, i.e. calyx (sepals), corolla (petals), androecium (male reproductive organs) and gynoecium (female reproductive organs). These are attached to the central axis called thalamus.

Flowers may contain both male (stamens) and female (carpels or pistils) reproductive parts or organs in it and is called bisexual. In unisexual flowers, only either of the

reproductive parts are present, e.g. corn, the tassels represent the male flowers (stamens) and the ears or silk represent the female flower (styles and stigma).



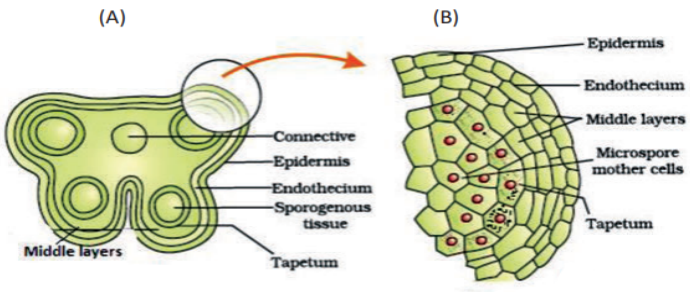
Stamen is the male reproductive unit of angiosperm.
It consists of the following two parts:
(i) The long and slender stalk called the filament.
(ii) The terminal generally bilobed structure called the anther.

Anther is bilobed has four microsporangia. Each anther lobe has two theca, therefore dithecous. In a cross section, it is a four sided (tetragonal) structure consisting of four microsporangia, located at the corners, two in each lobe. Microsporangia develop and become pollen sacs. Pollen sacs contain pollen grains.

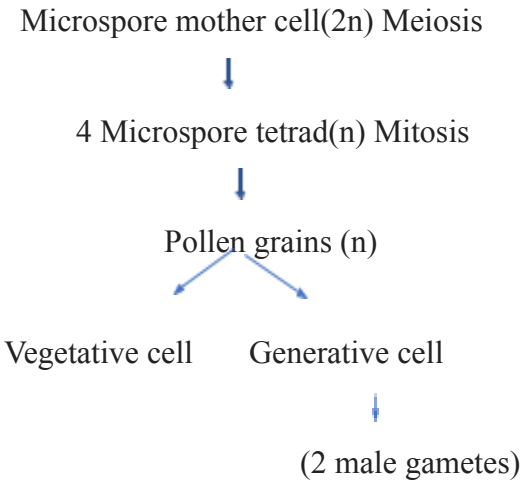
Microsporangium contains of following features in a transverse section:
Appears nearly circular in outline.It is surrounded by four wall layers.

The outer three layers are epidermis, endothecium and middle layers They are protective in function and help in dehiscence of anther to release the pollen. The fourth and innermost layer called the tapetum nourishes developing pollen grains. It contains cells with dense cytoplasm and more than one nuclei.
A sporogenous tissue occupies the centre of each microsporangium in a young anther.Each cell of sporogenous tissue undergoes meiosis to form microspore tetrads. Each cell of the tetrad is known as the microspore mother cell.

1. (A) T. S. OF A YOUNG ANTHER (B)ENLARGED VIEW OF A MICROSPORANGIUM SHOWING WALL LAYERS



Microsporogenesis is the process of formation of microspores from a pollen mother cell through meiosis



Mature pollen grain comprises two layers.

(a) Outer Exine made up of one of the most resistant organic materials sporopollenin. .The regions on the exine where sporopollenin is absent are called germ pores. It helps in the formation of pollen tubes, while the pollen grain germination on stigma.

(b) Inner thin, continuous layer Intine made up of cellulose and pectin.

A mature pollen grain contains two cells.

(a) Vegetative cell (The nucleus is large and irregular.)

(b) Generative cell (Refer fig2.7 of textbook) It is smaller cell usually spindle-shaped or spherical with thin dense cytoplasm and prominent nuclei. It divides mitotically to form two non-motile male gametes, prior to release of pollen grain.

Pistil/Gynoecium It is the female reproductive unit of flower. A flower may be monocarpellary (having one pistil) or multicarpellary (having more than one pistil). Pistils may be syncarpous (fused together) or apocarpous (free).

The main parts of pistil are:

(i) Stigma receives pollen grains.

(ii) Style is the elongated slender part beneath the stigma.

(iii) Ovary the bulged part at the base of style.

Megasporangia, commonly called ovules arise from the placenta. Ovule is attached to the placenta by a stalk called funicle. The number of ovules in an ovary may be one (wheat, paddy and mango) to many (papaya, watermelon and orchids).

The main parts of megasporangium (ovule) are:

(i) Hilum is a junction between ovule and funicle.

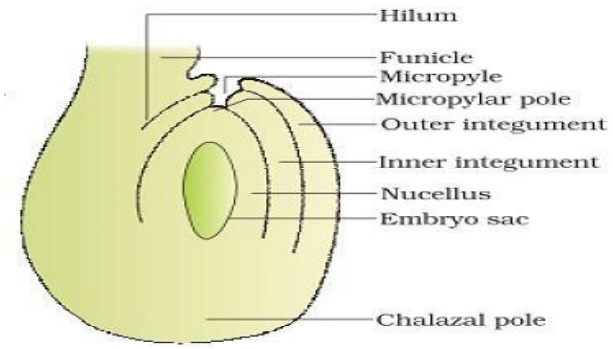
(ii) Each ovule has one or two protective envelopes called integuments.

Micropyle is an opening present at the tip where integument is absent.

Chalaza is opposite to the micropylar end representing the basal part of the ovule.

The integuments encloses a mass of cells called the nucellus which have food reserves.

Embryo sac or female gametophyte is located in the nucellus (generally one formed from megaspores through reductional division)



A diagrammatic view of a typical anatropous ovule

Megasporogenesis is the process of formation of megaspores from the Megaspore Mother Cell (MMC). The MMC is a large cell with dense cytoplasm and prominent nucleus. It undergoes meiosis resulting in the production of four megaspores.

Megaspore mother cell (2n) Meiosis

4 Megaspores (n) (Megaspore tetrad)

3 Megaspore degenerate.1 remains functional

Functional megaspore (n) Nucleus divide 3 times by mitosis

8 Nucleated embryo sac formed

2 polar nuclei at centre
(n each)

3 cells at chalazal end
called antipodals (n)

3 cells group at micropylar end

the egg cell(n) 2 synergids(n)

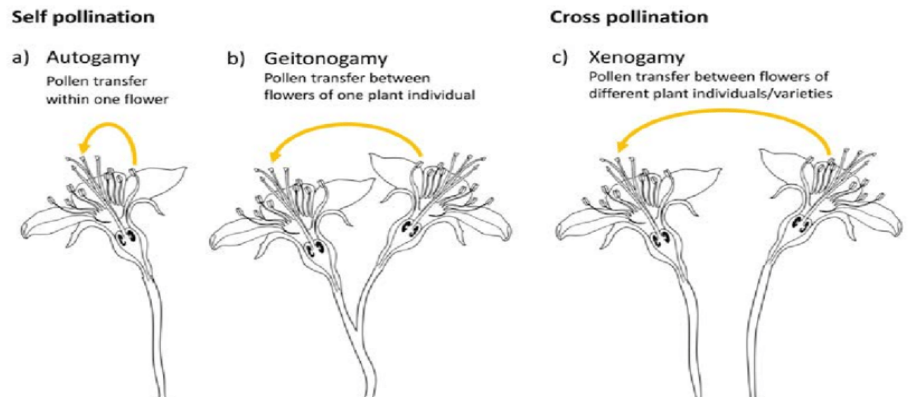
Ref fig 2.7 & 2.8 of textbook

POLLINATION – Transfer of pollen from anther to stigma

Autogamy (Same flower)

Geitonogamy (Different flowers on the same plant)

Xenogamy (Flowers on another plant of same species)



Chasmogamous flower: Open flower with exposed anther and stigma

Cleistogamous flower: Flowers do not open. Assured seed set even in the absence of pollinators

Oxalis, Commelina and Viola produce both Chasmogamous Cleistogamous flowers

VIOLA

<u>Agents of pollination</u>

Wind pollination (Anemophily): Pollen grains are light, non-sticky and numerous. Well exposed stamens. Large and feathery stigma. Eg: Paddy, Corn

Water pollination (Hydrophily): pollen grains are long ribbon-like. Mucilaginous covering for pollen Eg: Vallisnaria, Hydrilla, Zostera

Insect pollination (Entomophily): Flowers are large colourful,fragrant rich in nectar .Floral rewards in providing safe places to lay eggs. Eg: Amorphophallus, Yucca

<u>Outbreeding Devices:</u>

1.Non-synchronisation of pollen release and stigma receptivity

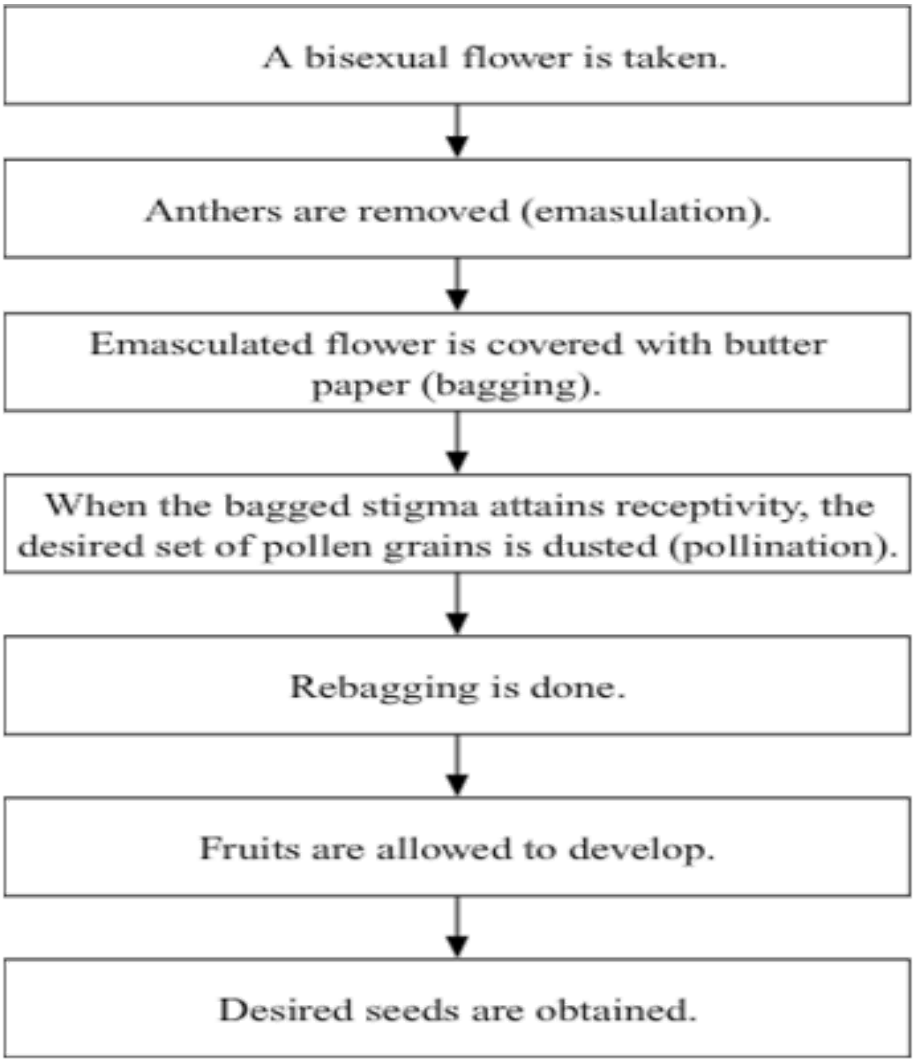
2.Anther and stigma at different positions

3.Self incompatibility

4. Unisexual flower

Pollen - pistil interaction The pistil has the ability to recognize the pollen, whether it is the right type (Compatible) or of the wrong type (incompatible). If it is compatible, the pistil accepts the pollen.

Artificial Hybridisation:



Double fertilisation:

1 Fusion of one male gamete with egg (Syngamy)

2 Fusion of fusion product of polar nuclei with second male gamete (Triple fusion)

Refer fig:2.13 NCERT

Post Fertilisation:

Endosperm: Endosperm develops before the embryo. Primary endosperm nucleus repeatedly divides to give rise to free nuclear endosperm. Cell wall formation occurs next to form cellular endosperm.

Endosperm may be either fully consumed by the growing embryo (as in pea and beans) or retained in the mature seed (as in coconut and castor)

Embryo: Zygote gives rise first to the pro-embryo, and then to the globular, heart shaped mature embryo with radicle, plumule and cotyledons.

Dicot embryo consists of an embryonal axis and two cotyledons

In monocot embryos there is only one cotyledon. In the grass family the cotyledon is called scutellum.

Mature ovaries become fruit. Walls of the ovary transform into the walls of the fruit (pericarp)

True Fruit develops only from the ovary Eg. mango, tomato

False Fruit develops from parts of the flower other than the ovary Eg: apple, peach

Parthenocarpic fruit develops without fertilisation Eg: banana

Mature ovule becomes seed.

Seeds are of two types

i) Albuminous (endosperm present as in wheat, rice maize etc)

ii) Non albuminous (endosperm absent as in pea and groundnut)

Some seeds have remnants of nucellus known as perisperm Eg: Black pepper

Some seeds can remain alive for hundreds of years. The oldest is that of a lupine, Lupinus arcticus. 2000 year old viable seed of the date palm , Phoenix dactylifera.

<u>Special mechanism of reproduction</u>

Apomixis: Apomixis is a form of asexual reproduction that mimics sexual reproduction where seed are formed without fertilisation.

Polyembryony: Occurrence of more than one embryo in a seed. e.g. Orange, lemon, onion, mango, ground nut.

Reasons of polyembryony: More than one egg may be formed in the embryo sac. More than one embryo sac may be formed in an ovule

MCQ

1. Match the following ovular structure with post fertilization structure and select the correct alternative.

a. Ovule	1. Perisperm
b. PEC	2. Endosperm
c. Nucellus	3. Fruit
d. Ovary	4. Seed

A. a-3, b-2, c-4, d-1
B. a-3, b-2, c-1, d-4
C. a-4, b-2, c-1, d-3
D. a-2, b-3, c-1, d-4

2. Find the correct combination with reference to pollen viability

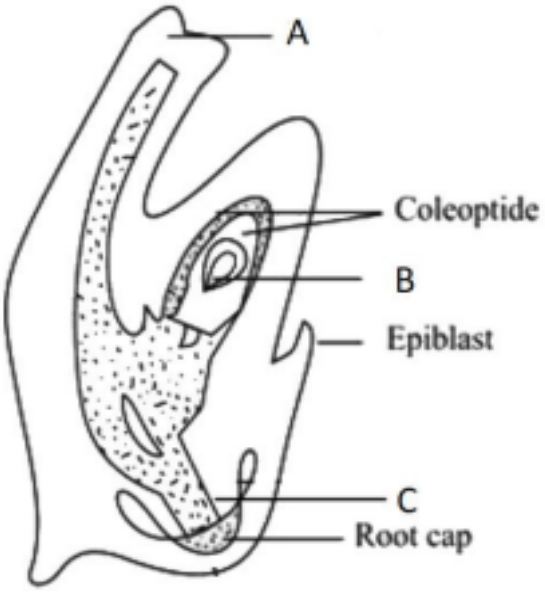
a. Pollen viability depends on prevailing temperature and humidity
b. In rice, pollen viability loses within 30 hours of release
c. Solanaceae can maintain viability for months
d. Pollen viability depends on prevailing temperature and atmospheric pressure

A. a & b are correct, c & d are incorrect
B. a & c are correct, b & d are incorrect
C. a & d are correct, b & c are incorrect
D. a & b are incorrect, c & d are correct

3. The functions related with outer three wall layers of microsporangium

A. Nourishment and protection
B. Protection and dehiscence of anther
C. Protection and nourishment
D. Protection, dehiscence of anther and nourishment

4. Identify A, B & C



A. A – Scutellum B – Plumule C. Radicle

B. A – Plumule B – Radicle C. Scutellum

C. A – Radicle B – Scutellum C. Plumule

D. A - Plumule B – Scutellum D – Radicle

5. Find the wrong combinations of plants in terms of consumption of endosperm during embryonic development

A. Castor, Coconut & Groundnut

B. Castor, Coconut & Beans

C. Castor, Coconut & Maize

D. Castor, Coconut & Pea

6. In citrus and mango polyembryony occurs due to the development of multiple embryos from cells of

A. Embryo sac

B. Nucellus

C. Integuments

D. Micropyle

7. Find the odd combination of plants with reference to development of fruits

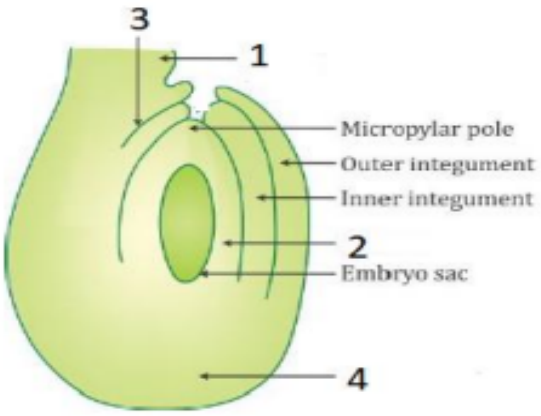
A. Apple, Strawberry & Cashew

B. Apple, Mango & Strawberry

C. Apple, Cashew & Mango

D. Apple, Orange & Mango

8. Observe the diagram and find the wrong option



A. Marked parts are 1- Funicle, 2- Nucellus ,3- Hilum 4- Chalaza

B. 4 represents the tip of ovule

C. 1 helps in holding the ovule

D. 2 is a nutritive tissue

9. Find the incorrect statement

A. Intine is a thin and continues layer composed of cellulose and lignin

B. Vegetative cell is bigger and has abundant food reserve

C. Generative cell is small and floats in cytoplasm of vegetative cell

D. Generative cell is spindle shaped with dense cytoplasm

10. The chromosome number in an angiosperm is 40 (2n). Number of chromosomes in its PEC is

A. 10

B. 20

C. 40

D. 60

11. When the seed matures

a. Its water content is reduced

b. General metabolic activity slows down

c. Embryo enter into a state of inactivity

A. a & b are correct but c is incorrect

B. a & c are correct but b is incorrect

C. b & c are correct but a is incorrect

D. All are correct

12. The plants that produces both chasmogamous and cleistogamous flowers are

A. Oxalis, Commelina, Mirabilis

B. Viola, Commelina, Oxalis

C. Oxalis, Mirabilis, Commelina

D. All are correct

13. Identify P, Q & R. Pollen tube, after reaching the ovary, enters the ovule through 'P' and then enters one of the 'Q' through the 'R'

A. P- Chalaza, Q – Polar Nuclei, R – Egg apparatus

B. P- Micropyle, Q – Synergids, R – Filiform apparatus

C. P- Micropyle, Q –Synergids, R – Egg apparatus

D. P- Chalaza, Q – Polar Nuclei, R – Filiform apparatus

14. In crossing experiments, pollination by desired pollen grains and protection of stigma from contamination are achieved by

A. Emasculation & Bagging

B. Emasculation

C. Bagging

D. Emasculation, bagging and re-bagging

15. Number of meiotic divisions takes place during gametogenesis in an angiosperm for the production of 200 seeds

A. 100

B. 150

C. 200

D. 250

16. Coconut water from tender coconut and white kernel respectively are

A. Cellular endosperm and free nuclear endosperm respectively

B. Free nuclear endosperm and cellular endosperm respectively

C. Helobial type endosperm and cellular endosperm respectively

D. Helobial type endosperm and free nuclear endosperm respectively

17. Match the following ovular structure with post fertilization structure and select the correct alternative.

a. Lupinus arcticus 1. Fruits having thousands of seeds

b. Phoenix dactylifera 2. Apomixis

c. Orobanche 3. Seed dormancy period about 10000 years

d. Asteraceae 4. 2000 years old viable seed

A. a-3, b-4, c-1, d-2

B. a-3, b-2, c-1, d-4

C. a-4, b-2, c-1, d-3

D. a-2, b-3, c-1, d-4

18. The correct sequence in the embryonic development in angiosperm

A. Proembryo – Globular Embryo – Heart shaped embryo – Mature embryo

B. Globular Embryo – Proembryo – Heart shaped embryo – Mature embryo

C. Globular Embryo – Heart shaped embryo –Proembryo- Mature embryo

D. Proembryo – Heart shaped embryo– Globular embryo – Mature embryo

19. Find the wrong statement with reference to pollen-pistil interaction

a. Pistil has the ability to recognize the pollen

b. If the pollen is of the right type, the pistil accepts it

c. Pollen-pistil interaction is mediated by chemical components of pollen and pistil

A. a & b are correct but c is incorrect

B. a & c are correct but b is incorrect

C. b & c are correct but a is incorrect

D. a & b & c are correct

20. Find P, Q, R, S & T. Pollen grains of many species cause severe allergies and bronchial afflictions in some people often leading to chronic respiratory disorders – 'P', 'Q', etc. It may be mentioned that 'R' or carrot grass that came into India as a contaminant with imported 'S', has become ubiquitous in occurrence and causes 'T'.

A. A. P- Asthma Q – Bronchitis R – Parthenium S – Rice T – Pollen allergy

B. B. P- Pneumonia Q – Bronchitis R – Parthenium S – Wheat T – Pollen allergy

C. P- Asthma Q – Bronchitis R – Parthenium S – Wheat T – Pollen allergy

D. P- Asthma Q – Pneumonia R – Parthenium S – Rice T – Pollen allergy

A. Both Assertion and Reason are true and Reason is the correct explanation of Assertion

B. Both Assertion and Reason are true and Reason is not the correct explanation of Assertion

C. Assertion is true but Reason is false

D. Assertion is false but Reason is true

21. Assertion: Tapetum nourishes the developing pollen grains.

Reason: Cells of the tapetum generally have more than one nucleus

22. Assertion: In some plants, pollen grains are shed at two-celled condition

Reason: The vegetative cell divides and forms the two male gametes during the growth of the pollen tube in the stigma.

23. Assertion: Banana is a parthenocarpic fruit

Reason: In banana fruit is developed from thalamus

24. Assertion: It is advantages to make hybrids apomicts

Reason: There is no segregation of characters in the hybrid progeny.

25. Assertion: A typical angiosperm anther is dithecous

Reason: A transverse groove runs lengthwise separating the theca.

26. Assertion: Exine cannot withstand high temperatures and strong acids and alkali

Reason: Exine is composed of sporopollenin

27. Assertion: Pollen grains can be used as pollen banks similar to seed banks in crop breeding programmes

Reason: It is possible to store pollen grains of a large number of species for years in liquid hydrogen

28. Assertion: In angiosperms development of embryo is monosporic

Reason: Embryo sac is formed formation from a single megaspore

29. Assertion: Mitotic divisions that takes place during megasporogenesis are free nuclear

Reason: Nuclear divisions are not followed immediately by cell wall formation

30. Assertion: In angiosperms, double fertilization occurs

Reason: In double fertilization two male gametes fuse with two eggs simultaneously

31. Assertion: Oxygen and water enter into the seed during germination

Reason: In angiosperms the micropyle remains as a small pore in the seed coat

32. Assertion: The transformation of ovules into seeds and ovary into fruit proceeds simultaneously

Reason: The wall of the ovary develops into the wall of fruit called pericarp

33. Assertion: Mango is a fleshy fruit

Reason: In mango nucellus is persistent

34. Assertion: Parthenocarpic fruits are seedless

Reason: Parthenocarpy can be induced through the application of growth hormones

35. Assertion: Distribution of bryophytes and pteridophytes are limited

Reason: Bryophytes and pteridophytes need water for the transport of male gametes and fertilization

36. Assertion: A typical angiosperm embryo sac is 8 nucleate and 7- celled

Reason: The large central cell of embryo sac has a big nucleus

37. Assertion: Complete autogamy is rare

Reason: Autogamy requires synchronisation in the release of pollen and receptivity of stigma

38. Assertion: Cleistogamous flowers are invariably autogamous

Reason: There is no chance of cross pollen landing on stigma

Read the passage and answer the questions

Pollination is one of the most important mechanisms in the maintenance and promotion of biodiversity and, in general, life on Earth. Many ecosystems, including many agro-ecosystems, depend on pollinator diversity to maintain overall biological diversity. Pollination also benefits society by increasing food security and improving livelihoods. Pollinators are extremely diverse, with more than 20,000 pollinating bee species and numerous other insect and vertebrate pollinators. Therefore, pollinators are essential for

diversity in diet and for the maintenance of natural resources. The assumption that pollination is a "free ecological service" is erroneous. It requires resources, such as refuges of natural vegetation. Where these are reduced or lost they become limiting, and adaptive management practices are required to sustain livelihoods.

39. Find the correct combination

a. Vallisneria - Hydrophily – Pollen grains are protected by mucilaginous covering

b. Amorphophallus – Entamophily – Provide a safe place for pollinators to lay eggs

c. Grass – Anemophily – Feathery stigma

A. a & b are correct but c is incorrect

B. a & c are correct but b is incorrect

C. b & c are correct but a is incorrect

D. a & b & c are correct

40. Genetic similarity is maintained between

A. Autogamy & Geitonogamy

B. Autogamy & Xenogamy

C. Xenogamy & Geitonogamy

D. None of the above

41. Ecosystem will loss the balance if all the pollinators get extinct

A. Strongly agree

B. Agree

C. Disagree

D. Strongly disagree

42. Aquatic plants that are pollinated by insects are

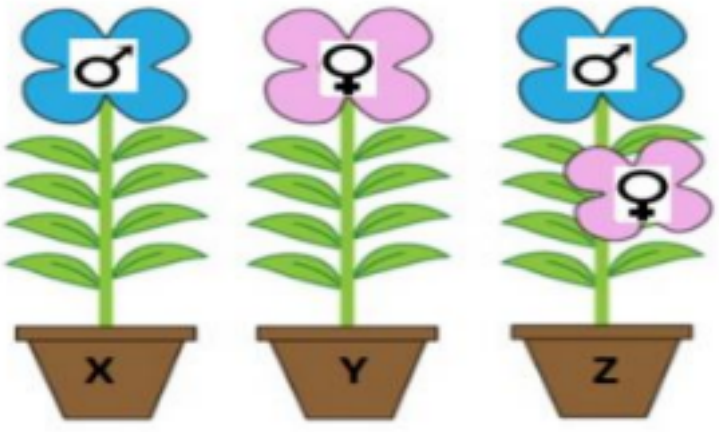
A. Water lily & Hydrilla

B. Water lily & Water hyacinth

C. Water hyacinth & Hydrilla

D. Water hyacinth & Water lily & Hydrilla

43. Observe the diagram and answer the questions



Find the incorrect statement with reference to the diagram

a. Z is monoecious

b. X & Y are dioecious

c. In Z only autogamy occurs

d. In X and Y autogamy and geitonogamy occur

A. a & b are correct but c & d are incorrect

B. a & c are correct but b & d are incorrect

C. a & d are correct but b & c are incorrect

D. c & d are correct but a & b are incorrect

44. In castor and maize

a. Male and female flowers are present on the same plant

b. Male and female flowers are present on different plants

c. Both autogamy and geitonogamy takes place

d. Only geitonogamy takes place

A. a & b are correct but c & d are incorrect

B. a & c are correct but b & d are incorrect

C. a & d are correct but b & c are incorrect

D. b & d are correct but a & c are incorrect

45. Self-incompatibility involves

A. Inhibition of pollen tube development

B. Inhibition of fertilization

C. Inhibition of embryonic development

D. None of the above

6. Male and female flowers are present in different plants in

A. Papaya & Castor

B. Castor and Maize

C. Papaya & Maize

D. Papaya

7. With reference to the product shown below answer the questions

1. Pollen grains are

a. Female gametophyte

b. Produced in anther

c. Rich in nutrients

A. Only a & b are correct

B. Only b & c are correct

C. . Only a & c are correct

D. All are correct

48. The diameter of pollen grains is about

A. 25-50 micrometres

B. 25-50 millimeters

C. 25-50 nanometers

D. 25-50 picometer

49. Pollen tablets are used as

A. Food

B. Food supplement

C. Medicines

D. Fodder

50. The relation between bee and a flowering plant is

A. Parasitism

B. Commensalism

C. Mutualism

D. ammensation

ANSWERS

Q	A	Q	A	Q	A	Q	A	Q	A
1	C	11	D	21	B	31	A	41	A
2	B	12	B	22	B	32	B	42	B
3	B	13	B	23	C	33	C	43	A
4	A	14	D	24	A	34	B	44	C
5	C	15	D	25	A	35	A	45	A
6	B	16	A	26	D	36	C	46	D
7	A	17	A	27	C	37	A	47	B
8	B	18	A	28	D	38	A	48	A
9	A	19	D	29	A	39	D	49	B
10	D	20	C	30	C	40	A	50	C

HUMAN REPRODUCTION

SUMMARY

The Human Reproductive System mainly consists of:

The Male Reproductive System:

- The male reproductive system is positioned in the pelvis region and comprises a pair of testes in addition to the accessory glands, ducts, and the external genitalia.
- A pouch-like structure known as scrotum encloses the testes located outside the abdominal cavity
- Each testis has close to 250 testicular lobules(compartments). These lobules comprise 1-3 seminiferous tubules wherein the sperms are produced. the lining of these tubules consists of two types of cells – male germ cells and sertoli cells
- The exterior of these tubules consist of spaces containing blood vessels and Leydig cells
- Male sex accessory ducts comprises rete testis, vasa efferntia, epididymis and vas deferens
- The urethra opens externally to the urethral meatus
- The male external genitalia, the penis is covered by foreskin which is a loose fold of skin.

The Female Reproductive System

The female reproductive system is made up of the internal and external sex organs, which consists of a pair of ovaries and oviducts, cervix, uterus, vagina and the external genitalia situated in the pelvic region. Along with the mammary glands, these female reproductive organs are combined both structurally and functionally in order to support the complete processes of reproduction including ovulation, fertilization, pregnancy, and the birth of a child.

The female accessory ducts are constituted by the oviducts, vagina and uterus

- The section closer to the ovary is funnel-shaped infundibulum that possesses the fimbriae – finger-like projections facilitating the assimilation of ovum post ovulation
- The infundibulum directs to a wider section of oviduct known as ampulla.
- The last section of the oviduct, isthmus, has a narrow lumen joining the uterus
- Uterus is also known as the womb
- The cervical cavity is known as the cervical canal which goes into form the birth canal along with the vagina
- Female external genitalia comprises – mons pubis, labia minora, labia majora, clitoris and hymen

Both the male and female reproductive systems play an important role in the process of reproduction. Other than these reproductive organs, there are sex hormones which are produced by the respective glands and are mainly involved in the development of secondary sexual characteristics and proper functioning of the reproductive tracts.

Process of Reproduction

The process of reproduction in all humans are carried out phase-wise:

Pre-fertilization – Gametes are formed and transferred

Gametogenesis: It is the process by which the primary male and female sex organs like the testes in males and the ovaries in the female produce gametes.

Spermatogenesis: This is the process by which the immature male germ cells also known as spermatogonia produce mature sperm cells in the testis.

Oogenesis: Oogenesis is the process by which the immature oogonia in the ovaries produces a mature ovum.

Spermatogenesis: The spermatogenesis process starts at puberty and proceeds as follows:

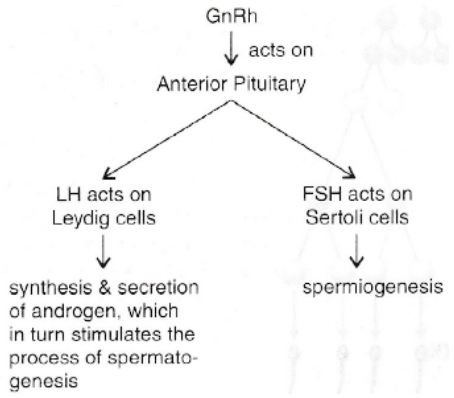
- First of all, the spermatogonia multiply by mitosis to increase in number.
- They are present inside the inner wall of seminiferous tubules where they multiply by mitotic division.
- Each spermatogonium is diploid in nature and contains 46 chromosomes.
- Some spermatogonia known as the primary spermatocytes occasionally undergo meiosis to form two equal, haploid cells.
- These cells are called secondary spermatocytes. Due to their haploid nature, they contain 23 chromosomes.
- The secondary spermatocytes further undergo second meiotic division and produce four haploid spermatids that also contain 23 chromosomes.
- The spermatids then undergo spermiogenesis to produce sperms (spermatozoa). The heads of the sperms are embedded in the Sertoli cells.
- The sperms are finally free from the seminiferous tubules by the process of spermiation.

Hormones Affecting Spermatogenesis:

Gonadotropin-releasing hormone (GnRH): Gonadotropin-releasing hormone is the hypothalamic factor. The levels of this hormone increase mainly at puberty. The secretion of GnRH stimulates the release of two gonadotropins from the anterior pituitary – Follicle Stimulating Hormone (FSH) and Luteinizing Hormone (LH).

Follicle Stimulating Hormone (FSH): This hormone acts on the Sertoli cells where it stimulates the release of some factors that play an important role in the process of spermatogenesis.

Luteinizing Hormone (LH): LH is important in regulating the function of testes and ovaries. It acts on the Leydig cells where it stimulates the synthesis and secretion of androgens.



Structure of Sperm:

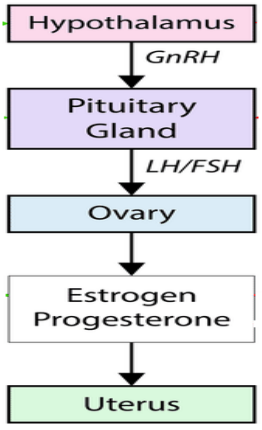
- Sperm is a male reproductive cell that is made up of a head, neck, middle piece, and tail.
- The whole body of the sperm is covered by a plasma membrane
- Head: The head portion of the sperm contains an elongated, haploid nucleus
- The anterior portion of the head contains an acrosome which contains some enzymes that help in dissolving the membrane of the egg cell and help in fertilization of the ovum.
- Middle Piece: It comprises several mitochondria that provide energy for the vigorous motility of the tail. The movement of the tail is essential for fertilization because it helps sperm to move towards the ovum.
- Approximately 200-300 million sperms are released during ejaculation. Out of these, at least 60% of them should have normal size and shape and at least 40% should show vigorous motility.
- Semen: It is a milky white organic liquid that is released by the penis at the time of ejaculation. It includes sperms and the fluids secreted by the accessory ducts and the accessory glands like epididymis, vas deferens, prostate, seminal vesicles, and the bulbourethral glands.
- The testicular hormones also known as androgens maintain the functions of the male accessory ducts and glands.

Oogenesis:

The process of formation of a mature female gamete is known as Oogenesis. It is introduced during the embryonic development stage. At this stage, a few million gamete mother cells or oogonia are formed in the fetal ovary. After birth, no more oogonia are formed or added.

- The oogonia form primary oocytes that form by the process of meiosis and get arrested at the stage of Prophase.
- Each primary follicle is formed by primary oocytes which are surrounded by a layer of granulosa cells.
- Between birth to puberty, a large number of primary follicles get degenerated. Therefore, there are only about 60,000-80,000 primary follicles available in the ovary at the time of puberty.
- These remaining primary follicles get surrounded by a few more layers of granulosa cells as well as a new theca to form the secondary follicle.
- The tertiary follicle is formed by the secondary follicle. It is characterized by the presence of a fluid-filled space called an antrum and two layers of the theca. The layers of theca are arranged into two layers-inner theca interna and the outer theca externa. The primary oocyte increases in size and completes its first meiotic division. This division is an unequal division that forms a large secondary oocyte and a tiny first polar body.
- Secondary oocyte consists of much of the nutrient-rich cytoplasm and it also develops a thick covering known as zona pellucida.
- The tertiary follicle is finally converted into the mature Graafian follicle.
- This Graafian follicle now ruptures and releases the secondary oocyte or ovum from the ovary. The process of release of the ovum is called ovulation.

HORMONAL CONTROL OF OOGENESIS:



Menstrual Cycle:

- Menstrual Cycle: This is the reproductive cycle that starts from one menstruation till the next one. It mainly occurs in female primates like monkeys, apes, and human beings. The cycle repeats at an interval of 28-35 days and normally releases one egg per cycle. This

cycle is important for the production of oocytes and for the preparation of the uterus for pregnancy.

- Menstruation: In this process, the blood and mucosal tissue are regularly discharged in a periodic manner. It occurs due to the breakage of the inner lining of the uterus. This process takes place once a month and is called a period.
- Menarche: Menarche is the first menstruation for a human female that begins at puberty.
- Menopause: Menopause is defined as the permanent ceasing of the menstrual cycle in females.

Phases of the Menstrual Cycle:

The menstrual cycle follows four phases:

1. Menstrual phase: menstrual flow takes place. The flow naturally lasts for 3-5 days.
2. Follicular phase: In this phase, maturation of Graafian follicle occurs.
3. Ovulation: This is the phase where the release of the ovum from the ovary takes place.
4. Luteal Phase: This is the phase of formation of the corpus luteum and it is also known as the secretory phase.

Fertilisation and Implantation: SERIES OF EVENTS AS FOLLOWS

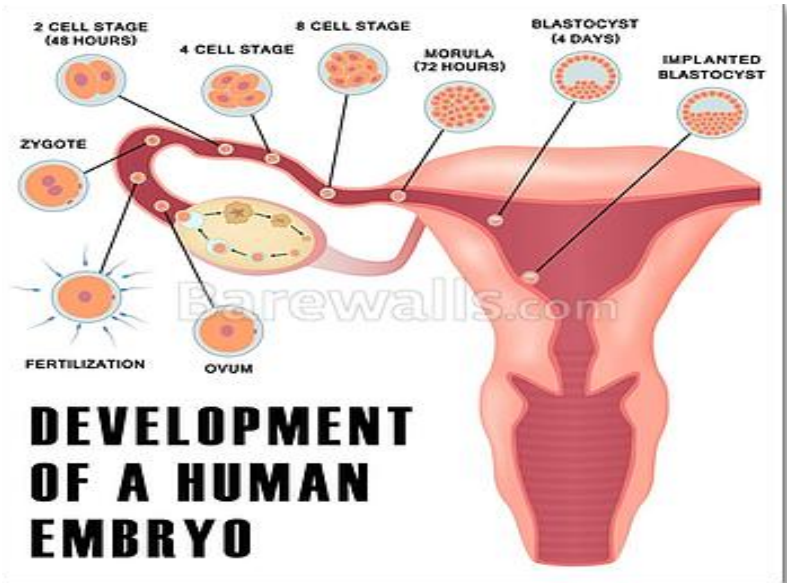
- Insemination,
- The motile male gamete swims rapidly through the cervix, enters into the uterus, and finally reaches the site of fertilization which is in the ampullary region of the fallopian tube.
- The ovum which is released by the ovary is also transferred to the ampullary region of the fallopian tube.
- Fertilization takes place in the fallopian tube only when the ovum and sperms are simultaneously transferred into the site of fertilization.
- Fertilization: It is the fusion of the haploid male gamete or sperm and the haploid female gamete or egg. At the time of fertilization, the sperm makes changes in the zona pellucida layer of the ovum to block the entry of other sperms. This ensures that only one sperm can fertilize a single ovum.
- The secretions of the acrosome make easy the entry of the sperm to the ovum by the zona pellucida and the plasma membrane.

- This phenomenon induces the secondary oocyte to complete meiosis. This is again an unequal division and forms a second polar body and a haploid ovum.
- The haploid nucleus of the sperm and the ovum fuse together and form a diploid zygote. Hence, a zygote contains 46 chromosomes.

Sex Determination:

- The sex chromosome in the sperm is the factor that determined the sex of the fetus. As the female is XX the ovum will always carry the X chromosome, however, Males are XY and therefore, the sperm can contain either X or Y. Hence, half of all the sperms carry the X chromosome, and the remaining half carry the Y chromosome.
- The zygote that carries an XY would develop into a male while XX would develop into a female.

Embryo Development:



- The zygote is divided by the mitotic division which starts as it moves along the isthmus of the oviduct towards the uterus and forms 2, 4, 8, and 16 daughter cells known as blastomeres.
- Morula: The embryo with 8-16 blastomeres is known as a morula.
- It continues its division as it moves further along into the uterus.
- The blastomeres are arranged into two layers. First is the outer layer called the trophoblast and the other is the inner cell mass which is attached to the trophoblast.
- The trophoblast layer then attaches to the endometrium of the uterus.
- The inner cell mass differentiates to cover the blastocyst.
- The cells of the blastocyst embedded in the uterine wall. This phenomenon is called implantation which leads to pregnancy.
- Fertilization- formation of zygote after a sperm fertilizes the egg
- Post-fertilization- Mitotic division of zygote leading to the formation of an embryo. This reproductive stage is referred to as embryogenesis.

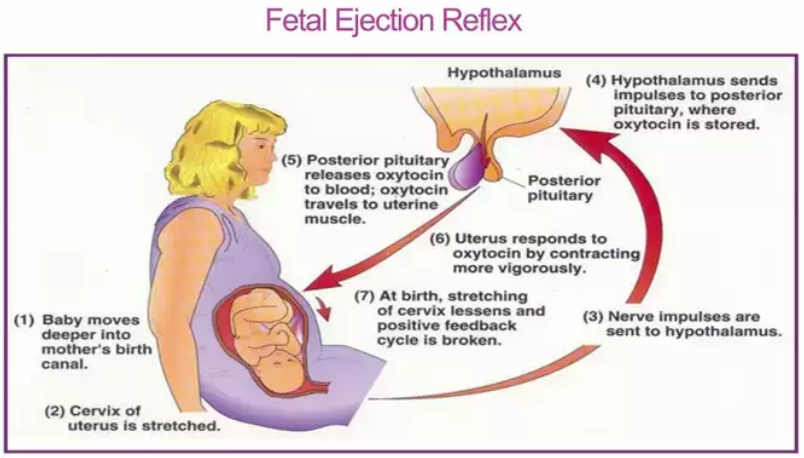
Duration and Stages of Pregnancy

Human gestation lasts for an average of 266 days or 38 weeks or 9 months and these intervals are called trimesters.

- 1st trimester (1st 3 months or week 1 – 12) – pre embryonic and embryonic development.
- 2nd trimester (next 3 months: week 13 – 24) – The fetal development begins.
- 3rd trimester (next 3 months: week 25 – birth) – At this stage the baby continues to grow and mature.

Parturition:

- Parturition is induced by a complex neuroendocrine mechanism.
- The signals for parturition originate from the fully developed fetus and the placenta which induce mild uterine contractions called foetal ejection reflex.
- This triggers release of oxytocin from the maternal pituitary.
- Oxytocin acts on the uterine muscle and causes stronger uterine contractions, which in turn stimulates further secretion of oxytocin.
- The stimulatory reflex between the uterine contraction and oxytocin secretion continues resulting in stronger and stronger contractions. This leads to expulsion of the baby out of the uterus through the birth canal – parturition.



Lactation:

- The mammary glands of the female undergo differentiation during pregnancy and start producing milk towards the end of pregnancy by the process called lactation. This helps the mother in feeding the newborn.
- The milk produced during the initial few days of lactation is called colostrum which contains several antibodies absolutely essential to develop resistance for the new-born babies.
- Breast-feeding during the initial period of infant growth is recommended by doctors for bringing up a healthy baby.

MCQ

1. Which part of sperm plays an important role in penetrating the egg membrane

   a) Allosome

   b) autosome

   c) Tail

   d) acrosome

2. How many sperms are formed from four primary spermatocytes

   a) 4

   b)16

   c) 1

   d)32

3. Where is the testis located in a human male?

   (a) Abdominal cavity

   (b) Dorsal side of the abdominal cavity

   (c) (a) and (b) both

   (d) Scrotal sac

4. Which hormone is released from testes?

   (a) Testosterone

   (b) Estrogen

   (c) Progesterone

   (d) Relaxin

5. Which hormone is released from ovaries?

   (a) Testosterone

   (b) Estrogen

   (c) Progesterone

   (d) (b) and (c) both

6. Which of the following glands is seen in the male reproductive system?

   (a) Seminal vesicle

   (b) Prostate gland

   (c) Bulbourethral gland

   (d) All of these

7. How much lower is the temperature of the scrotal sac than the body temperature?

   (a) 2 degree celsius

   (b) 4 degree celsius

(c) 5 degree celsius

(d) 6 degree celsius

8. What is the size of the testis?

(a) 6 cm length and 2.5 cm diameter

(b) 5 cm length and 2.5 cm diameter

(c) 5 cm length and 3.5 cm diameter

(d) 6 cm length and 3.5 cm diameter

9. Which connective tissue surrounds the testis?

(a) Fibrous tissue

(b) Spongy connective tissue

(c) Tunica albuginea

(d) None of them

10. Seminiferous tubules in the testis are lined with which type of cells?

(a) Germinal cells

(b) only germinal cells

(c) Sertoli cell

(d) Both a and c

11. In testis, which cells produce sperms?

(a) Germinal cells

(b) Epithelial cell

(c) Sertoli cell

(d) Both a and c

12. Which cells provide nutrition to the sperms?

(a) Germinal cells

(b) Epithelial cell

(c) Sertoli cell

(d) None of them

13. In tests, which cells are present in the interstitial space between seminiferous tubules?

(a) Sertoli cells

(b) Germinal cells

(c) Leydigs cells

(d) (a)and(b)both

14. Which cells secrete testosterone?

(a) Sertoli cells

(b) Germinal cells

(c) Interstitial cells

(d) (a)and(b)both

15. Where do the seminiferous tubules of each lobe empty their sperms?

(a) Vas deferens

(b) Vasa efferentia

(c) Epididymis

(d) Seminal vesicles

16. What is the location of the epididymis?

(a) External surface of the testis

(b) Above the testis

(c) Below the testis

(d) Internal surface of the testis

17. After delivery, the mammary gland starts producing milk. In milk, which necessary substance is present for immunity?

(a) Lactose

(b) Protein

(c) Fat

(d) Antibodies

18. Function of the epididymis is

(a) A temporary storage site

(b) For the immature sperms to complete their maturation process

(c) Gain the ability of swimming (motility)

(d) All of these

19. When are sperms transported from the epididymis to the vas deferens?

(a) Male is not sexually stimulated

(b) Male is sexually stimulated

(c) The walls of the epididymis contract

(d) First b and after c process occurs

20. The signals for parturition originate from

(a) Fully developed foetus

(b) placenta

(c) Uterus

(d) (a) & (b) both

21. Through which of the following vas deferens runs upward from the epididymis and enters the abdominal cavity?

(a) Ejaculatory duct

(b) Inguinal canal

(c) Urethra

(d) (a)and(b)both

22. The distal end of vas deferens is expanded and in this region the opens?

(a) Prostate gland

(b) Bulbourethral gland

(c) Seminal vesicle

(d) Ejaculatory duct

23. What is the region present between the part of the seminal vesicle and duct of the urinary bladder called?

(a) Ejaculatory duct

(b) Duct of urinary

(c) Urethra

(d) Seminal vesicle duct

24. Duct of which gland joins with urethra before it passes through penis?

(a) Prostate gland

(b) Bulbourethral gland

(c) Seminal vesicle gland

(d) (a) and (b) both

25. In male accessory reproductive glands which is incorrect?

(a) Seminal vesicle

(b) Prostate gland

(c) Urinary bladder

(d) Bulbourethral gland

26. The seminal vesicles are located at?

(a) Over urinary bladder

(b) Base of the urinary bladder

(c) Near urinary bladder

(d) Besides urinary bladder

27. What percentage of semen is produced by seminal vesicles?

(a) 50%

(b) 55%

(c) 60%

(d) 65%

28. Which substances present in seminal vesicles are thick and yellowish secretion?

(a) Sugar

(b) Vitamin c

(c) Fat

(d) (a) and (b) both

29. What is provided to sperms by secretion of seminal vesicles?

(a) Nourishment

(b) Activating

(c) Lubricant

(d) (a) and(c) both

30. Where is the prostate gland located?

(a) Over urinary bladder

(b) Base of the urinary bladder

(c) Posterior region of the urinary

(d) Side of the urinary bladder

31. What is provided to sperm by secretion of the prostate gland?

(a) Nourishes

(b) Activating

(c) Lubricant

(d) (a)and (c) both

32. Where is the bulbourethral gland located?

(a) Beneath the prostate

(b) Lateral side of the urethra

(c) Over urinary bladder

(d) (a) and (b) both

33. Which gland secretes alkaline fluid?

(a) Seminal vesicle gland

(b) Prostate gland

(c) Bulbourethral gland

(d) (b) and (c) both

34. What is the function of bulbourethral gland secretion?

(a) Nourishes sperms

(b) role in activating sperms

(c) Serves as a lubricant during sexual intercourse

(d) Enhancing the motility of sperms

35. Which of the following constitute semen?

(a) Sperms

(b) Secretion of accessory glands

(c) Organic substance

(d) Both a and b

36. What is the pH of semen?

(a) 7.3 to 7.7

(b) 7.2 to 7.6

(c) 7.4 to 7.8

(d) 7.5 to 7.9

37. What is the pH of vaginal fluid?

(a) 3.5 to 4.0

(b) 3.6 to 4.1

(c) 3.7 to 4.2

(d) 3.8 to 4.3

38. The average volume of semen for each ejaculation is

(a) 3 to 4 ml

(b) 3.5 to 4.5 ml

(c) 4 to 5 ml

(d) 4.5 to 5.5 ml

39. Internally the penis is

(a) Composed of three cylindrical mass of connective tissue bound together

(b) Composed of three cylindrical mass of tissue bound together by fibrous tissue

(c) Composed of three cylindrical mass of epithelium tissue bound together

(d) Composed of three mass of tissue only

40. When does the penis get erect?

(a) If masses of tissue filled with air

(b) If masses of tissue filled with blood

(c) If masses of tissue filled with hormones

(d) (b) and (c) occurs both

41. Which is an accessory part of the female reproductive system?

(a) Vulva

(b) Pudendum

(c) Mammary gland

(d) Vagina

42. What is the size of ovaries?

(a) 3 c.m long, 2 c.m wide, 1 c.m thick

(b) 2 c.m long, 2 c.m wide, 1 c.m thick

(c) 3 c.m long, 2 c.m wide, 2 c.m thick

(d) 2 c.m long, 2 c.m wide, 2 c.m thick

43. Where are ovaries situated?

(a) In the upper pelvic cavity

(b) Below pelvic cavity

(c) At one on each side of the uterus

(d) (a) and (c) both

44. The ovaries maintain their position by

(a) Series of ligaments

(b) Connective layer

(c) Epithelium layer

(d) Muscular filament

45. What is the entry point for blood vessels and nerves into the ovaries called?

(a) Cortex

(b) Hilus

(c) Medulla

(d) None of them

46. Which tissue layer covers the ovary?

(a) Columnar epithelium

(b) Squamous epithelium

(c) Cuboidal epithelium

(d) Ciliary epithelium

47. What is the surrounding layer of the ovary called?

(a) Germinal epithelium

(b) Tunica albuginea

(c) Stroma

(d) Collagenous

48. What is called a capsule of collagenous connective tissue immediately after the germinal epithelium of ovaries?

(a) Stroma

(b) Tunica albuginea

(c) Ovarian epithelium

(d)None of them

49. Which tissue layer of tunica albuginea

(a) Connective tissue

(b) Collagenous connective tissue

(c) Epithelial tissue

(d) Collagenous epithelium tissue

50. What is called a region of connective tissue deep to the tunica albuginea?

(a) Stroma

(b) Follicular epithelium

(c) Graffian follicles

(d) Corpus luteum

51. Ovarian stroma is composed by?

a) Cortex

(b) Medulla

(c) Follicles

(d) (a) and (b) both

52. Stroma of ovarian cortex contains

(a) Ovarian follicles

(b) Corpus luteum

(c) Graffian follicles

(d) (a) and (c) both

53. What is the structure consisting of ova and their surrounding tissues in various stages of development called?

(a) Primary follicle

(b) Ovarian follicles

(c) Graffian follicles

(d) Corpus luteum

54. What is the structure consisting of the mature ovum and its surrounding tissues called?

(a) Mature ovum

(b) Ovarian follicles

(c) Graffian follicle

(d) Corpus luteum

55. Graffian follicle after ovulation produces a glandular body, it is called

(a) Graffian follicle

(b) Corpus luteum

(c) Mass of Graafian follicle

(d) both a and b

56. Which hormones are produced by the corpus luteum?

(a) Estrogen

(b) Progesterone

(c) Testosterone

(d) (a) and (b) both

57. What is the length of the fallopian tube?

(a) 10 c.m

(b) 10 m.m

(c) 12 c.m

(d) 12 m.m

58. The uterine tube from the side runs forwards and becomes associated with

(a) Vagina

(b) Uterus

(c) Urethra

(d) Ovary

59. Where does ovum fertilization occur?

(a) Vagina

(b) Uterus

(c) Fallopian tube

(d) Infundibulum

60. Where is the uterus situated?

(a) Between the urinary bladder and rectum

(b) Between the urinary bladder and urethra

(c) Between the urinary bladder and ovary

(d) Between the urinary bladder and intestine

61. What is the shape of the uterus?

(a) Inverted apple-shaped

(b) Inverted pear-shaped

(c) Inverted mango shaped

(d) None of this

62.The wall of the uterus is made of _____number of layers

(a) Three

(b) Two

(c) one

(d) Four

63. A fertilized egg is implanted in the uterus?

(a) Endometrium

(b) Myometrium

(c) Perimetrium

(d) None of this

64. It is a middle layer of the uterus and it plays an active role during the delivery of a baby

(a) Endometrium
(b) Myometrium

(c) Perimetrium
(d) None of this

65. The distal narrow end of the uterus is called

(a) Vagina

(b) Cervix

(c) Hymen

(d) (a) and (c) both

66. Which part is connected to the uterus through the cervix?

(a) Vagina

(b) Hymen

(c) Mucosal membrane

(d) (a) and (c) both

67. It is a fold at the distal end of the vagina

(a) Hymen

(b) Mucosal membrane

(c) Cervix

(d) Clitoris

68. What is called cushion of fatty tissue in female external genitalia?

(a) Mons pubis

(b) Labia majora

(c) Labia minora

(d) Clitoris

69. Which region of the vulva is located below the mons pubis?

(a) Labia majora

(b) Labia minora

(c) Clitoris

(d) None of this

70. What is called a tiny finger-like structure which lies at the upper junction of the two labia minora

(a) Penis

(b) Clitoris

(c) Mons

(d) Pubis

71. Which is part of the vulva is considered equivalent to the male penis

(a) Clitoris

(b) Hymen

(c) Mons

(d) Pubis

72. During the puberty stage, which sex hormone stimulates the enlargement of the breast?

(a) Progesterone

(b) Estrogen

(c) Testosterone

(d) (a) and (b) both

73. What is called the process of gamete formation in sexually reproducing animals?

(a) Spermatogenesis

(b) oogenesis

(c) Gametogenesis

(d) None of this

74. Which cells produce spermatids

(a) Secondary germinal cells

(b) Primary germinal cells

(c) Spermatogonium

(d) Spermatocytes

75. Name the process involved in the multiplication phase of spermatogenesis?

(a) Mitotic

(b) Meiosis

(c) Amitosis

(d) (a) and (b) both

76. In spermatogenesis, which cells are produced at the end of the multiplication phase?

(a) Primary spermatocyte

(b) Spermatogonia

(c) Secondary spermatocyte

(d) Spermatids

77. In spermatogenesis, which cells are produced at the end of the growth phase?

(a) Primary spermatocyte

(b) Spermatogonia

(c) Secondary spermatocyte

(d) Spermatids

78. In spermatogenesis, which processes occur for secondary spermatocytes?

(a) Mitotic

(b) Meiosis

(c) Amitosis

(d) (a) and (b) both

79. In spermatogenesis, which cells are produced at the end of the maturation phase?

(a) Primary spermatocyte

(b) Spermatogonia

(c) Secondary spermatocyte

(d) Spermatids

80. The metamorphosis of the spermatids into the sperms is known as

(a) Multiplication phase

(b) The growth phase

(c) The maturation phase

(d) Spermiogenesis

81. These form a middle piece of the sperm

(a) Mitochondria

(b) Golgi Complex

(c) Ribosomes

(d) Nucleus

82. In oogenesis, which cells are produced at the end of the multiplication phase?

(a) Primary oocyte

(b) Secondary oocyte

(c) First polar body

(d) Secondary polar body

83. In oogenesis, which cells are produced at the first division of primary oocytes in the maturation phase?

(a) Secondary oocyte

(b) First polar body

(c) Secondary polar body

(d) (a) and (b) both

84. A cell at ovulation is at which stage

(a) Secondary oocyte

(b) First polar body

(c) Secondary polar body

(d) Primary oocyte

85.When sperm penetrates the secondary oocyte during its unequal meiotic division, how many polar body (bodies) is/are produced?

(a) One

(b) Two

(c) Three

(d) None of this

86. The events of the menstrual cycle are the cyclic changes in the

(a) Endometrium

(b) Myometrium

(c) Perimetrium

(d) All of this

87.The events of the menstrual cycle are comprised of how many days

(a) 27 days

(b) 28 days

(c) 29 days

(d) 30 days

88. In the menstrual cycle, which period is known as the menstrual phase?

(a) 1 to 5 days

(b) 6 to 14 days

(c) 15 to 28 days

(d) 14 to 15 days

89.Which period of the menstrual cycle is known as a proliferative phase?

(a) 1 to 5 days

(b) 6 to 14 days

(c) 15 to 28 days

(d) 14 to 15 days

90. On which day of the menstrual cycle does ovulation occur?

(a) on 12th day

(b) on 13th day

(c) on 14th day

(d) on 15th day

91. During which days of the menstrual cycle do estrogen levels rise?

(a) 1 to 5 days

(b) 6 to 14 days

(c) 14 to 15 days

(d) 15 to 28 days

92. On which days of the menstrual cycle do progesterone levels rise?

(a) 1 to 5 days

(b) 6 to 14 days

(c) 14 to 15 days

(d) 15 to 28 days

93. The sperms emptied in the vagina start moving towards oviducts through the uterus which is helpful in their locomotion

(a) Contraction of uterine wall

(b) Contraction vagina passage

(c) The slimy secretion of oviduct wall

(d) All these

94. In fertilization, which part of sperm enters the secondary oocyte?

(a) Tail

(b) Head

(c) Middle part

(d) (b) and (c) both

95. During movement of zygote into oviduct the division of zygote in 2 to 16 daughter cells. This process called

(a) Cleavage

(b) Gastrulation

(c) Morula

(d) (a) and (b) both

96. The embryo with 16 cells is called

(a) Blastocyst

(b) Blastomeres

(c) Morula

(d) Cleavage

97. The fluid within the blastocyst is formed by the cells of

(a) Blastomere

(b) Trophoblast

(c) Inner layer of blastocyst

(d) None of this

98. Which hormones are not produced by placenta?

(a) hcG

(b) hpL

(c) estrogens

(d) relaxin

99. Cleavage is the series of rapid mitotic division in zygote and forms blastula, The 2 4 8 16 daughter cells are called blastomeres Embryo with 64 blastomeres is known as blastocyst and has blastocoel cavity .Blastocyst gets implanted in uterine wall and leads to pregnancy

1) Solid mass of cells with 16 blastomere is called

a) morula
b) Blastula
c) gastrula
d) Zygote

2) At which stage of embryonic development trophoectoderm develops ?

a) zygote
b) morula
c) blastula
d) gastrula

3) Site of implantation is

a) endometrium of uterus
b) Cervix
c) uterine fundus
d) infundibulum of oviduct

4) Correct sequence of various structure formed during embryonic development is

a) morula ---embryo -- gastrula --- blastula
b) zygote -- embryo--- morula--- blastula
c) blastula--- morula---- gastrula ----embryo
d) zygote ---morula ---blastula ---gastrula

1. Assertion: In human male testis are extra abdominal and lie in scrotal sacs
   Reason: Scrotum act as thermoregulator and keeps testicular temperature lower by two degree Celsius for normal spermatogenesis
2. Assertion: Ovum retains most of the content of primary oocyte and is much larger than a
   Reason: Ovum needs energy to go about in search of a spermatozoa for fertilization
3. Assertion: Interstitial cells that are present in the region outside the seminiferous tubule are called interstitial space.
   Reason: Interstitial cells provide nutrition to the sertoli cells.

100. Read the following and answer any four questions:

Oogenesis is the process of formation of ovum in ovaries. It consists of three phases: multiplication,Growth and maturation.Oogenesis is controlled by hormones GnRH, LH,FSH. GnRH secreted by the hypothalamus stimulates the anterior lobe of the pituitary gland to secrete LH and FSH.

1. What is the function of hormone FSH?
   a) it inhibits the formation of oestrogen.
   b) it induces the release of secondary oocytes.
   c) it stimulates the growth of graffian follicles.
   d) it causes ovulation.
2. Which hormone induces the rupture of mature Graffian follicles?
   a) follicle stimulating hormone
   b) gonadotropin-releasing hormone
   c) progesterone
   d) luteinizing hormone
3. Which cell division is involved in the formation of secondary oocytes?
   a) mitosis b) meiosis I c) Amitosis d) meiosis II
4. Identify the functions of LH?
   a) release of secondary oocyte from Graafian follicle
   b) stimulates Corpus luteum to secrete progesterone
   c) stimulates oestrogen formation
   d) promotes development of egg to form secondary oocyte
   a) A and B only
   b) B and C only
   c) A,C and D only
   d) B only

ANSWERS

Q	A	Q	A	Q	A	Q	A	Q	A
1	D	21	B	41	C	61	B	81	A
2	B	22	C	42	A	62	A	82	A
3	D	23	A	43	B	63	A	83	D
4	A	24	B	44	A	64	B	84	A
5	D	25	C	45	B	65	B	85	C
6	D	26	B	46	C	66	A	86	A
7	A	27	C	47	A	67	B	87	B
8	B	28	D	48	B	68	A	88	A
9	C	29	A	49	B	69	A	89	B
10	D	30	C	50	A	70	B	90	C
11	A	31	B	51	D	71	A	91	B
12	C	32	D	52	A	72	B	92	D
13	C	33	D	53	B	73	C	93	D
14	C	34	C	54	C	74	B	94	D
15	B	35	D	55	B	75	A	95	A
16	A	36	B	56	B	76	B	96	C
17	D	37	A	57	A	77	A	97	B
18	D	38	A	58	B	78	B	98	C
19	D	39	B	59	C	79	D	99	---
20	D	40	B	60	A	80	D	100	---

REPRODUCTIVE HEALTH

SUMMARY

Reproductive health: problems and strategies

A reproductively healthy society with people having physically and functionally normal reproductive organs and normal emotional and behavioural interaction among them in all sex- related aspects.

Programmes involved in maintaining reproductive health:

Family planning programmes

- Reproductive and child health care (RCH)

AIMS OF REPRODUCTIVE HEALTH PROGRAMMES

- To provide sex education in the schools to safeguard young school girls from myths and misconceptions about sex- related issues.
- To prevent and control sexually transmitted disease (STDs) by providing proper information about reproductive organs, adolescence and safe and hygienic sexual practices.
- To educate the fertile couples and those in marriageable age-groups about birth control measures, prenatal and postnatal care of mother and child, importance of breastfeeding for a few months etc.
- To provide medical facilities and support.
- To manage disorders related to reproductive systems.
- To lessen the problems of infertility by promoting assisted reproductive activities.

Population explosion

- Increased health facilities and improvement in technology leading to better living conditions, have an explosive impact on the growth of population.

The probable reason are:

- Decline in death rate
- Decline in maternal mortality rate (MMR)
- Decline in infant mortality rate (IMR)
- Increase in the no. of people in the reproductive age.

Methods to control over population

- Education
- Age of marriage
- Family planning methods

Methods of birth control

The contraceptive methods are grouped into the following categories:

- Natural method
- Barrier methods
- Intra- uterine devices (IUDs)
- Oral contraceptives
- Injectable and Implants
- Surgical Methods.

Amniocentesis:

A sample of amniotic fluid from the womb of a pregnant woman is taken during the early stage of Foetal development and the cells are cultured and analysed.

- By this method the chromosomal abnormalities, the sex of the Foetus and developmental disorders could be detected.
- It is misused, for destroying a normal female Foetus. (female foeticide) Intra-uterine devices
- These are the devices introduced into the uterus.IUDs are of the following types
- Non-Medicated IUDs Example Lippes loop.
- Copper releasing IUDs example .CuT, Cu-7, Multiload-375
- Hormone releasing IUDs Example . Progestasert, LNG-20,They delay, alter/ inhibit ovulation and implantation or conception in the following ways.
  i. By increasing phagocytosis of sperms within the uterus.
  ii. By suppressing sperm motility and thereby suppressing the fertilizing ability of sperm by Cu ion released by some IUDs.
  iii. Hormone releasing IUDs make the uterus unsuitable for implantation and the cervix hostile to the sperms.

Medical termination of pregnancy(MTP)

- MTP is essential where pregnancy could be harmful to the mother or the Foetus or both.
- MTP are safe during the first trimester (upto 12 weeks of pregnancy) Sexually Transmitted Diseases (STDs)
- Diseases or infections which are transmitted through sexual intercourse are collectively called STDs or venereal disease (VD) or reproductive tract infections (RTI).
- Gonorrhoea, syphilis, genital herpes chlamydiasis, genital warts, trichomoniasis, hepatitis B and AIDS are some of the common STDs.

THE EARLY GENERAL SYMPTOMS INCLUDE THE FOLLOWING IN THE GENITAL REGION.

- Itching
- Fluid discharge
- Slight pain
- Swelling

These infections could be avoided / prevented by following practices:

- Avoiding sex with unknown partners or multiple partners.
- Using condoms during coitus every time.
- Seeking medical help in case of doubt and getting it completely cured.

Infertility

- It is the inability to conceive or produce children even after 2 years of unprotected sexual relation.
- The reasons for infertility could be physical, congenital disease, use of certain drugs, immunological reactions or even physiological reactions.
- Where corrective treatments are not available, there are special techniques called Assisted Reproductive Technologies (ARTs) to help the couple to produce children. They are as follows:

  1. Test tube baby programmes:
- In this method, ova from the wife or a donor female and sperm from the husband or donor male are allowed to fuse under stimulated conditions (as that of the body) in the laboratory. This is called in vitro fertilization (IVF).
- The zygote or early embryo is transferred into the uterus or fallopian tube for further development. This process is called embryo transfer (ET) and can be done in following ways: (i) Zygote/ Embryo up-to 8 blastomeres is transferred into the fallopian tube, it is called zygote intra fallopian transfer (ZIFT).

  (ii) Embryos with more than 8 blastomeres are transferred into the uterus, it is called intra- uterine transfer (IUT).

  2. Gamete intra fallopian transfer (GIFT)

  This method involves the transfer of an ovum collected from a donor female into another female who cannot produce ova but can provide suitable conditions for fertilization and further development of the Foetus through parturition.

3. Intra-Cytoplasmic Sperm Injection (ICSI)

   In this method, the sperm is directly injected into the ovum to form an embryo in the laboratory and then embryo transfer is carried out.

4. Artificial Insemination (IUI).

In this method, the sperm collected from the husband or healthy donor is artificially introduced into the vagina or into the uterus. It is called Intra uterine insemination.

MCQ

1. *Saheli* was developed by
    a. CDRI
    b. CCMB
    c. ICMR
    d. FDTRC
2. An ideal contraceptive should be
    a. User friendly
    b. effective
    c. cause least side effects
    d. all the above
    e. both a & c
3. A rapid rise in Indian population was due to
    a. Increase in MMR
    b. increase in number of people in reproducible age
    c. decline in IMR
    d. both b & c
    e. All the above
4. In periodic abstinence, couples avoid coitus from
    a. day 10-17 of menstrual cycle
    b. day 12-15 of menstrual cycle
    c. day 5-10 of menstrual cycle
    d. Day 16-24 of menstrual cycle
5. Use of condoms has increased in recent years as
    a. It prevents conception
    b. Protects the user from contracting STD
    c. Gives privacy to the user
    d. All the above
6. The oral pills for contraception are effective as they
    a. Inhibit ovulation
    b. Inhibit implantation
    c. Retard entry of sperms

    Choose the correct option from the above
    i. a

ii. a and b

iii. a,b and c

Iv. b& c

7. Symptoms of STD include
   a. Itching & fluid discharge in genital areas
   b. PID
   c. Infertility
   d. Abortions

   Choose the correct options from the above

   i.a

   ii. a&b

   iii.b&c

   iv. c&d

   v. a,b,c&d

8. A test tube baby programme involves
   a. IVF
   b. ET
   c. IUT
   d. ZIFT

   CHOOSE the correct option

   i. a&b

   ii. b&c

   iii. a.b.c&d

   iv. c&d

9. Match the following

A	B
1.syphilis	a.multiload 375
2. non medicated IUD	b. VD
3. Hormone releasing IUD	c. lippes loop
4. Cu releasing IUD	d. LNG20

   a. 1-b,2-c,3-d,4-a
   b. 1-d,2-a.3-b, 4-c
   c. 1-b, 2-d,3-c,4-a
   d. 1-c, 2-d, 3-b,4-a

10. Natural methods of contraception are

a. Highly effective
b. Have no side effects
c. Work on the principle of avoiding chance of ovum & sperm meeting
d. No devices are used in this method

Choose the incorrect option among the following

11. *In-vitro* fertilization involves transfer of _____ into the fallopian tube.

(*a*) Embryo up to eight cell stage

(*b*) Embryo of thirty two cell stage

(*c*) Zygote

(*d*) Either zygote or embryo up to eight cell stage

12. The method of directly injecting a sperm into ovum in Assisted Reproductive Technology is called

(a) GIFT

(b) ZIFT

(c) ICSI

(d) ET

13. Intensely lactating mothers do not generally conceive due to the

(a) Suppression of gonadotropins

(b) Hyper secretion of gonadotropins

(c) Suppression of gametic transport

(d) Suppression of fertilisation

14. Choose the right one among the statements given below.

(a) IUDs are generally inserted by the user herself

(b) IUDs increase phagocytosis reaction in the uterus

(c) IUDs suppress gametogenesis

(d) IUDs once inserted need not be replaced

15. Following statements are given regarding MTP.

(i) MTPs are generally advised during 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)

16. From the sexually transmitted diseases mentioned below, identify the one which does not specifically affect the sex organs.

(a) Syphilis

(b) AIDS

(c) Gonorrhea

(d) Genital warts

17. Condoms are one of the most popular contraceptives because of the following reasons.

(a) These are effective barriers for insemination

(b) They do not interfere with coital act

(c) These help in reducing the risk of STDs

(d) All of the above

18. Which of the following is/are a barrier method of contraception?

(a) Rhythm method/Periodic abstinence

(b) Lactational amenorrhea

(c) Withdrawal method

(d) None of these

19. Amniocentesis is a process to

(a) Grow of cells on the culture medium

(b) Determine any hereditary disease of the embryo

(c) Know about the diseases of the brain

(d) Determine any disease of heart

20. A couple went to a doctor for the regular checkup of the developing foetus. The doctor ran some tests and found that the developing foetus had chromosomal abnormalities and suggested the couple to undergo abortion, the technique used by doctor to check the abnormalities is

(a) Vasectomy

(b) ICSI

(c) Amniocentesis

(2) ZIFT

21. A male is infertile which is due to very low sperm count production. What technique would you suggest for correcting his infertility?

(a) Artificial insemination

(b) GIFT

(e) ZIFT

(d) IVF

22. Which IUD would you suggest to promote cervix hostility to sperms?

(a) LNG-20

(b) CUT

(c) Cu 7

(d) Multiload 375

23. Which of the following ARTs would you suggest to form an embryo in laboratory conditions without a donor for a couple in which the male partner can inseminate normally but mobility of sperms is very low?

(a) IUD

(b) ICSI

(c) GIFT

(d) None of these

24. Vaults are one of the barrier methods that

(a) Prevent conception by blocking the entry of sperm through cervix

(b) Release Cu ions

(c) Are not reversible

(d) Release progesterone

25. What is extracted from the developing foetus to test the presence of genetic disorders?

(a) Yolk sac

(b) Endometrium

(c) Amniotic fluid

(d) Placenta

26. Hormone containing structures which are placed under the skin are called

(a) Vaults

(b) Implants

(c) Cervical cap

(d) Pill

27. Birth control pills are taken for a period of _days daily

(a) 7

(b) 31

(c) 21

(d) 10

28. Which of the following statements is true about pills?

(a) They are very effective.

(b) They have less side effects,

(c) They are widely accepted by females. (d) All of these

29. Choose the odd one out.

(a) Cut

(b) Diaphragms

(c) Pills having vasopressin

(d) Vasectomy

30. Medical Termination of Pregnancy is safe up to

(a) 8 weeks of pregnancy

(b) 12 weeks of pregnancy

(c) 18 weeks of pregnancy

(d) 24 weeks of pregnancy

ANSWERS

1.a	2.d	3.d	4.a	5.d	6.iii	7.v	8.iii	9.a	10.a
11.d	12.c	13.a	14.b	15.c	16 b	17.d	18.d	19.b	20.c
21. a	22 a	23 b	24.a	25.c	26.b	27.c	28.d	29.c	30.c

SECTION B: ASSERTION REASONING TYPE

These questions consist of two statements- Assertion and Reason. While answering choose any one of the following four responses

A- assertion and Reason are true and the Reason is a correct explanation of the Assertion

B- assertion and Reason are true but Reason is not a correct explanation of the Assertion

C- Assertion is true but the Reason is false.

D. If both Assertion and Reason are false

1. Assertion: Mother should not be blamed for the birth of girls in the family.

   Reason: Father is responsible for the sex of the child.

2. Assertion: Amniocentesis is often misused.

   Reason: Amniocentesis is meant for determining the genetic disorders in the foetus, but it is being us determine the sex the foetus so that female foetus may be aborted.

3. Assertion: Human population now doubles every 35 years as against 200 years in 1600-1800.

   Reason: Rapid increase is due to better health facilities and food resources.

4. Assertion: IVF helps couples with infertility to have children

   Reason: a couple who are unable to beget children within a year have to visit an infertility clinic

5. Assertion: Infertility may be because the male partner has low sperm count

   Reason: This can be corrected by AI or ICSI.

6. Assertion: IUT is the transfer of embryo with more than 8 blastomeres into the uterus.

   Reason: IUT is a very popular method of forming embryos in vivo.

7. Assertion: Syphilis, gonorrhea and AIDS are some common STDs.

Reason: STDs are transmitted through sexual intercourse..

8. Assertion: *Saheli* is an oral contraceptive pill for females containing nonsteroidal preparation.

Reason: It is a 'once in a day' pill with very few effects.

9. Assertion: Diaphragms and cervical caps are barriers made of rubber.

Reason: They block the entry of sperms through the cervix.

10. Assertion: In barrier methods of contraception ovum and sperms are prevented from physical meeting.

Reason: Barrier methods are used during coitus to prevent entry of sperms into the female reproductive tract.

11. Assertion: Lactational amenorrhea is a natural method of contraception.

Reason: Ovulation does not take place during the period of intense lactation following childbirth.

12. Assertion: ICSI is an assisted reproductive technique.

Reason: In ICSI sperm is directly injected into the ovum to form an embryo in vitro.

13. Assertion : Subcutaneous implants involve implantation of synthetic progesterone under the skin.

Reason: Implants block ovulation and thickens the cervical mucus to prevent sperm transport.

14. Assertion : Oral contraceptive pills check ovulation.

Reason : Oral pills always contain a combination of progesterone and estrogen.

15.Assertion : Periodic abstinence is a natural method where couples abstain from coitus.

Reason : Coitus from day 5-10 should be avoided because this is the time of ovulation.

ANSWERS

1. b	2.a	3.a	4.c	5.b
6. c	7.a	8.c	9.b	10.a
11. a	12.a	13.b	14. C	15. c

SECTION B

1. An intrauterine device (IUD) is a small contraceptive device that is put into the uterus (womb) to prevent pregnancy. The 2 types available -the copper IUD and the hormonal IUD.The copper IUD is designed to stay in place for up to 10 years and the hormonal IUD for 5 years. Both can easily be removed sooner, if needed. Both copper and hormonal IUDs are more than 99% effective at preventing pregnancy.

Advantages of IUDs include:

- They last for a long time –hormonal IUD's can last for 5 years, and the copper IUD can last for 10 years.
- They are safe to use if you are breastfeeding.
- No medications stop them from working.
- The device can be taken out at any time by an appropriately trained doctor or nurse.
- Your chance of getting pregnant will go back to normal as soon as the copper or hormonal IUD has been taken out.

1. Choose the most apt answer-

New mothers prefer IUD for contraception as

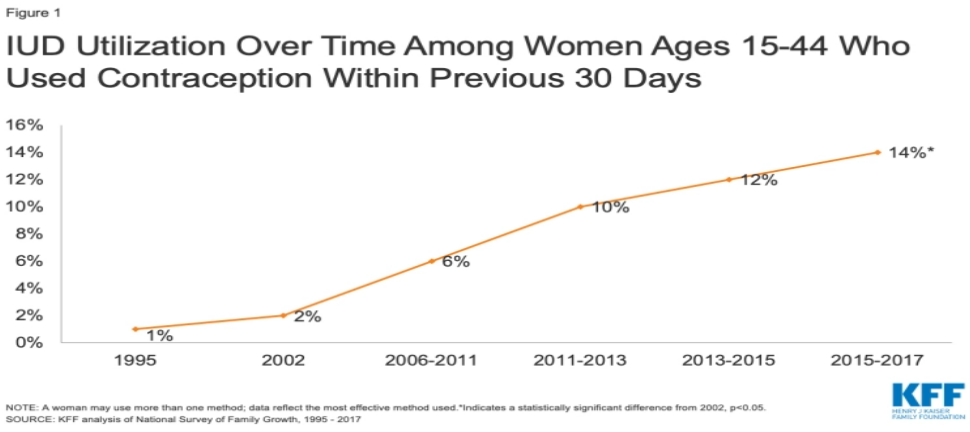
a. they prevent unwanted pregnancy

b. Do not affect the new-born as no medicines/hormones enter the bloodstream.

c. it is 99% effective

d. they last for a long time

2. Analyse the graph and pick out all the choices that are correct with reference to it.



a. IUD's have become popular among the female community

b. Modern women are now aware of the types of contraceptives available.

c. IUD's are effective contraceptive devices

d. IUD's are cost effective

1. a &b
2. b& c
3. c &d
4. a,b,c & d

3. ASSERTION: Copper T is an effective IUD used by females

REASON: Copper T prevents STD's.

(a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A).

(b) Both assertion (A) and reason (R) are true but reason (B) is not the correct explanation of assertion (A).

(c) Assertion (A) is true but reason (R) is false .

(d) Assertion (A) is false but reason (R) is true.

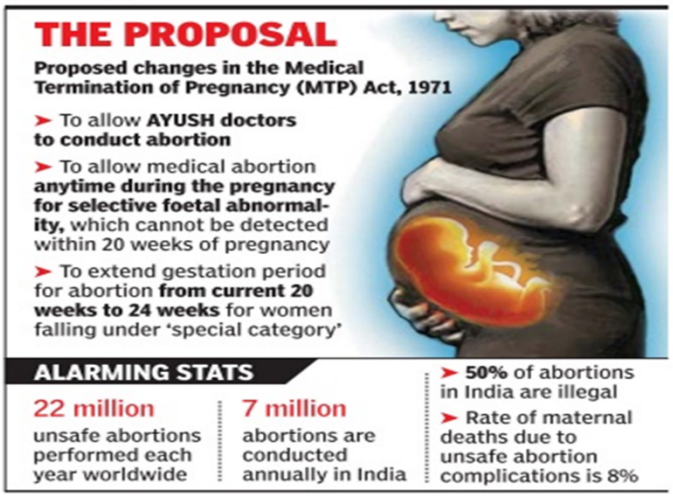
4. Use of IUD's may initially show side effects like spotting, tender breasts, headaches, skin changes and mood changes.

AGREE	DISAGREE

ANSWERS

1.b 2. 4 3.c 4. AGREE

2.



1. What is the other term for MTP?

a) Induced abortion

b) Forced death

c) Pregnancy-induced sterilization

d) Unwanted pregnancy

2. What restriction has been posed by the Government of India on the use of MTP?
   a) Illegal female foeticide
   b) Illegal male foeticide
   c) Illegal drug smuggling
   d) Illegal use of narcotics
3. Which of the following is not the correct reason for the use of MTP?
   a) Get rid of unwanted pregnancy
   b) Terminate pregnancies that are fatal to mother
   c) Terminate pregnancies that are fatal to foetus
   d) Female foeticide
4. The primary purpose of MTP is to prevent the population rise.
   a) True
   b) False
5. What period of pregnancy are the MTPs safest?
   a) First trimester
   b) Second trimester
   c) Third trimester
   d) Fourth trimester

ANSWERS

1.a 2. a 3. d 4. b

3. Read the following and answer the questions given below:

Amniocentesis is a technique for detection of foetal abnormalities such as Down's syndrome, cystic fibrosis. It is performed between 16 and 20 weeks of the pregnancy. It is based on the chromosomal pattern in the cells present in amniotic fluid surrounding the developing embryo. The amniotic fluid contains cells from foetal tissues. The amniotic fluid is sampled from the amniotic sac surrounding the foetus. The foetal cells and foetal DNA is examined to identify some abnormalities in the number of chromosomes and to detect certain genetic abnormalities. It can also be used to determine sex of the infant. These prenatal examinations can prove helpful to expectant guardians as they allow for evaluating the foetal health status and feasibility of treatment. However nowadays it has been responsible for female foeticide. The normal female foetus is aborted in want of a male child who is preferred over the female in most of the ignorant families.

(1) Amniocentesis can be used for

(a) Determination of chromosomal abnormalities

(b) Detection of genetic disorders

(c) Detection of sex of infant

(d) all of these

(ii) Amniocentesis has been banned as it has promoted

(a) Foeticide

(b) Homicide

(c) Female foeticide

(d) Male foeticide

(iii) The technique of amniocentesis was developed mainly for

(a) Detection of chromosomal abnormalities

(b) Detection of foetal sex

(c) Detection of metabolic disorders

(d) all of these

(iv) Which of the following option(s) is correct regarding amniotic fluid?

(a) It is a fluid enclosed within an amniotic sac.

(b) It is a fluid surrounding foetus.

(c) It is a fluid containing cells from foetal tissue.

(d) All of these

(v) Assertion: Amniocentesis is a prenatal diagnostic technique.

Reason: It is done to detect chromosomal disorders and genetic disorders in foetuses.

(a) Both assertion and reason are true, and the reason is correct explanation of assertion

(b) Both assertion and reason are true, but the reason is not the correct explanation of assertion.

(c) Assertion is true but reason is false.

(d) Both assertion and reason are false

ANSWERS:

i) d ii) c iii) a iv) d v) a

4. Read the following and answer questions from 4(i) to 4(v) given below:

Overpopulation causes a number of family problems. Strategies like birth control methods help to control population explosion. Natural methods of birth control do not involve medications or devices to prevent pregnancy but rather rely on behavioural practices and/or making observations about the menstrual cycle.

(i) Which method helps in contraception by temporary absence of sex?

(a) Coitus interruptus

(b) Withdrawal method

(c) Rhythm method

(d) Lactational amenorrhea method

(ii) Assertion : The effectiveness of coitus interruptus method is limited.

Reason: Some sperms may pass into vagina before ejaculation.

(a) Both assertion and reason are true and reason is the correct explanation of assertion.

(b) Both assertion and reason are true but reason is not the correct explanation of assertion.

(c) Assertion is true but reason is false.

(d) Both assertion and reason are false.

(iii) Why is lactational amenorrhea effective for about 4-5 months after parturition?

(a) Ovulation occurs on about the 14th day of menstruation.

(b) Ovulation does not occur during intense lactation.

(C) This method inhibits motility of sperm.

(d) Both (b) and (c)

(iv) Which fact is not the basis of the periodic absence method of birth control?

(a) Ovum remains alive for about 1-2 days.

(b) Ovulation occurs on about the 14th day of menstruation.

(C) Sperms survive for about 3 days.

(d) Alteration in uterine endometrium

(v) On which days of menstrual cycle should coitus be avoided to prevent fertilisation?

(a) 10-17

(b) 6-13

(C) 1-5

(d) 15-28

ANSWERS:

i) c ii) a iii) b iv)d v) a

5. Intrauterine devices are the most widely accepted methods of contraception. These are used by females and are inserted by doctors or nurses in the uterus through vagina. However these devices are not recommended for those who eventually intend to conceive.

(i) How does cutting prevent conception?

(a) Cu ions make the uterus unsuitable for implantation.

(b) Cu ions make the cervix hostile to the sperms.

(C) Cu ions suppress sperm motility.

(d) Cu ions inhibit ovulation.

(ii) Which of the following IUDs makes the uterus unsuitable for implantation?

(a) LNG-20

(b) Multiload 375 (c) Cu7

(d) Lippes loop

(iii) Identify the correct statement for IUDs.

(a) They slowly release synthetic progesterone in the body.

(b) They increase phagocytosis of sperms within the uterus.

(c) They block the entry of sperm through the cervix.

(d) Both (b) and (c)

(iv) Select the correct matched pair.

(a) Hormone releasing IUD - LNG-20

(b) Non-medicated IUD - Progestasert

(c) Copper releasing IUD - Lippes loop

(d) None of these

(v) Assertion : IUDs can cause excess menstrual bleeding and pain.

Reason: IUDs can perforate uterus.

(a) Both assertion and reason are true and reason is the correct explanation of assertion.

(b) Both assertion and reason are true but reason is not the correct explanation of assertion.

(c) Assertion is true but reason is false.

(d) Both assertion and reason are false.

ANSWERS:

i) C ii) a iii) b iv)a v) b

PRINCIPLES OF INHERITANCE AND VARIATION

SUMMARY

Mendel's laws of inheritanceGregor Mendel, conducted hybridisation experiments on garden peas for seven years (1856-1863) and proposed the laws of inheritance in living organisms

1. Mendel investigated characters in the garden pea plant that were manifested as two opposing traits.
2. Mendel conducted artificial pollination/cross pollination experiments using several true-breeding (produced by continuous self-pollination, shows the stable trait inheritance and expression for several generations) pea lines.

3. Types of genetic crosses

	Definition	Phenotypic ratio	Genotypic ratio
Monohybrid Cross	Cross between parents differing in only one trait or in which only one trait is being considered	F1: 100% dominant trait F2: 3:1	F1: All heterozygous F2: 1:2:1
Dihybrid Cross	Cross between parents differing in two pairs of contrasting characters are studied simultaneously	F1: 100% dominant trait F2: 9:3:3:1	F1: All heterozygous F2: 1:2:1:2: 4:2:1: 2:1
Test Cross	Cross between an organism with unknown genotype and a recessive parent. It is used to determine whether an individual is homozygous or heterozygous for a trait	Organism with unknown genotype is ❖ Homozygous All offsprings resemble unknown ❖ Heterozygous 50% resemble unknown parent and 50% resemble recessive parent	

4. Law of Dominance

(i) Characters are controlled by discrete units called factors.

(ii) Factors occur in pairs.

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

5. Law of segregation

   Allele pairs separate or segregate during gamete formation and the paired condition is restored by the random fertilization of gametes.

6. Law of independent assortment

   If the inheritance of two or more genes is considered at a time, their distribution in the gametes and in the progeny of subsequent generation is independent of each other

7. Allelic interaction

Type	Interaction	Example
complete dominance	A cross between organisms with two different phenotypes (RR X rr) produces offspring with *third (Rr)* phenotype One allele is incompletely dominant	Flower colour in snapdragon Starch grain size in pea
b. Multiple alleles	Existence of more than two allele Heterozygotes express both dominant phenotypes - Codominance	ABO blood group system in humans

8. Pleiotropy: Multiple effect of a gene

   Example In *Drosophila* white eye mutation leads to depigmentation in many other parts of the body.

   Phenylketonuria is characterized by mental retardation and a reduction in hair and skin pigmentation.

9. Polygenic Inheritance: Phenotype is influenced by three or more gene and each type of allele in the genotype would determine the phenotype

   Example A - B - C gene control human skin

   In 1900, three Scientists (de Vries, Correns and von Tschermak) independently rediscovered Mendel's results on the inheritance of characters

10. Chromosomal Theory of Inheritance

Walter Sutton and Theodore Boveri noted that the behaviour of chromosomes was parallel to the behaviour of genes

1. Both chromosomes and genes occur in pairs
2. Segregate at the time of gamete formation such that only one of each pair is transmitted to a gamete
3. Independent pairs segregate independently of each other

Chromosome theory of inheritance states that individual genes are found at specific locations on particular chromosomes, and that the behaviour of chromosomes during meiosis can explain inheritance of genes according to Mendel's laws

11. Thomas Hunt Morgan worked with fruit flies; *Drosophila melanogaster*

He coined the term linkage to describe this physical association of genes on a chromosome and the term recombination to describe the generation of non-parental gene combinations.

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.

12. Sex determination

Henking (1891) traced a specific nuclear structure in 50 per cent of the sperm received after spermatogenesis in a few insects and named it X body. X body was later renamed as X chromosome

Type	Male	Female	Example	
XO	X0	XX	Insects-Grasshopper	Males heterogamety
XY	XY	XX	Human, Fruit fly	
ZW	ZZ	ZW	Birds	Females heterogamety
Haplodiploidy	Haploid	Diploid	Bees	----------

13. Mutation is a phenomenon which results in alteration of DNA sequences leading to changes in the genotype and the phenotype of an organism. Chemical and physical factors that induce mutations are referred to as mutagens.
14. Pedigree analysis involves study of traits in several generations of a family.
    a. Determine if the pedigree chart shows an autosomal or X linked disease.

Autosomal	X linked
50/50 ratio between affected men and women	Most of the males in the pedigree are affected

b.Determine whether the disorder is dominant or recessive.

Dominant	Recessive
One of the parents must be affected.	Neither parent would be affected

c.

Autosomal Recessive	Autosomal Dominant
Appears in both sexes with equal frequency	Appears in both sexes with equal frequency. Both sexes transmit the trait to their offspring
skip generations	Does not skip generations
Affected offspring are usually born to unaffected parents	Affected offspring must have an affected parent

d.

X linked dominant	X-Linked Recessive
Both males and females are affected; often more females than males are affected	More males than females are affected
Affected sons must have an affected mother	Affected sons are usually born to unaffected mothers, thus the trait skips generations.

Affected daughters must have either an affected mother or an affected father.	

15. Genetic disorders

Mendelian disorders	Chromosomal disorders	
Due to alteration or mutation in the single gene	chromosomal disorders on the other hand are caused due to absence or excess or abnormal arrangement of one or more chromosomes. Two types	
Transmitted to the offspring on the same lines as in the principle of inheritance of Mendel	Aneuploidy	Polyploidy
Can be traced in a family by pedigree analysis	Failure of segregation of chromatids during cell division cycle results in the gain or loss of a chromosome(s)	Failure of cytokinesis after telophase stage of cell division results in an increase in a whole set of chromosomes

16. Examples of Mendelian disorders

Name of disorder	Type	Cause	Symptoms
Colour Blindness	Sex-linked recessive	mutation in certain genes present in the X chromosome	failure to discriminate between red and green colour
Haemophilia	Sex linked recessive	A single protein that is a part of the cascade of proteins involved in the clotting of blood is affected	Simple cut will result in non-stop bleeding.
Sickle-cell anaemia	Autosome linked recessive	Point mutation in the beta globin gene of Hb, Valine	Mutant haemoglobin molecule

		substitution glutamic acid at sixth position	undergoes polymerisation under low oxygen tension causing the change in the shape of the RBC
Phenylketonuria	Autosomal recessive trait	Lacks an enzyme (phenyl alanine hydroxylase) that converts the amino acid phenylalanine into tyrosine	Accumulation of phenyl pyruvic acid in brain results in mental retardation
Thalassemia α thalassemia β thalassemia	Autosomal recessive trait	 Mutation or deletion of genes HBA1 and HBA2 on chromosome 16 Mutation HBB on chromosome 11	 Reduced production of α globin chain Reduced production of β globin chain

17. Examples of chromosomal disorder

Name of the disorder	Karyotype	Symptoms
Down's Syndrome	47, Due to an additional copy of the chromosome number 21 (trisomy of 21).	Short stature with small round head, furrowed tongue and partially open mouth. Palm is broad with characteristic palm crease. Physical, psychomotor and mental development is retarded.

Klinefelter's Syndrome	47, XXY	Overall masculine development, however, the feminine development is expressed (Gynaecomastia), sterile
Turner's Syndrome	45, XO	Females are sterile as ovaries are rudimentary besides other features including lack of other secondary sexual characters

MCQ

The following questions consist of two statements – Assertion (A) and Reason (R). Answer these questions selecting the appropriate option given below:

A. Both A and R are true and R is the correct explanation of A

B. Both A and R are true and R is not the correct explanation of A

C. A is true but R is false

D. A is False but R is true

1. Assertion: Sickle cell anaemia occurs due to a point mutation.
   Reason: The mRNA produced from the HbS gene has GUG instead of GAG.
   Ans. A
2. Assertion: The possibility of a human male becoming haemophilic is extremely rare.
   Reason: Mother of such a male should be normal and the fathers should be haemophilic.
   Ans. D
3. Assertion: In dog flowers F1 plants produce pink flowers.
   Reason: It is due to the codominance of flower colour alleles with both genes expressing themselves equally.
   Ans. C
4. Assertion: XO type of sex determination is found in large number of insects.

Reason; 50 % of sperms contain X chromosome and the other 50% contain “O” chromosome.

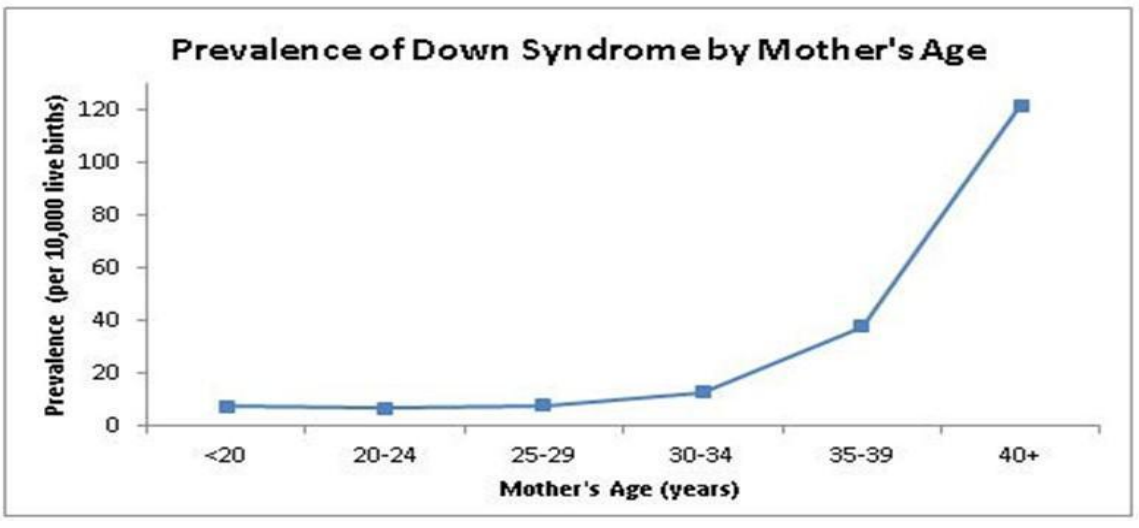
Ans. C

5. Assertion: A test cross is used to determine the phenotype of an organism.
   Reason: F2 generation of a monohybrid test cross produces one or two phenotypes depending upon the genotype of the unknown organism.
   Ans. D
6. Assertion: Mendel used true-breeding pea lines for artificial pollination experiments for his genetic studies.
   Reason: For several generations, a true-breeding line shows the stable trait inheritance and expression.
   Ans. A
7. Assertion: Cross of F1 individual with recessive homozygous parent is test cross.
   Reason: No recessive individual is obtained in the monohybrid test cross progeny.
   Ans. C
8. Assertion: In monohybrid cross, at F2 stage, both parental traits are expressed in 3 : 1 proportion.
   Reason: At F2 stage, the contrasting parental traits show blending.
   Ans. C
9. Assertion: Gametes receive only one allele of a gene.
   Reason: During gamete formation, mitosis takes place leads to formation of haploid cells.
   Ans. C
10. Assertion: A good example of multiple alleles is the ABO blood group system.
    Reason: When I^A and I^B are present together in the ABO blood group system, they both express their own types.
    Ans. B

1. Nondisjunction is the failure of homologous chromosomes to disjoin correctly during meiosis. It leads to the formation of a new cell with an abnormal amount of genetic material. A number of clinical conditions are the result of this type of chromosomal mutation. This results in the production of gametes containing a greater or lesser chromosomal amount than normal ones. Consequently, the individual may develop a trisomy or monosomy syndrome. Nondisjunction can occur in both Meiosis I and Meiosis II of the cellular division. Non disjunction can occur in both Meiosis I and Meiosis II of the cellular division. It is also the main cause of many genetic disorders; however, its origin and process remain vague. Although it results in the majority of cases

from errors in the maternal meiosis II, both paternal and maternal meiosis I do influence it. The maternal age is considered a risk factor of trisomy's, as well as recombination alterations and many others that can affect the chromosomal segregation.

1. Which of the following conclusions can be true regarding aneuploidy?
   i. It is the presence of an extra chromosome in a diploid cell.
   ii. An aneuploid cell differs from other cells only in size.
   iii. There can be less number of chromosomes in a diploid cell.
   iv. Aneuploidy always affects female individuals.
      a. i only
      b. both i and iii
      c. both ii and iii
      d. i, iii and iv.
2. Considering the different phases of meiosis, select the correct statements from the following.
   i. Errors in meiosis I is the only cause of aneuploidy
   ii. Aneuploidy always affects sex chromosomes.
   iii. Most of the aneuploidy results from errors in cell division involved in egg formation.
   iv. Nondisjunction in meiosis I can lead to more abnormal cells than disjunction in meiosis II.
      a. i only
      b. both i and iii
      c. both iii and iv
      d. i, iii and iv.
3. By interpreting the graph of Down syndrome frequency and mothers age, select the best conclusion (s) from the following options.



i. Aneuploidy is not influenced by mother's age.

ii. Delivery before 30 years of age can decrease the incidence of aneuploidy in most cases

iii. The chance of aneuploidy increases up to 22 years of age.

iv. There is a dramatic increase in aneuploidy if maternal age exceeds 30

a. i only

b. both i and iii

c. both ii and iv

d. i, iii and iv.

4. The type of genetic disorders mainly caused by chromosomal nondisjunction is

a. Chromosomal disorders

b. Mendelian disorders

c. Incomplete dominance

d. All the above

5. Assertion: All types of genetic disorders are caused by chromosomal nondisjunction Reason: Chromosomal nondisjunction always affects female individuals.

a. Both assertion and reason are correct and reason is the correct explanation of assertion

b. Both assertion and reason are correct but reason is not the correct explanation of assertion

c. Assertion is correct but reason is incorrect

d. Both Assertion and reason are incorrect.

ANSWERS

1	B
2	C
3	C
4	A
5	D

4. The word parthenogenesis originates from the Greek language meaning virgin birth. In honeybees, the drones are entirely derived from the queen, their mother. Parthenogenesis is a form of reproduction where the unfertilized egg will develop into a DRONE BEE while fertilized eggs will hatch into the WORKER BEES. This type of reproduction occurs in various species in nature. Fertilized eggs will develop into QUEEN BEES or WORKER BEES. It will depend on the size and type of the cells and

on the composition of food fed by WORKER BEES to BEE LARVAE. The DRONE BEES are always born from unfertilized eggs. Drones produce sperm cells that contain their entire genome, so the sperm are all genetically identical except for mutations. The male bees' genetic makeup is therefore entirely derived from the mother, while the genetic makeup of the female worker bees is half derived from the mother, and half from the father. The QUEEN BEES mate with numerous DRONE BEES high in the air. This polyandry and the phenomenon of parthenogenesis in honey bees create a super-organism in the beehive populations. The WORKER BEES who share the same father and mother are called SUPER SISTERS because they are more closely related to each other than their sisters who have different fathers.

i. Identify the members of a bee colony which possess the same chromosome number.

   a. Drone and Queen

   b. Drone and Worker

   c. Queen and Worker

   d. Both a and c.

ii. The cell division involved in the formation of egg and sperm in honey bees respectively

   a. Mitosis and meiosis

   b. Mitosis only

   c. Meiosis and mitosis

   d. Meiosis only.

iii. In a honey bee colony, the queen is different from workers in

   a. Chromosome number

   b. The way of production in sexual or asexual method

   c. The type of gametes involved in production

   d. The type of food given in the larval stage.

iv. Some of the members in a honey bee colony have no father but have grandfather, they are

   a. Workers

   b. Drones

   c. Queen

   d. Both drones and workers.

v. What can be the advantage of parthenogenesis for species survival?

a. It leads to much variation in offspring

b. It helps isolated female individuals to reproduce.

c. It helps to evolve clones

d. It conserves the same chromosome number in generations.

ANSWERS

i	c
ii	c
iii	d
iv	b
v	b

5. In 1911, while studying the chromosome theory of heredity, biologist Thomas Hunt Morgan had a major breakthrough. Morgan occasionally noticed that "linked" traits would separate. Meanwhile, other traits on the same chromosome showed little detectable linkage. Morgan considered the evidence and proposed that a process of crossing over, or recombination, might explain his results. Specifically, he proposed that the two paired chromosomes could "cross over" to exchange information. When proposing the idea of crossing over, Morgan also hypothesized that the frequency of recombination was related to the distance between the genes on a chromosome, and that the interchange of genetic information broke the linkage between genes. Morgan imagined that genes on chromosomes were similar to pearls on a string; in other words, they were physical objects. The closer two genes were to one another on a chromosome, the greater their chance of being inherited together. In contrast, genes located farther away from one another on the same chromosome were more likely to be separated during recombination. Therefore, Morgan correctly proposed that the strength of linkage between two genes depends upon the distance between the genes on the chromosome. This proposition became the basis for construction of the earliest maps of the human genome

i. The traits which are found tightly linked in Morgan’s experiments were

a. Body colour and wing size

b. Eye colour and wing size

c. Body colour and eye colour

d. Body size and wing size.

ii. Which of the following conditions favours linkage?

a. Genes are on the same chromosome and are closely placed.

b. Genes on different chromosomes and distantly placed.

c. Genes on the same chromosome but distantly placed

d. Genes present on different autosomes.

iii. How does the concept of linkage help in gene mapping?

a. Distance between the linked genes can be measured by frequency of recombination.

b. Linked genes express the characters easily than non-linked genes

c. Linked genes are larger in size

d. Position of linked genes can be observed in ultra-microscopy.

iv. The linked genes behave differently in the way that

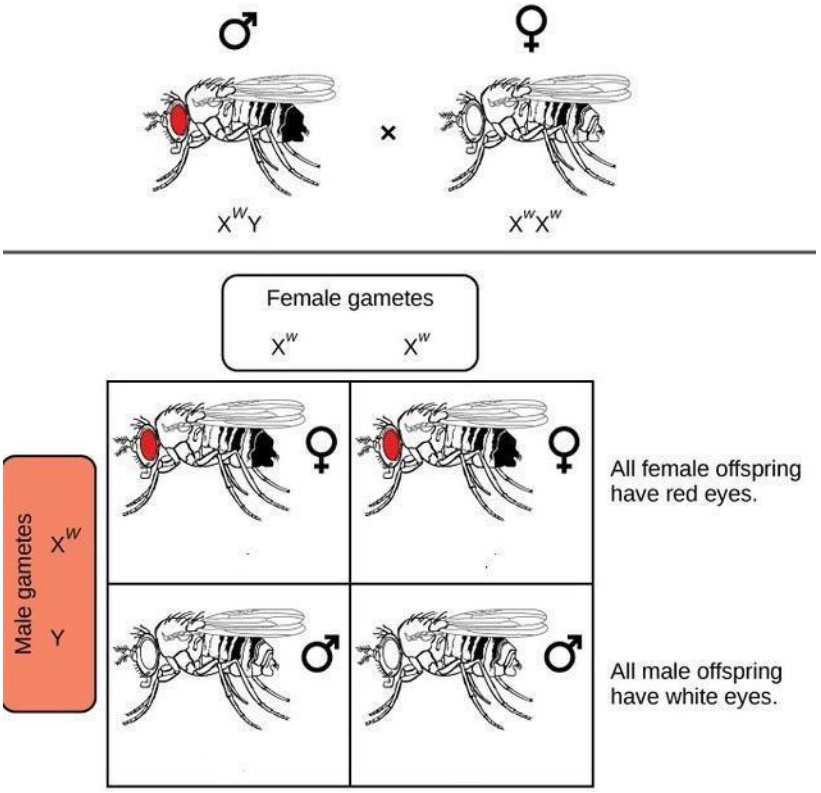
a. Linked genes assort easily and enter different gametes

b. Linked genes don't segregate easily and inherit as a unit

c. Linked genes lead to high crossover and recombination

d. Linked genes segregate only at the time of cell division

v. In Morgan's experimental crosses, the white eyed flies were all males. The



clue that it gives

a. White eye colour is X-linked dominant trait

b. White eye colour is Y linked dominant trait

c. White eye colour is X-linked recessive trait

d. White eye color is a Y- linked dominant trait.

ANSWERS

i	c
ii	a
iii	a
iv	b
v	c

1. Which law of Mendel has universally accepted?
   a) Law of dominance
   b) Law of segregation
   c) Law of independent assortment
   d) None of these

   Ans: b. Law of segregation

2. In his classic experiments on pea plants, Mendel did not use
   a) seed shape
   b) flower position
   c) seed colour
   d) Pod length.

3. Ans: d.Pod length.According to Mendelism, which character shows dominance?

   a) Terminal position of flower

   b) Green pod colour

   c) Green colour in seed coat

   d) Wrinkled seeds

   Ans: b.Green pod colour

4. In hybridisation, Tt × tt gives rise to the progeny of ratio
   a) 2 : 1
   b) 1 : 2 : 1

   c) 1 : 1

   d) 1 : 2.

Ans: c.1 : 1

5. An allele is dominant if it is expressed in
   a) both homozygous and heterozygous states
   b) second generation
   c) heterozygous combination only
   d) homozygous combination only

Ans: a. both homozygous and heterozygous states

6. In a cross Bb X Bb, the percent of offspring with the same genotype as parents is
   a) 20 %
   b) 25 %
   c) 30 %
   d) 50 %

Ans: d. 50 %

7. In garden pea plants, round seeds are dominant over wrinkles. If a heterozygous round seeded plant is crossed with a wrinkled seeded plant, then the ratio of both round and wrinkled plants appeared in the F1 progeny
   a) 50: 50
   b) 25:75
   c) 25:50:25
   d) 3:1

Ans: a. 50: 50

8. Which one of the following does not account for the Mendelian conclusion?
   a) Dominance
   b) Purity of gametes
   c) Linkage
   d) Independent assortment

Ans: c. Linkage

9. Which of the following crosses will give tall and dwarf pea plants in the same proportion?
   a) TT x tt
   b) Tt x tt
   c) TT x Tt
   d) tt x tt

Ans: b. Tt x tt

10. A true breeding line is one, that:-

a) Having crossed with superior quality.
b) Only superior quality.
c) The best out of inferior quality.
d) Having undergone continuous self-pollination.

Ans: d. Having undergone continuous self-pollination.

11. Based on the monohybrid cross, Gregor Mendel formulated
    a) Law of dominance
    b) Law of independent assortment
    c) Law of segregation
    d) Both a and c

    Ans: d. Both a and c

12. The percentage of Gr type gametes produced by a parent with the genotype GgRr will be
    a) 50
    b) 25
    c) 75
    d) 100

    Ans: b. 25

13. Which of the following is / are recessive traits selected by Mendel in Pisum sativum?

    i. Terminal flower

    ii. Inflated Pod

    iii. Wrinkled seed

    iv. Yellow seed

    a. i only

    b. i and iii

    c. iii and iv

    d. i and ii

    Ans: b. i and iii

14. Which of the following pairs is wrongly matched?

    a. Starch synthesis in Pea plant: Multiple alleles

    b. AB Blood group: Co-dominance

    c. Flower colour in snapdragon: Incomplete Dominance

d. T. H. Morgan : Linkage

Ans: a. Starch synthesis in Pea plant: Multiple alleles

15. In which way is incomplete dominance different from Mendelian pattern?

a) It never obeys law of segregation
b) It shows typical Mendelian inheritance
c) It shows same phenotype in F1 and F2
d) Phenotypic and genotypic ratios in F2 are the same.

Ans: d. Phenotypic and genotypic ratios in F2 are the same

16. Who rediscovered the mendel's work:-

a. Correns
b. Hugo de Vries
c. Tschermak
d. All of the above

Ans:d. All of the above

17. Pleiotropy , can be defined as:-

a. When one gene controls one trait
b. When one gene exhibits multiple traits
c. When multiple genes control one trait
d. When multiple genes control multiple traits.

Ans: b. When one gene exhibits multiple traits

18. In a monohybrid cross involving incomplete dominance, the phenotypic ratio equals the genotypic ratio in F2 generation. The ratio is

a. 3:1

b. 1:2:1

c. 1:1:1:1

d. 2:3

Ans: b. 1:2:1

19. A pea plant parent having violet colour flowers with unknown genotype was crossed with a plant having white colour flowers, in the progeny 50% flowers were violet and 50% were white. The genotypic constitution of the parent having violet colour flower was-

a. Homozygous
b. Merozygous
c. Heterozygous

d. Hemizygous

Ans: c.Heterozygous

20. Identify the wrong statement with reference to the gene 'I' that controls ABO blood groups.

a. The gene (I) has three alleles.
b. A person will have only two of the three alleles.
c. When I^A and I^B are present together, they express the same type of sugar
d. Allele i does not produce any sugar

Ans: c. When IA and IB are present together, they express the same type of sugar.

21. The genotypes of a husband and wife are I^A I^B and I^A i. Among the blood types of their children, how many different genotypes and phenotypes are possible?

a. 3 genotypes; 4 phenotypes
b. 4 genotypes; 3 phenotypes
c. 4 genotypes; 4 phenotypes
d. 3 genotypes; 3 phenotypes

Ans: b. 4 genotypes; 3 phenotypes22.

22. Which idea is depicted by a cross in which the F1 generation resembles both the parents?

a. Inheritance of one gene
b. Co-dominance
c. Incomplete dominance
d. Complete dominance

Ans: b. Co-dominance

23. Allele A is dominant over allele a. What will be the genotype of the offspring obtained from the mating Aa X aa?

a. AA and aa
b. Aa and aa
c. AA and Aa
d. All Aa

Ans: b. Aa and aa

14. In a Mendelian cross, F2 generation showed that both genotypic and phenotypic ratios are the same as 1: 2: 1. It represents a case of

a. Co-dominance

b. Dihybrid cross
c. Monohybrid cross with complete dominance
d. Monohybrid cross with incomplete dominance.

Ans:d. Monohybrid cross with incomplete dominance.

15. A man with blood group ‘A’ marries a woman with blood group ‘B’. What are all the possible blood groups of their offspring?

a. A, B, AB and O
b. O only
c. A and B only
d. A, B and AB only

Ans: a.A, B, AB and O

16. Common test to find the genotype of a hybrid is by
a. crossing of one F2 progeny with female parent
b. Crossing of one F2 progeny with male parent
c. Crossing of F1 progeny with a homozygous dominant parent.
d. Crossing of F1 progeny with homozygous recessive parent.

Ans: d.Crossing of F1 progeny with homozygous recessive parent.

17. When two alleles of a character express together, it is called
a. Codominance
b. Dominance
c. Incomplete dominance
d. Pseudo dominance.

Ans: a.Co-dominance

18. A child’s blood group is ‘O’. The parent’s blood groups cannot be
a. A and B
b. A and A
c. AB and O
d. B and O.

Ans: c.AB and O

19. A child of an O-group has a B-group father. The genotype of father will be
a. I^iI^i
b. $I^B I^B$

c. $I^A I^B$

d. $I^B I^i$

Ans: $I^B I^i$

20. What can be the blood group of offspring when both parents have AB blood group?

a. AB only

b. A,B and AB

c. A,B,AB and O

d. A and B only

Ans: b.A, B and AB

21. If the children of a husband and wife represent the four types of blood group, what would be the genotypes of the parents concerned with the blood group?

a	**$I^A I^A$ and $I^B I^B$**
b	**$I^A i$ and $I^B I^B$**
c	**$I^A I^A$ and $I^B i$**
d	**$I^A i$ and $I^B i$**

a. Option a

b. Option b

c. Option c

d. Option d

Ans: d.Option d

22. How many types of gametes can be produced by a diploid organism who is heterozygous for 4 loci?

a. 4

b. 8

c. 16

d. 32

Ans:c. 16

23. What type of allelic inheritance do you find in the blood group of humans?

a. Incomplete dominance

b. Codominance

c. Multiple allelism
d. Both b and C

Ans: d.Both b and C

24. For finding the possible gametes from a typical Mendelian garden pea plant, one has to cross the suspected plant, having the genotype AaBb, to another plant with the genotype.

a. AABB

b. Aabb
c. aaBb
d. Aabb

Ans: b. aabb

25. Inheritance of skin colour in humans is an example of

a. Point mutation
b. Polygenic inheritance
c. Codominance
d. Chromosomal aberration.

Ans: b. Polygenic inheritance

26. In humans, ABO blood group is determined by three alleles. When a man with A blood group marries a woman with B blood group, 50 % of their children were with A blood group and the remaining 50 % with AB blood group. The possible genotypes of the parents are:

a. I^B I^B and I^A i
b. I^B i and I^A I^A
c. I^A i and I^B i
d. I^A I^A and I^A I^B

Ans: I^A I^A and I^A I^B

27. In a cross between a pure tall pea plant with yellow seed and a pure short plant with green seeds out of 16, what proportion is expected to be dwarf yellow in the second filial generation?

a. 9/16
b. 3/16
c. 2/16
d. 1/16

Ans: b.3

28. ABO blood groups in humans are controlled by the gene 'I'. It has three alleles – I^A, I^B and i. Since there are three different alleles, six different genotypes are possible. How many phenotypes can occur?
    a. Three
    b. One
    c. Four
    d. Two

    Ans: c.Four

29. How many different kinds of gametes will be produced by a plant having the genotype AABbCC?
    a. Two
    b. Three
    c. Four
    d. Nine

    Ans: a.Two

30. In Pisum sativum, violet flower colour (W) is dominant over white (w) and tallness (T) is dominant to dwarfness (t). A cross between two parents produces 4 types of offspring in equal proportion. What will be the genotypes of the parents?
    a. Rrtt and RRTT
    b. RrTt and rrtt
    c. RrTT and rrtt

RRTT and rrtt

    Ans: b.RrTt and rrtt

31. The possibility of full dominant and recessive offsprings in the F2 generation of dihybrid cross involving two true breeding parents is
    a. $2/16^{th}$ each
    b. $1/16^{th}$ each
    c. $3/16^{th}$ each
    d. $3/4^{th}$ each

    Ans: b.$1/16^{th}$ each

32. In a certain plant, two genes leaf shape and fruit colour. A leaf with smooth margin (R) is dominant to a leaf with incised margin (r), the green colour of fruit (G) is dominant over white colour of fruit (g). A true breeding plant with smooth leaf margin and green colour fruit is crossed with another plant with incised leaf margin

and white fruit. What will be the genotypes of the plants involved in this cross?

a. RRGg X RrG
b. RRGG X rrgg
c. RRGG X rrGg
d. RrGg X rrgg

Ans: b.RRGG X rrgg

33. Which of the following statements is true when a cross between RrYy x RRYY is made?

a. All the offspring are recessive
b. Dominant and recessive is in 9: 7 ratios
c. Dominant and recessive in 1:1 ratio
d. All offspring are dominant.

Ans: d.All the offspring are dominant.

34. Which of the following is/ are not relevant to linkage?

a. Linkage reduces the possibility of producing variability in offspring.
b. Linkage reduces the chance of production of non-parental combinations.
c. Linked genes do not show independent assortment.
d. The main cause of genetic variation in organisms is linkage.

Ans: d.The main cause of genetic variation in organisms is linkage.

35. Two genes very close on a chromosome will show-

a. More recombination
b. High crossing over
c. Less recombination
d. Only double crossing over

Ans: c. Less Recombination

36. The frequency of recombination between genes present on the same chromosome as a measure of the distance between genes was explained by

a. Sutton Boveri
b. T.H. Morgan
c. Gregor J Mendel
d. Alfred Sturtevant.

Ans: d.Alfred Sturtevant.

37. The tendency of genes located on the same chromosome to inherit together is known a

a. Mutation
b. Nondisjunction
c. Linkage
d. Crossing over.

Ans:c.Linkage

38. The characters which are identified by T H Morgan in drosophila as linked are

a. Yellow body and broad wing
b. White eye and broad wing
c. Brown body and broad wing
d. Yellow body and white eyes.

Ans: d. Yellow body and white eyes.

39. Choose the correct statement (s) only

a. Linkage is a common phenomenon seen in recombination
b. Genetic map can be used for the identification of genetic disorders and sex
c. Linked genes are situated in non-homologous chromosomes.
d. Complete linkage results in more parental progeny than recombinants.

Ans: d.Complete linkage results in more parental progeny than recombinants.

40. In a complete linkage phenomenon, the possible phenotypic ratio in the F2 generation of a dihybrid cross is

a. 7:1:1:7

b. 4:4:4:4

c. 1:7:7:1

d. 1:1:1:1

Ans: a.7:1:1:7

41. The distance between the genes is generally measured by

a. Angstrom
b. map unit
c. Dobson unit
d. Millimeter

Ans: b.map unit

42. Which one of the following conditions correctly describes the manner of determining the sex?

a. Homozygous sex chromosomes (ZZ) determine female sex in birds.
b. XO type of sex chromosomes determines male sex in grasshopper.
c. XO condition in humans as found in Turner's syndrome, determines female sex.
d. Homozygous sex chromosomes (XX) produce male in Drosophila.

Ans: b.XO type of sex chromosomes determines male sex in grasshopper.

43. The X body of Henking was observed in

a. 100 % sperms during spermatogenesis
b. 100 % eggs during oogenesis
c. 50 % sperms during spermatogenesis
d. 50 % eggs during oogenesis.

Ans: c. 50 % sperms during spermatogenesis

44. Which of the following pair (s) is /are correct?

i. Henking – X body detection
ii. Sturtevant – Genetic map
iii. Hb^A Hb^S – Carrier person
iv. T.H Morgan – Mutation in Drosophila

a. i only
b. i and iii
c. i, ii, iii and iv
d. ii and iii.

Ans: c.i, ii, iii and iv

45. In most of the birds, reptiles and fishes

a. Males are homogametic
b. Males are heterogametic
c. Females are heterogametic
d. Both a and C

Ans: a.Males are homogametic

46. Number of autosomes present in skin cell of a human male is

a. 22 autosomes
b. 22 pairs
c. 23 autosomes
d. 23 pairs

Ans: b. 22 pairs

47. In a certain species of insects some have17 chromosomes and the others have 18 chromosomes. The 17 and 18 chromosome-bearing organisms are

a. males and females respectively
b. females and males respectively
c. all males
d. all females

Ans: a.males and females respectively

48. Sex of the child in human beings is determined by chromosomes of father

a. Chromosomes in egg
b. Chromosomes of both the parents
c. Chromosomes of mother

Ans: a.chromosomes of father

49. Which of the following groups possess Homogametic male?

a. Birds
b. Grasshopper
c. Man
d. Drosophila

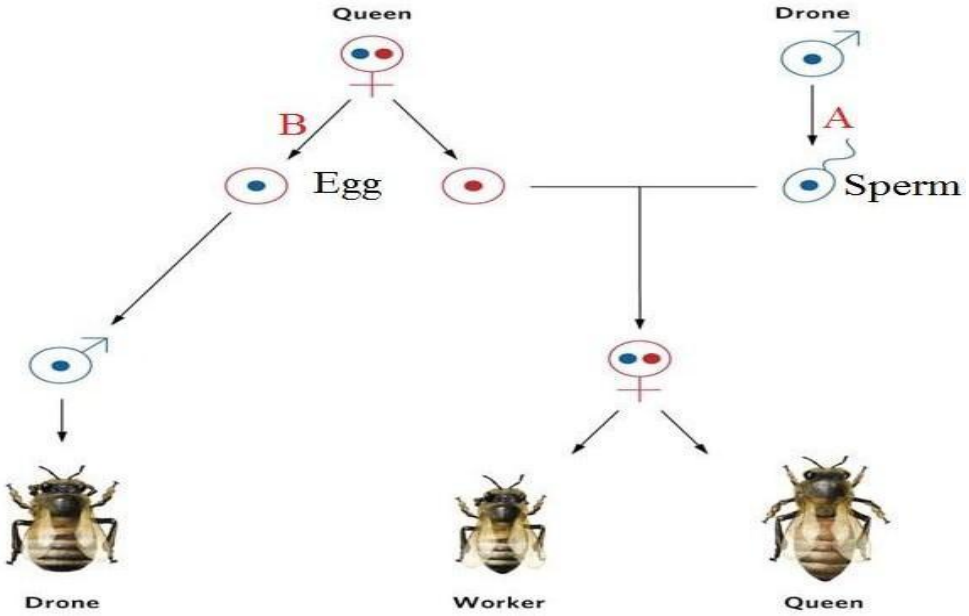
Ans: a.Birds

50. In Drosophila, the sex is determined by

a. the ratio of number of X-chromosome to the sets of autosomes
b. X and Y chromosomes
c. the ratio of pairs of X-chromosomes to the pairs of autosomes
d. Whether the egg is fertilized or develops parthenogenetically.

Ans: b. X and Y chromosomes

51. In the following figure, the type of cell division represented by ‘A’ and the chromosome of the drone respectively



a. Mitosis, 32 chromosomes

b. Meiosis, 32 chromosomes

c. Mitosis, 16 chromosomes

d. Meiosis, 16 chromosomes.

Ans: c.Mitosis, 16 chromosomes

52. Male heterogametic condition is found in: -

a. Human being

b. Drosophila

c. Both A & B

d. Birds

Ans: c.Both A & B

53. Match the items in column I with column II and choose the correct option.

COLUMN I		COLUMN II	
a	Down Syndrome	1	22AA + XXY
b	Turner's Syndrome	2	Trisomy 21
c	Klinfelter's Syndrome	3	Royal disease
d	Haemophilia	4	22AA + X

a. a-2, b-1, c-3, d-4

b. a-1, b-3, c-4, d-2

c. a-4, b-1, c-3, d-2

d. a-2, b-4, c-1, d-3

Ans: d.a-2, b-4, c-1, d-3

54. The disorder is caused due to the absence of one X-chromosome i. e. 45 with XO such females are sterile. Identify the syndrome

a. Turner's syndrome
b. Down's syndrome
c. Klinefelter's syndrome
d. Edward syndrome

Ans: Turner's syndrome

56. The Royal disease is

a. Colour Blindness
b. Haemophilia
c. Phenyl pyruvic idiocy
d. Sickle cell anaemia

Ans: b.Haemophilia

57. Name the inborn error of metabolism that is inherited as an Autosomal recessive trait, the disease is characterized by the absence of phenylalanine hydroxylase in affected individual

a. Thalassemia
b. Phenylketonuria
c. Sickle cell anemia
d. Colour blindness.

Ans: b. Phenylketonuria

58. Which of the following Amino acid substitution is responsible for causing Sickle cell anemia?

a. Valine is substituted by Glutamic acid in the alpha globin chain at the sixth position
b. Valine is substituted by Glutamic acid in the Beta-globin chain at the seventh position
c. Glutamic acid is substituted by valine in the alpha chain at the sixth position
d. Glutamic acid is substituted by Valine in the Beta-chain at the sixth position

Ans: d. Glutamic acid is substituted by Valine in the Beta-chain at the sixth position

59. Which of the following diseases belong to autosomal recessive disorder-?

a. Colour blindness
b. Haemophilia
c. Cystic fibrosis
d. All of the above

Ans: c.Cystic fibrosis

60. Which one of the following is a correct statement?

a. Recessive trait can only be expressed in the homozygous condition
b. Recessive trait can always be expressed in the heterozygous condition
c. Dominant trait is expressed only in the homozygous condition
d. Dominant traits cannot be expressed in the heterozygous condition.

Ans: a.Recessive trait can only be expressed in the homozygous condition

61. What is the genetic disorder in which an individual has an overall masculine development, gynecomastia and is sterile?

a. Down's syndrome

b. Turner's syndrome

c. Klinefelter's syndrome

d. Edward syndrome

Ans: c.Klinefelter's syndrome

62. Which of the following is not related to the genetic disease, haemophilia?

a. Sex linked recessive disease

b. Y-linked character

Transmitted from father to grandson through his daughter

a. Common in men but rare in women.

Ans: b.Y-linked character

63. Thalassemia and sickle cell anaemia are caused due to a problem in globin molecule synthesis. Select the correct statement.

a. Both are due to a quantitative defect in globin chain synthesis.

b. Thalassemia is due to less synthesis of globin molecules

c. Sickle cell anaemia is due to a quantitative problem of globin molecules.

d. Both are due to a qualitative defect in globin chain synthesis.

Ans: b.Thalassemia is due to less synthesis of globin molecules.

If a colour-blind man marries a woman who is homozygous for normal colour vision, the probability of their son being colour-blind is

a. 0
b. 0.5
c. 0.75
d. 1

Ans: a.0

55. The most striking example of point mutation is found in a disease called

a. Down's syndrome
b. Sickle cell anaemia
c. Thalassaemia
d. Night blindness.

Ans: b.Sickle cell anaemia

56. Which of the following most appropriately describes haemophilia?

a. Chromosomal disorder
b. Dominant genetic disorder
c. Recessive genetic disorder
d. X-linked recessive genetic disorder

Ans: d.X-linked recessive genetic disorder

57. If a colour blind woman marries a normal visioned man, their sons will be

a. all colour blind
b. all with normal vision
c. one-half colour blind and one-half with normal vision
d. three-fourths colour blind and one-fourth with normal vision.

Ans: a.all colour blind

58. A woman with 47 chromosomes due to three copies of chromosome 21 is characterised by

a. Super femaleness
b. Triploidy
c. Turner's syndrome
d. Down's syndrome.
e. Ans: d.Down's syndrome.

59. Haemophilia is more commonly seen in human males than in human females because

a. a greater proportion of girls die in infancy
b. the disease is due to a Y-linked recessive mutation
c. the disease is due to an X-linked recessive mutation
d. The disease is due to an X-linked dominant mutation.

Ans: c.the disease is due to an X-linked recessive mutation

60. Sickle-cell anaemia is

a. caused by substitution of valine by glutamic acid in the beta globin chain of haemoglobin
b. caused by a change in a single base pair of DNA
c. characterized by elongated sickle like RBCs with a nucleus
d. an autosomal linked dominant trait.

Ans: b.caused by a change in a single base pair of DNA

61. Down's syndrome is due to

a. crossing over
b. Linkage
c. sex-linked inheritance
d. Non-disjunction of chromosomes.

Ans: d. Non-disjunction of chromosomes.

62. In human beings 45 chromosomes/single X/XO abnormality causes

a. Down's syndrome
b. Klinefelter's syndrome
c. Thalassemia
d. Turner's syndrome

Ans: d.Turner's syndrome

63. β- thalassemia in human is controlled by

a. HBA2 gene on chromosome 16
b. HBB gene on chromosome 11
c. HBA1 gene on chromosome 15
d. HBA1 and HBA2 gene on chromosome 8

Ans: HBB gene on chromosome 11

63. A haemophilic man marries a normal woman. What is the probability that their son will be haemophilic?

a. No chance

b. 100 % Chance

c. 50 % Chance

d. 25 % Chance

Ans: a.No chance

64. Which of the following is a sex- linked disorder?

a. Sickle cell anaemia

b. Phenylketonuria

c. Turner's syndrome

d. Colour blindness.

Ans: d.Colour blindness.

65. Woman has an X-linked condition on one of her X chromosomes. This chromosome can be inherited by

a. only daughters

b. only sons

c. only grandchildren

d. both sons and daughters.

Ans: d.both sons and daughters.

66. A normal-vision man whose father was colour blind marries a woman who had a colour blind mother and normal father. What percentage of male children of this couple will be colour blind?

a. 25 %

b. 0 %

c. 75 %

d. 50 %

Ans: a.25 %

67. In Down's syndrome of a male child, the sex complement is

a. XO

b. XY

c. XX

d. XXY.

Ans: b. XY

68. Find the wrongly matched pair

a. Sickle cell anaemia – Abnormal haemoglobin in RBCs
b. Phenylketonuria – Defective form of blood clotting factors
c. Turner's Syndrome – Absence of one X chromosome.
d. Aneuploidy – Gain or loss of chromosome (s) from the usual chromosome complement number.

Ans: b. Phenylketonuria – Defective form of blood clotting factors

69. If a genetic disease is transferred from a phenotypically normal but carrier female to only some of the male progeny the disease is

a. Autosomal dominant
b. Autosomal recessive
c. Sex-linked dominant
d. Sex-linked recessive

Ans: d. Sex-linked recessive

70. A female child inherited a particular genetic trait from his normal father and mother. The trait can be

a. Sickle cell anaemia
b. Muscular dystrophy
c. Haemophilia
d. Colour blindness

Ans: a.Sickle cell anaemia

71. In genetics, trisomy means

a. Presence of 3 sets of chromosomes.
b. Presence of an extra chromosome in a diploid cell
c. Lack of a single chromosome out of a diploid nucleus.
d. Lack of 3 chromosomes in a diploid nucleus.

Ans: b.Presence of an extra chromosome in a diploid cell

72. In sickle cell anemia glutamic acid is replaced by valine. Which one of the following triplet codes is for valine?

a. GGG
b. AAG
c. GUG
d. GCA

Ans: c. GUG

73. If a normal man marries a woman whose father was haemophilic, then the possibility of haemophilic children being born to the couple at a time is

a. 50 %

b. 25 %

c. 100 %

d. 75 %

Ans: b. 25 %

74. In Sickle cell anaemia, at which position of beta chain, the amino acid gets changed: -

a. Fourth position
b. Fifth position
c. Sixth position
d. Seventh position

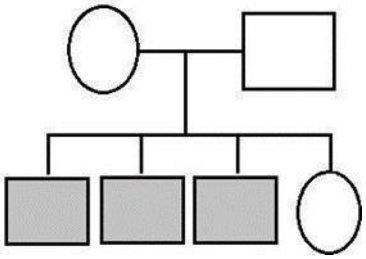
Ans: c. Sixth position

75. Which one of the following symbols and its representation, used in human pedigree analysis is correct?

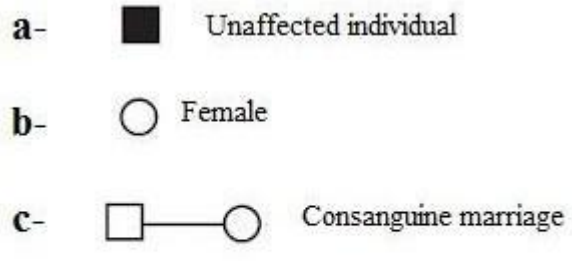
a. Unaffected individual
b. Female
c. Consanguine marriage
d. Mating

Ans: b. Female

76. In the given pedigree, which of the following seems to be the most appropriate mode of inheritance?



a. Simple Mendelian recessive trait.
b. Codominance
c. X linked recessive
d. Y linked



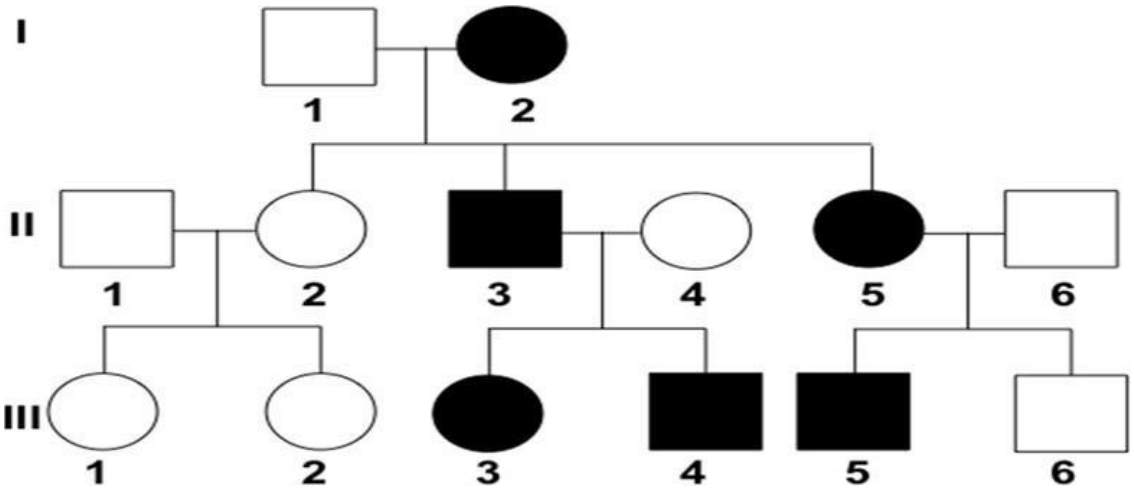
Ans: c. X linked recessive

77. In the following human pedigree chart of haemophilia, the filled symbols represent the affected individuals. Identify the genotype of the male and female parents respectively

a. XX and X^hY
b. XX^h and X^hY
c. X^hX^h and XY
d. X^hX^h and X^hY

Ans: b.XXh and XhY

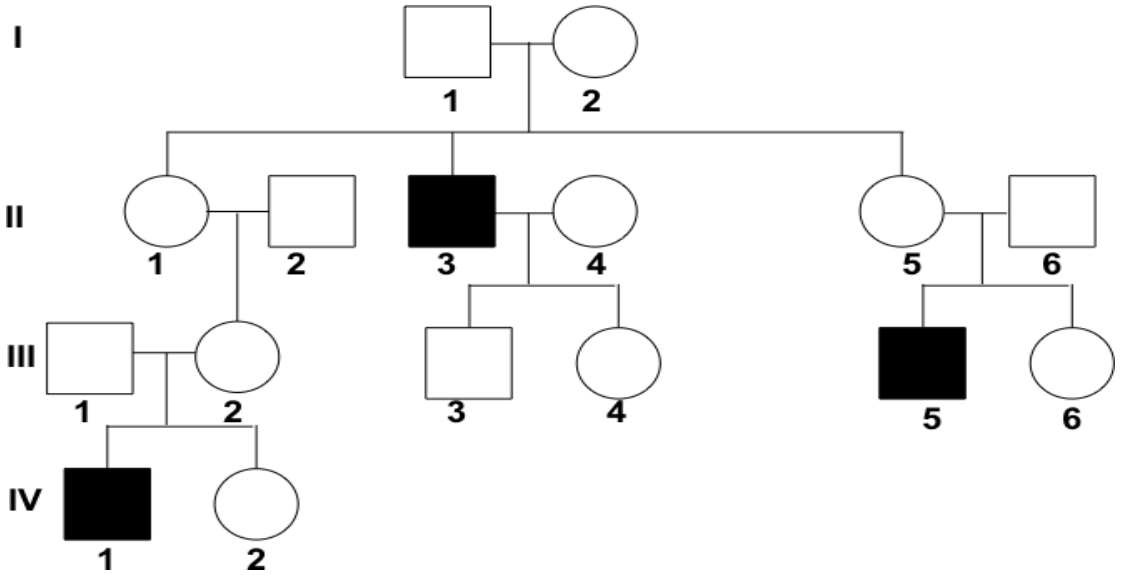
78. Given below is the pedigree chart of a family in which the black shades represent an autosomal dominant trait. What will be the genotypes of mother and father?



a. Mother Aa and father aa
b. Mother AA and father aa
c. Mother aa and father Aa
d. Mother aa and father AA

Ans: a.Mother Aa and father aa

79. The given pedigree chart shows the inheritance of sickle cell anaemia in a family. What can be the probable genotypes of member 5 in generation II and member 6 in generation III respectively?



a. Hb^AHb^A and Hb^AHb^A

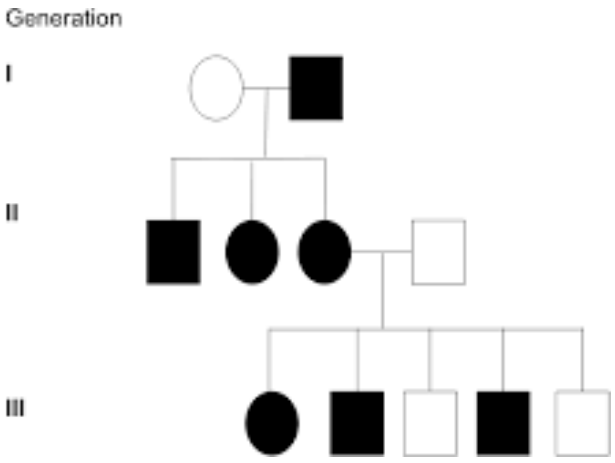
b. Hb^AHb^A / Hb^AHb^S and Hb^AHb^A

c. Hb^AHb^S and Hb^SHb^S

d. Hb^AHb^S and Hb^AHb^A / Hb^AHb^S

Ans: Hb^AHb^S and Hb^AHb^A / Hb^AHb^S

80. Inheritance of muscular dystrophy is represented in the given pedigree chart. Identify the genotype of the parents of offspring in the third generation.



a. Mother MM and father Mm
b. Mother Mm and father Mm
c. Mother Mm and father mm
d. Mother mm and father mm

Ans: c.Mother Mm and father mm

MOLECULAR BASIS OF INHERITANCE

SUMMARY

THE DNA: DNA is a long polymer of deoxyribonucleotides.

- The length of the DNA depends on, number of nucleotide pairs present in it.
- Characteristics of the organism depend on the length of the DNA.
- Bacteriophage ø174 has 5386 nucleotides.
- Bacteriophage lambda has 48502 base pairs
- Escherichia coli have 4.6 X 106 base pairs.
- •Human genome (haploid) is 3.3 X 109 bp

Structure of polynucleotide chain:

- A nucleotide has three component:-
  - A nitrogen base
  - A pentose sugar (ribose in RNA and deoxyribose in DNA)
  - A phosphoric acid.
- There are two types of nitrogen bases:
  - Purines (Adenine and Guanine)
  - Pyrimidines (Cytosine, Uracil and Thymine)
- Adenine, Guanine and Cytosine are common in RNA and DNA.
- Uracil is present in RNA and Thymine is present in DNA in place of Uracil.
- Pentose sugar is ribose in RNA and Deoxyribose in DNA.
- A nitrogen base attached to the pentose sugar at C1 of pentose sugar by
- Phosphoric acid attached to the 5’ OH of a nucleoside by Phosphodiester linkage a corresponding nucleotide is formed. (Ribonucleotide or deoxyribonucleotides depending on the sugar unit).
- Two nucleotides are joined by 3’-5’ Phosphodiester linkage to form dinucleotide.
- More than two nucleotides joined to form a polynucleotide chain.
- Polynucleotide chain has a free phosphate moiety at 5’ end of sugar, which is referred to as 5’ end.
- In the other end of the polymer with 3’-OH group called 3’ end.
- The backbone of the polynucleotide chain is sugar and phosphate.
- Nitrogen bases linked to the sugar moiety project from the backbone.
- In RNA every nucleotide has an additional –OH group at 2’ of ribose.
- In RNA Uracil is found in place of thymine.

- 5-methyl uracil is the other name of thymine

History of DNA:

- DNA is an acidic substance in the nucleus that was first identified by Friedrich Meischer in 1869. He named it as 'Nuclein".
- 1953 double helix structure of DNA was given by James Watson and Francis Crick, based on X-ray diffraction data produced by Maurice Wilkins and Rosalind Franklin.
- Hallmark of their proposition was base pairing between two strands of polynucleotide chains. This was based on the observation of Erwin Chargaff.
- Chargaff 's observation was that for a double stranded DNA, the ratio between Adenine and Thymine, and Guanine and Cytosine are constant and equal.

Salient features of Double helix structure of DNA:

- Made of two polynucleotide chains.
- Sugar and phosphate forms the backbone and bases projected to the inside.
- Two chains have antiparallel polarity.
- Two strands are held together by hydrogen bonds present in between bases.
- Adenine of one strand pairs with Thymine of another strand by two hydrogen bonds and vice versa.
- Guanine of one strand pairs with Cytosine of another strand by three hydrogen bonds and vice versa.
- A purine comes opposite to a pyrimidine. This generates approximately uniform distance between the two strands of the helix.
- The two chains are coiled in a right – handed fashion.
- The pitch of the helix is 3.4 nm or 34 A0.
- There are roughly 10 bp in turn.
- The distance between the bp in a helix is 0.34nm or 3.4 A0 .
- The plane of one base pair stacks over the other in a double helix.
- H-bond confers stability of the helical structure of the DNA.
- Central dogma of flow of genetic information: DNA→ RNA→ Protein.

Packaging of DNA Helix:

- Distance between two conjugative base pairs is 0.34nm, the length of the DNA in a typical mammalian cell will be 6.6 X109 bp X 0.34 X10-9 /bp, it comes about 2.2 meters.
- The length of DNA is more than the dimension of a typical nucleus (10-6m).

Packaging in prokaryotes:

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

Packaging in Eukaryotes:

- In eukaryotes the packaging is more complex.
- There is a set of positively charged, basic proteins called Histones.
- Histones are positively charged due to being rich in basic amino acids like Lysines and arginines.
- Histones are organized to form a unit of eight molecules called histone octamer.
- Negatively charged DNA wrapped around positively charged histone octamer to form a structure called nucleosome.
- A typical nucleosome contains 200 bp of DNA helix.
- Nucleosome constitutes the repeating unit of a structure in the nucleus called chromatin, thread like stained bodies seen in the nucleus.
- The nucleosomes are seen as a ‘beads-on-string’ structure when viewed under electron microscope.
- The chromatin is packaged to form chromatin fibers that are further coiled and condensed at the metaphase stage to form chromosomes.
- Packaging at a higher level required an additional set of proteins called Non-histone Chromosomal (NHC) proteins.
- In a typical nucleus some loosely coiled regions of chromatin (light stained) is called euchromatin.
- The chromatin that is more densely packed and stains dark are called Heterochromatin.
- Euchromatin is transcriptionally active chromatin and heterochromatin is inactive.

The Search of genetic material: Transforming principle:

- Given by Frederick Griffith in 1928.
- His experiment was based on Streptococcus pneumoniae (caused pneumonia).

- There is a change in the physical form of bacteria.
- There are two colonies of bacteria:
  - Smooth shiny colonies called S strain.
  - Rough colonies called R strain.
- S-strain bacteria have a mucous (polysaccharide) coat.

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

Biochemical characterization of transforming principle:

- Biochemical nature of transforming principle was discovered by Oswald Avery, Colin Macleod and Maclyn McCarty. (1933-44)
- Prior to their work genetic material was thought to be protein.
- They worked to determine the biochemical nature of the 'transforming principle' of Griffith's experiment.
- They purified biomolecules (proteins, DNA and RNA) from the heat-killed S cells to see which one could transform live R cells to S cells.
- Heat killed S-Strain + protease + Live R-Strain → transformation.
- Heat killed S-Strain + RNase + Live R-Strain → transformation.
- Heat killed S-Strain + DNase + Live R-Strain → No transformation.

Conclusion of the experiments:

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

Conclusion of experiment:

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

The Genetic Material is DNA:

- 'DNA is the genetic material' is proved by Alfred Hershey and Martha Chase (1952).
- They worked on the virus that infects bacteria called bacteriophage.
- During normal infection the bacteriophage first attaches the bacteria cell wall and then inserts its genetic material into the bacterial cell.

- The viral genetic material became an integral part of the bacterial genome and subsequently manufactured more virus particles using host machinery.
- Hershey and Chase worked to discover whether it was protein or DNA from the viruses that entered the bacteria.
- Experiment :(blenders experiment)
    - They grew some viruses on a medium having radioactive phosphorus and some others on a medium having radioactive sulfur.
    - Viruses grown in radioactive Phosphorus have radioactive DNA but not radioactive protein because Phosphorus present in DNA not in protein.
    - Viruses grown in radioactive sulfur have radioactive protein not radioactive DNA because sulfur is present in protein but not in DNA.
    - Infection: radioactive phages were allowed to attach to E.coli bacteria; the phages transfer the genetic material to the bacteria.
    - Blending: the viral coats were separated from the bacteria surface by agitating them in a blender.
    - Centrifugation:The virus particles were separated from the bacteria by spinning them in a centrifuge machine.
- Observation:
    - Bacteria infected with viruses that had radioactive DNA were radioactive and had no radioactivity in the supernatant.
    - Bacteria infected with viruses that had radioactive protein were not radioactive, but radioactivity found in the supernatant.
- Conclusion of Experiment:

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

<u>Properties of genetic material(DNA versus RNA):</u>

<u>Criteria for genetic material:</u>

- It should be able to generate its replica (replication).
- It should be chemically and structurally stable.
- It should provide the scope for slow changes (mutation) that are required for evolution.
- It should be able to express itself in the form of ‘Mendelian Character’.
- Protein does not fulfill the criteria hence it is not the genetic material.
- RNA and DNA fulfill the criteria.
- RNA is unstable:
- 2’-OH group present at every nucleotide (ribose sugar) in RNA is a reactive group and makes RNA liable and easily degradable.
- RNA is also now known as catalyst, hence reactive.

- RNA is unstable and mutates faster. Consequently the viruses having RNA genome and having shorter life span mutate and evolve faster.
- DNA is more stable:
- Stability as one of the properties of genetic material was very evident in Griffith's 'transforming principle' itself that heat, which killed the bacteria at least, did not destroy some of the properties of genetic material.
- Two strands being complementary if separated by heating come together, when appropriate conditions are provided.
- Presence of Thymine in place of uracil confers additional stability to DNA.
- DNA is chemically less reactive and structurally more stable when compared to RNA.
- Therefore among the two nucleic acids the DNA is a better genetic material. Better genetic material (DNA or RNA).
- Presence of thymine at the place of uracil confers more stability to DNA.
- Both DNA and RNA are able to mutate.
- In fact RNA being unstable mutates at a faster rate.
- RNA can directly code for the synthesis of proteins, hence easily expressed.
- DNA however depends on RNA for protein synthesis.
- The protein synthesis machinery has evolved around RNA.
- Both RNA and DNA can function as genetic material, but DNA being more stable is preferred for storage of genetic information.
- For the transmission of genetic information RNA is better.

<u>RNA World:</u>

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

<u>Types of RNA:</u>

- In prokaryotes there are three major types of RNAs: mRNA (messenger), tRNA (transfer), and rRNA(ribosomal).
- All three RNAs are required to synthesize protein in a cell.
- The mRNA provides the template and has genetic information in the form of genetic code.

- The tRNA brings the amino acids and reads the genetic code of mRNA.
- The rRNA is the structural part of the ribosome and also has a catalytic role during the process of translation.

Replication: The Process

- Watson and Crick proposed a scheme for replication of DNA.
- The Original statement that "It has not escaped our notice that the specific pairing we have postulated immediately suggests a possible copying mechanism for the genetic material (Watson and Crick, 1953).
- The scheme suggested that the two strands would separate and act as template for the synthesis of new complementary strands.
- New DNA molecule must have one parental strand and one new strand.
- This scheme of replication is called the Semiconservative type of replication.
- Experimental Proof of semiconservative nature of replication:
    - It is now proved experimentally that replication is a semiconservative type.
    - It was first shown in Escherichia coli and subsequently in higher organisms.
    - Mathew Messelson and Franklin Stahl performed the following experiment in 1958.
- Steps:
    - They grew E.coli in 15NH4Cl medium for many generations. (15N is heavy nitrogen, not a radioactive element).
    - The result was that 15N was incorporated into newly synthesized DNA and other nitrogen-containing compounds as well.
    - This heavy DNA molecule could be distinguished from normal DNA by centrifugation in a cesium chloride (CsCl) density gradient.
    - Then they transferred the E.coli into a medium with normal 14NH4Cl and let them grow.(E.coli divides in 20 minutes).
    - They took samples at definite time intervals as the cells multiplied, and extracted the DNA that remained as double-stranded helices.
    - Various samples were separated independently on CsCl gradients to measure the densities of DNA.

    - The DNA that was extracted from the culture one generation after the transfer from 15N to 14N medium had a hybrid or intermediate density.
    - DNA extracted from the culture after another generation (after 40 min.) was composed of equal amounts of this hybrid DNA and of 'light 'DNA.
- Experiment by Taylor and colleagues:
    - Used radioactive thymidine to detect distribution of newly synthesized DNA in the chromosomes.

- They performed the experiment on Vicia faba (faba beans) in 1958.
- They proved the semiconservative nature of DNA replication in eukaryotes

Replication Machinery and Enzymes:

- In all living cells such as E.coli replication requires a set of enzymes.
- E.coli completes the replication of its DNA within 38 min.
- The average rate of polymerization has to be approx. 2000 bp per sec.
- The polymerization process must be accurate; any mistake during replication would result in mutation.
- Deoxyribonucleoside triphosphates (dATP, dGTP, dCTP, dTTP) serve dual purposes:
  - Provide energy for polymerization.
  - Acts as substrates for polymerization.
- The replication process occurs within a small opening of the DNA helix called replication fork.
- The region where, replication fork formed is called the origin of replication.
- The replication fork is formed by an enzyme called helicase.
- Two separated strands are called template strands.
- Main enzyme is DNA-dependent DNA polymerase, since it uses a DNA template to catalyze the polymerization of deoxyribonucleotides.
- DNA polymerase catalyses polymerization only in one direction i.e. 5'→3'.
- On one strand (template with 3'→5' polarity) the replication is continuous hence called the leading strand.
- In another strand (template with 5'→3' polarity) the polymerization takes place in the form of a short fragment called Okazaki fragment.
- The short fragments are joined by DNA ligase, hence called lagging strand. • In eukaryotes replication takes place in the S-phase of the cell cycle.
- A failure of cytokinesis after replication results in polyploidy.

TRANSCRIPTION:

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

Transcription vs. Replication:

- Principle of complementarity governs the process of transcription except Adenine of DNA forms base pair with the Uracil instead of thymine. During replication Adenine pairs with thymine instead of uracil.
- During replication once started the whole DNA is duplicated, whereas transcription takes place only a segment of DNA.
- In replication both strand acts as template, whereas in transcription only one strand acts as template to synthesize RNA.
- In replication DNA copied from a DNA, whereas in transcription RNA copied from the DNA.
- Why both strands of DNA not copied during transcription:
    - If both strands of DNA act as a template, they would be translated into two RNA of different sequences and in turn if they code for proteins, the sequence of amino acids in the protein would be different. Hence one segment of DNA would be coding for two different proteins.

The two RNA molecules if produced simultaneously would be complementary to each other, hence will form double stranded RNA. This would prevent RNA translation into protein.

Transcription unit:

- A transcription unit in DNA consists of three regions:
    - A promoter
    - The structural gene
    - A terminator.
- DNA dependent RNA polymerase catalyses the polymerization in only one direction that is 5'→3'.

Structural gene:

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

- Promoter and Terminator present on either side of the structural gene.
- The promoter is located towards the 5' end (upstream) of the structural gene.
- It is a short sequence of DNA that provides binding sites for RNA polymerase. (mostly TATA , Commonly called TATA box)
- Presence of the promoter defines the template and coding strands.

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

Terminator:

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

Transcription unit and the gene:

- Gene is defined as the functional unit of inheritance.
- Genes are located on the DNA.
- The DNA sequence coding for tRNA and rRNA molecules also defines a gene.
- Cistron: a segment of DNA (structural gene) coding for a polypeptide.
- Monocistronic: most eukaryotic structural gene codes for single polypeptide.

Polycistronic:

- Most prokaryotic structural gene code for more than one polypeptide. In eukaryotes the monocistronic structural genes have interrupted coding sequences, the genes are said to be split gene:
- The coding sequences or expressed sequences are called Exons.
- Exons are interrupted by Introns.
- Exons are said to be those sequences that appear in mature or processed mRNA.
- Introns never appear in the mature or processed mRNA. They are spliced out Process of transcription: prokaryotes.
- There is a single DNA dependent RNA polymerase that catalyses transcription or synthesis of all three types of RNAs in prokaryotes.
- The process of transcription completed in three steps:
    - Initiation:
        - RNA polymerase binds to the specific site of DNA called promoter.
        - Promoter of the DNA is recognized by initiation factor or sigma (σ).
        - RNA polymerase along with initiation factor binds to the promoter.

    - Elongation:
        - RNA polymerase unzips the DNA double helix and forms an open loop.
        - It uses ribonucleoside triphosphates as substrate and polymerizes in a DNA template following the rule of complementarity.
        - Only a short stretch of polymerized RNA remains binds with the enzyme.

- The process of polymerization continues till the enzyme reaches the terminator gene.

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

Additional complexities in eukaryotes:

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

- RNA polymerase I transcribes rRNA (28S, 18S, and 5.8S)
- RNA polymerase II transcribes heterogeneous nuclear RNA (hnRNA).
- RNA polymerase III transcribes tRNA, 5srRNA and snRNA.

Post transcriptional processing: (occurs inside the nucleus)

(a) Splicing:

- The primary transcript (hn RNA) contains both exons and introns and is required to be processed before translationally active (mRNA).
- The introns are removed and exons are joined in a defined order.
- This process is catalyzed by SnRNP, introns removed as spliceosomes.

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

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

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

GENETIC CODE:

Contribution to discovery:

- The process of replication and transcription based on complementarity.

- The process of translation is the transfer of genetic information from a polymer of nucleotides to a polymer of amino acids. There is no complementarity between nucleotides and amino acids.
- If there is change in the nucleic acid (genetic material) there is change in amino acids in proteins.

- There must be a genetic code that could direct the sequence of amino acids in proteins during translation.
- George Gamow proposed the code should be a combination of bases, he suggested that in order to code for all the 20 amino acids, the code should be made up of three nucleotides. • Har Govind Khorana enables instrumental synthesizing RNA molecules with desired combinations of bases(homopolymer and copolymers).
- Marshall Nirenberg's cell – free system for protein synthesis finally helped the discovery of genetic code.
- Severo Ochoa enzyme (polynucleotide phosphorylase) was also helpful in polymerizing RNA with desired sequences in a template independent manner (enzymatic synthesis of RNA)

Salient features of genetic code:

- The codon is a triplet. Three nitrogen base sequences constitute one codon.
- There are 64 codons, 61 codes for amino acids and 3 codons are stop codons.
- One codon codes for only one amino acid, hence it is unambiguous.
- Degeneracy: some amino acids are coded by more than one codon.
- Comma less: the codon is read in mRNA in a continuous fashion. There is no punctuation.
- Universal: From bacteria to human UUU codes for phenylalanine.
- Initiation codon: AUG is the first codon of all mRNA. And also it codes for methionine (met), hence has dual function.
- Non-overlapping: The genetic code reads linearly
- Direction: the code only reads in 5' → 3' direction.
- Anticodon: Each codon has a complementary anticodon on tRNA.
- Nonsense codon: UAA, GUA, and UAG do not code for amino acids and have no anticodon on the tRNA.

Mutation and Genetic code:

- Relationships between DNA and genes are best understood by mutation.

Point mutation:

- It occurs due to replacement nitrogen base within the gene.
- It only affects the change of particular amino acids.
- Best understood the cause of sickle cell anemia.

Frameshift mutation:

- It occurs due to insertion or deletion of one or more nitrogen bases in the gene.
- There is change in the whole sequence of amino acids from the point of insertion or deletion.
- Best understood in β-thalasemia.

tRNA-the Adaptor molecule:

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

Translation:

- It refers to polymerization of amino acids to form a polypeptide.
- The number and sequence of amino acids are defined by the sequence of bases in the mRNA.
- The amino acids are joined by peptide bonds.
- Amino acids are activated in the presence of ATP and linked to their specific tRNA is called charging of tRNA or aminoacylation of tRNA.
- Ribosome is the cellular factory for protein synthesis.
- Ribosomes consist of structural rRNA and 80 different proteins.
- In inactive state ribosome(70S) present in two subunits:-
  - A large subunit 50S.
  - A small subunit 30S.

Initiation:

- The process of translation or protein synthesis begins with attachment of mRNA with a small subunit of ribosome.

- The ribosome binds to the mRNA at the start codon (AUG).
- AUG is recognized by the initiator tRNA.

Elongation:

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

Termination:

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

Regulation of gene expression:

- Regulation of gene expression in eukaryotes takes place in different level:
  - Transcriptional level (formation of primary transcript)
  - Processing level (regulation of splicing)
  - Transport of mRNA from nucleus to the cytoplasm.
  - Translational level.
- In prokaryotes control of rate of transcriptional initiation is the predominant site for control of gene expression.
- The activity of RNA polymerase at the promoter is regulated by accessory proteins, which affects its ability to recognize the start site.
- The regulatory proteins can acts both positively (activators) or negatively (repressor)
- The regulatory proteins interact with a specific region of DNA called the operator, which regulates the accessibility of RNA polymerase to the promoter.

Lac operon:

- Francois Jacob and Jacque Monod first to describe a transcriptionally regulated system of gene expression.

- A polycistronic structural gene is regulated by common promoter and regulatory genes. Such a regulation system is common in bacteria and is called operon.

Lac operon consists of:-

- One regulator gene (i-gene).
- Three structural genes (z,y,a).
- Operator. (binding site of repressor protein).
- Promoter.(binding site of the RNA polymerase).
- The i-gene codes for the repressor of the lac operon.
- The structural gene consists of three genes (z, y and a).
- 'z'-gene codes for beta-galactosidase, which hydrolyzes lactose into Galactose and glucose.
- 'y' –gene codes for permease, which increases the permeability of bacterial cells. to lactose.
- 'a'-gene codes for transacetylase.
- All three genes are required for the metabolism of lactose in bacteria.
- Inducer: lactose is the substrate for β- galactosidase and it regulates the switching on and off of the lac operon. Hence it is called inducer.
- In the absence of glucose, if lactose is added in the growth medium of the bacteria, the lactose is transported into the cell by permease.
- Very low level of expression of lac operon has to be present in the cell all the time; otherwise lactose cannot enter the cell.
- Mechanism of regulation of lac operon:
    - The repressor protein is synthesized from i-gene (all time constitutively)
    - In the absence of the inducer i.e. lactose the active repressor binds to the operator and prevents RNA polymerase from transcribing the structural gene
    - In the presence of the inducer such as lactose or allolactose, the repressor is inactivated by interaction with the inducer.
    - This allows RNA polymerase access to the promoter and transcription proceeds.
    - The regulation of lac operon by repressor is referred to as negative regulation.

Human Genomic project:

- Genetic make-up of an organism or an individual lies in the DNA sequences.
- Two individuals differ in their DNA sequences at least in some places.

- Finding out the complete DNA sequence of the human genome.
- Sequencing the human genome was launched in 190.

Goals of HGP:

- Identify all the approximately 20.000 – 25000 genes in human DNA.
- Determine the sequence of all 3 billion chemical base pairs.
- Store this information in 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.

Methodology:

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

Human Genome:

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

DNA Fingerprinting:

- DNA fingerprinting is a very quick way to compare the DNA sequences of any two individuals.
- DNA fingerprinting involves identifying differences in some specific regions in DNA called repetitive DNA,because in these sequences, a small stretch of DNA is repeated many times.

- During centrifugation the bulk DNA forms a major peak and the other small peaks are called satellite DNA.
- Depending on base composition (A:T rich or G:C rich), length of segment, and number of repetitive units, the satellite DNA is classified into many types, such as mini –satellite and micro – satellite.
- These sequences do not code for any proteins.
- These sequences show a high degree of polymorphism and form the basis of DNA fingerprinting.
- Polymorphism in DNA sequence is the basis of genetic mapping of the human genome as well as of DNA fingerprinting.
- Polymorphism (variation at genetic level) arises due to mutations. • If an inheritable mutation is observed in a population at high frequency it is referred to as DNA polymorphism.

The process:

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

Different steps of DNA fingerprinting are:-

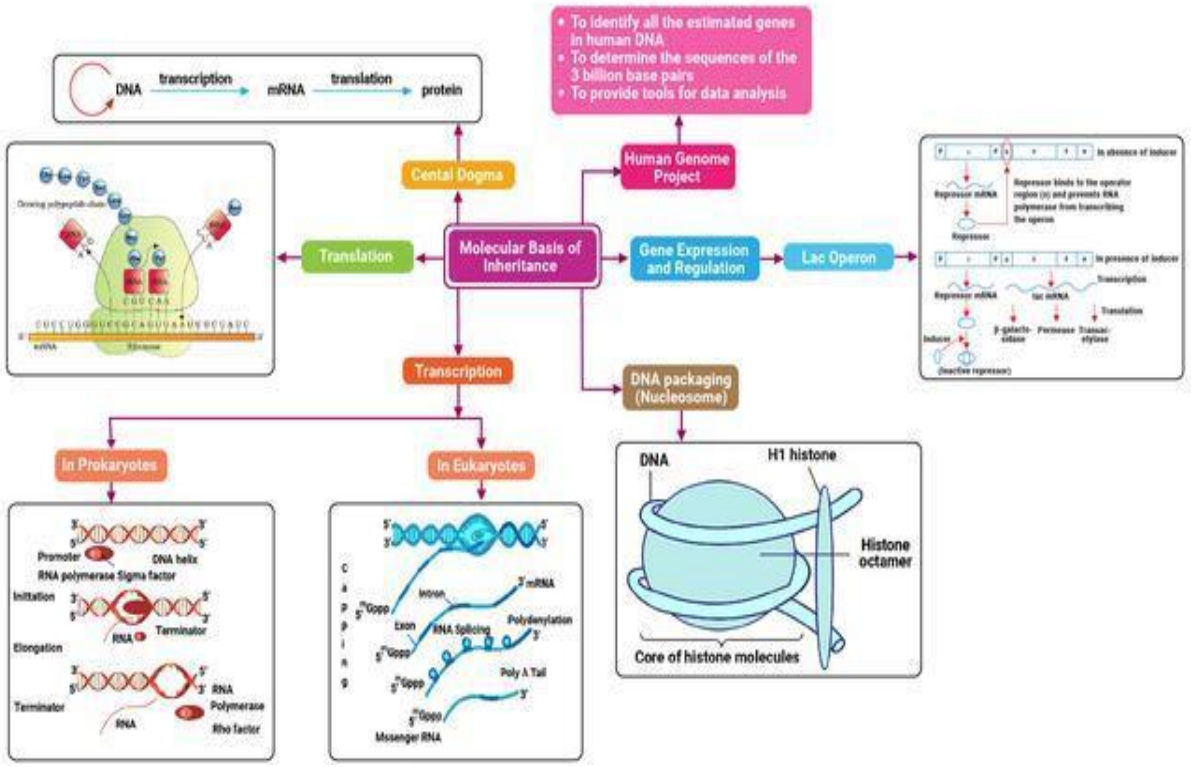
- Isolation of DNA.
- Digestion of DNA by restriction of endonucleases.
- Separation of DNA fragments by gel electrophoresis.
- Transferring (blotting) of separated DNA fragments to synthetic membranes, such as nitrocellulose or nylon.
- Double stranded DNA made single stranded.
- Hybridization using labeled VNTR probes.
- Detection of hybridized DNA fragments by autoradiography.
- The VNTR belongs to a class of satellite DNA referred to as minisatellite.
- The size of VNTR varies from 0.1 to 20 kb.
- After hybridization with the VNTR probe the autoradiogram gives many bands of different sizes. These bands give a characteristic pattern for an individual DNA. It differs from individual to individual.
- The DNA from a single cell is enough to perform DNA fingerprinting.

Applications:

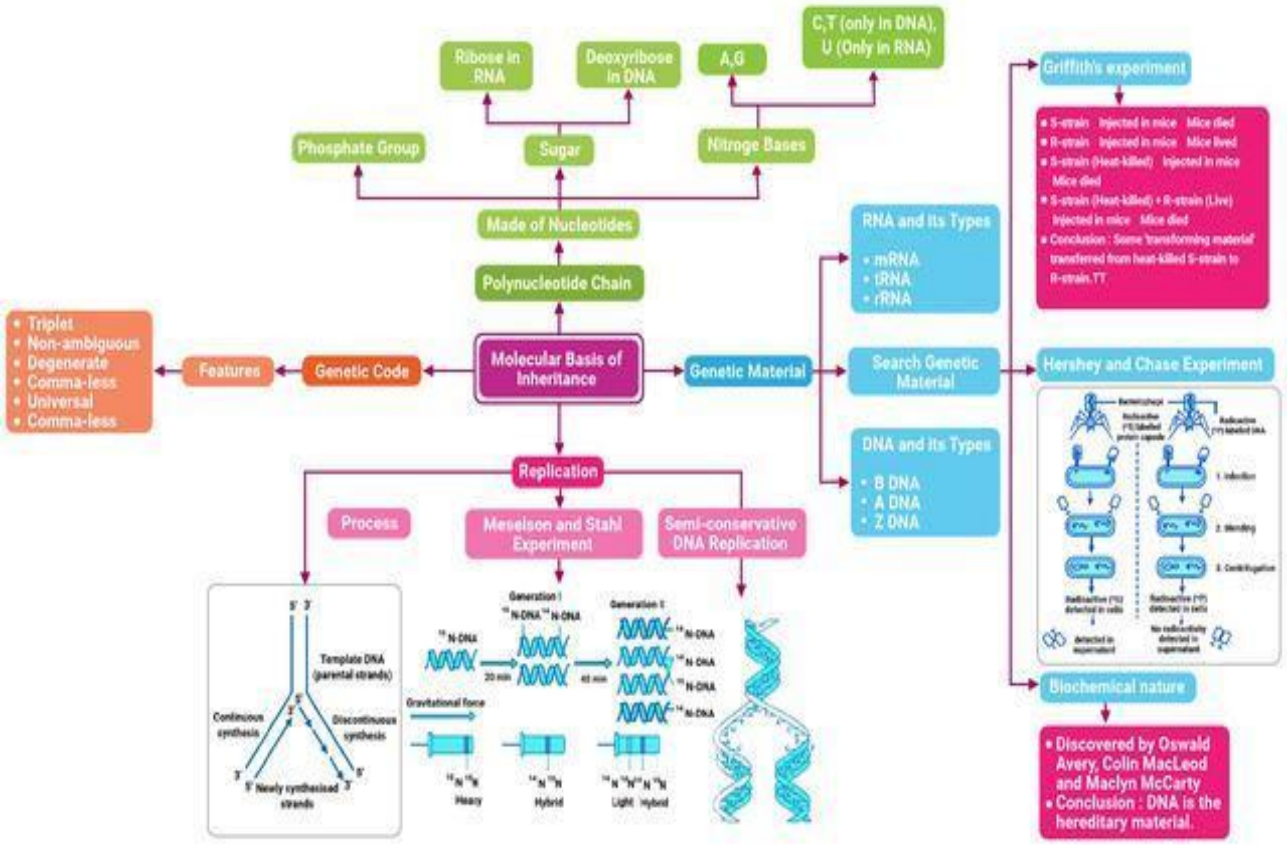
- Test of paternity.
- Identify the criminals.

- Population diversity determination.
- Determination of genetic diversity.

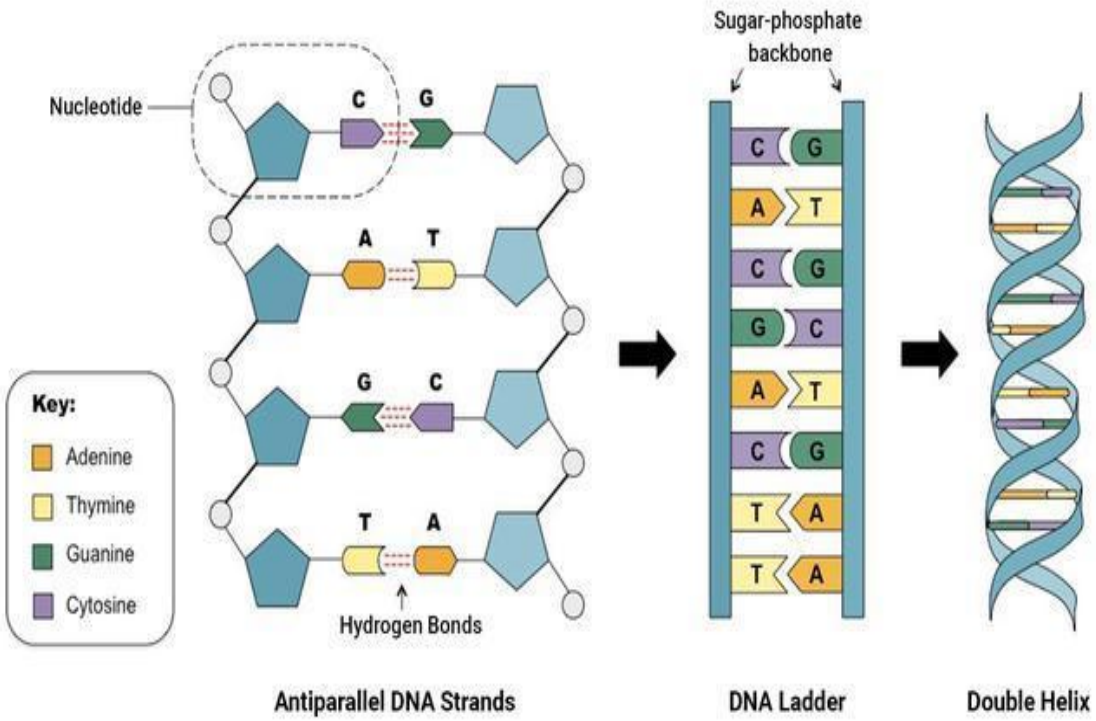
(1) MIND MAPS



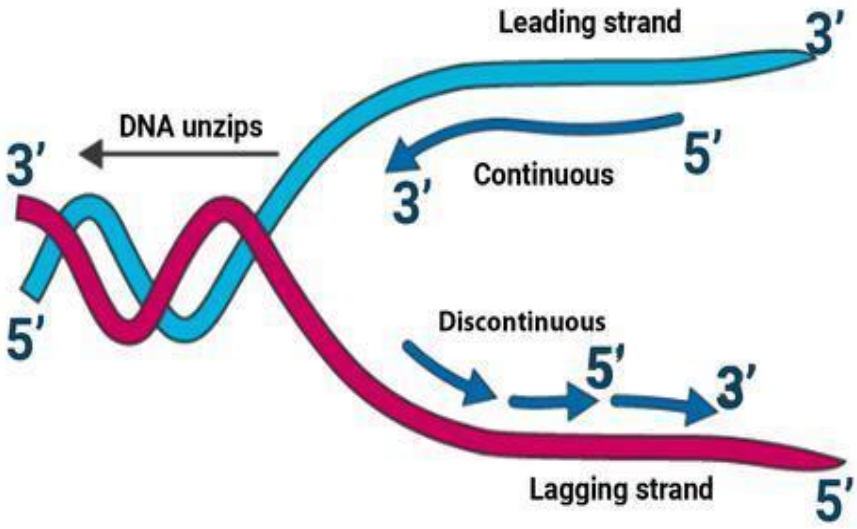
(2) HISTONE OCTAMER

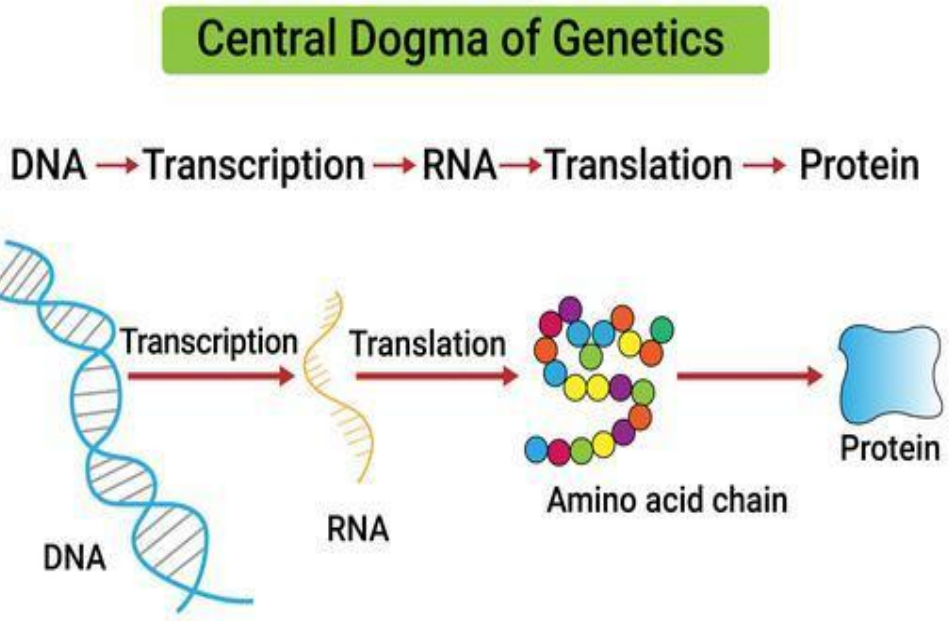


(3) DNA STRUCTURE

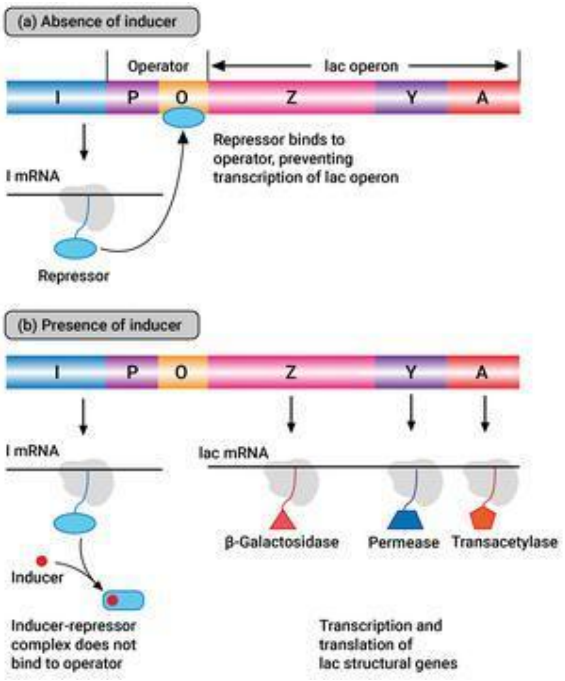


(4) REPLICATION FORK

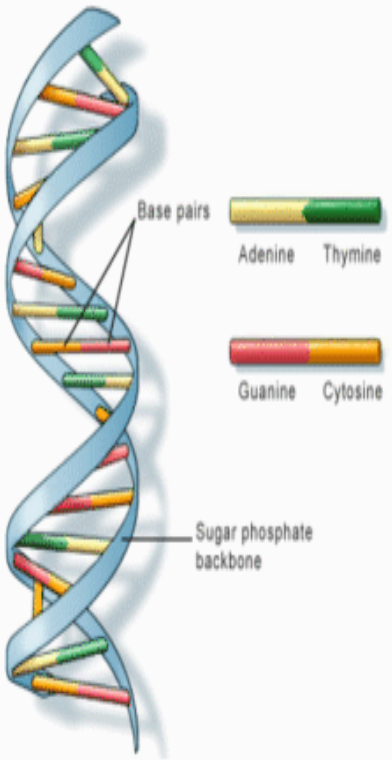

Leading strand
3'
DNA unzips
3'
5'
Continuous
3'
5'
Discontinuous
5'
3'
Lagging strand
5'


Central Dogma of Genetics
DNA → Transcription → RNA → Translation → Protein
Transcription
Translation
Protein
Amino acid chain
RNA
DNA

(5) LAC OPERON



Length of DNA



MCQ

1. In a DNA strand the nucleotides are linked together by

(a) glycosidic bonds

(b) phosphodiester bonds

(c) peptide bonds

(d) hydorgen bonds.

Answer: (b) phosphodiester bonds

2. The net electric charge on DNA and histones is

(a) both positive

(b) both negative

(c) negative and positive, respectively

(d) zero.

Answer: (c) negative and positive, respectively

3. Which of the following statements is the most appropriate for sickle cell anaemia ?

(a) It cannot be treated with iron supplements.

(b) It is a molecular disease.

(c) It confers resistance to acquiring malaria.

(d) All of the above

Answer: (d) All of the above.

4. The first genetic material could be

(a) Protein

(b) Carbohydrates

(c) DNA

(d) RNA.

Answer: (d) RNA.

5. The human chromosome with the highest and least number of genes in them are respectively

(a) chromosome 21 and Y

(b) chromosome 1 and X

(c) chromosome 1 and Y

(d) chromosome X and Y.

Answer: (c) chromosome 1 and Y

6. Who amongst the following scientists had no contribution in the development of the double helix model for the structure of DNA ?

(a) Rosalind Franklin

(b) Maurice Wilkins

(c) Erwin Chargaff

(d) Meselson and Stahl

Answer: (b) Maurice Wilkins

7.Which of the following steps in transcription is catalysed by RNA polymerase ?

(a) Initiation

(b) Elongation

(c) Termination

(d) All of the above

Answer: (d) All of the above

8. Control of gene expression takes place at the level of

(a) DNA-replication

(b) transcription

(c) translation

(d) none of the above.

Answer: (b) transcription

9. Which was the last human chromosome to be completely sequenced ?

(a) Chromosome 1

(b) Chromosome 11

(c) Chromosome 21

(d) Chromosome X

Answer: (a) Chromosome 1

10. In some viruses, DNA is synthesised by using RNA as a template. Such a DNA is called

(a) A – DNA

(b) B – DNA

(c) cDNA

(d) rDNA.

Answer: (c) cDNA

11. If the sequence of nitrogen bases of the coding strand of DNA in a transcription unit is: 5' – ATG ATG – 3', the sequence of bases in its RNA transcript would be

(a) 5’ – AUG A AUG – 3’

(b) 5’ – UACUU AC – 3’

(c) 5’ – CAU CAU – 3’

(d) 5’ – GUAGUA – 3’.

Answer: (d) 5’ – GUAGUA – 3’.

12. The RNA polymerase holoenzyme transcribes

(a) the promoter, structural gene and the terminator region.

(b) the promoter and the terminator region

(c) the structural gene and the terminator region

(d) the structural gene only.

Answer: (b) the promoter and the terminator region

13. If the base sequence of a codon in mRNA is 5’ – AUG – 3′ the sequence of tRNA pairing with it must be

(a) 5’ – UAC – 3’

(b) 5’ – CAU – 3’

(c) 5’-AUG – 3’

(d) 5’ – GUA – 3’

Answer: (b) 5’ – CAU – 3’

14. The amino acid attaches to the tRNA at its

(a) 5’- end

(b) 3’ – end

(c) anticodon site

(d) DHUloop.

Answer: (b) 3’ – end

15. To initiate translation, the m RNA first bind to

(a) the small ribosomal subunit

(b) the large ribosomal subunit

(c) the whole ribosome

(d) no such specificity exists.

Answer: (a) the small ribosomal subunit

16. In E. colt, the lac operon gets switched on when

(a) lactose is present and it binds to the repressor

(b) repressor binds to operator

(c) RNA polymerase binds to the operator

(d) lactose is present and it binds to RNA polymerase.

Answer: (a) lactose is present and it binds to the repressor

17. In DNA strand, the nucleotides are linked together by

(a) glycosidic bonds

(b) phosphodiester bonds

(c) peptide bonds

(d) hydrogen bonds.

Answer: (b) phosphodiester bonds

18. If a double stranded DNA has 20% of cytosine, what will be the percentage of adenine in it ?

(a) 20%

(b) 40%

(c) 30%

(d) 60%

Answer: (c) 30%

19. If the sequence of bases in one strand of DNA is ATGCATGTCA, what would be the sequence of bases on a complementary strand ?

(a) ATGCATGTCA

(b) AUGCAUGCA

(c) TACTACGT

(d) UACGUACGU

Answer: (c) TACTACGT

20. How far is each base pair from the next one in the DNA double helix model ?

(a) 2 nm

(b) 3.4 nm

(c) 34 nm

(d) 0.34 nm

Answer: (d) 0.34 nm

21. Synthesis of DNA from RNA is explained by

(a) central dogma reverse

(b) reverse transcription

c) feminism

(d) all of these.

Answer: (d) all of these.

22. Histone proteins are

(a) basic, negatively charged

(b) basic, positively charged

(c) acidic, positively charged

(d) acidic, negatively charged

Answer: (b) basic, positively charged

23. The structure in chromatin seen as 'beads-on string' when viewed under electron microscope are called

(a) nucleotides

(b) nucleosides

(c) histone octamer

(d) nucleosomes.

Answer: (d) nucleosomes.

24. Find out the wrong statement about heterochromatin,

(a) It is densely packed

(b) It stains dark.

(c) It is transcriptionally active.

(d) It is late replicating.

Answer: (c) It is transcriptionally active.

25. They year 2003 was celebrated as the 50th anniversary of discovery of

(a) transposons by Barbara Me Clintock

(b) structure of DNA by Watson and Crick

(c) Mendel's laws of inheritance

(d) biotechnology by Kary Muliis.

Answer: (b) structure of DNA by Watson and Crick

26.The process of transformation is not affected by which of the following enzymes ?

A. DNase

B. RNase

C. Peptidase

D. Lipase

(a) A, B

(b) A, B, C, D

(c) B, C, D

(d) A, B, C

Answer: (c) B, C, D

27. The three codons which result in the termination of polypeptide chain synthesis are

(a) UAA, UAG, GUA

(b) UAA, UAG, UGA

(c) UAA, UGA, UUA

(d) UGU, UAG, UGA

Answer: (b) UAA, UAG, UGA

28. Amino acids which are specified by single codons are

(a) phenylalanine and arginine

(b) tryptophan and methionine

(c) valine and proline

(d) methionine and arginine.

Answer: (b) tryptophan and methionine

29. Which out of the following statements is incorrect ?

(a) Genetic code is ambiguous.

(b) Genetic code is degenerate.

(c) Genetic code is universal.

(d) Genetic code is non-overlapping.

Answer: (a) Genetic code is ambiguous.

30. Some amino acids are coded by more than one codon, hence the genetic code is

(a) overlapping

(b) degenerate

(c) wobbled

(d) unambiguous.

Answer: (d) unambiguous.

31. The mutations that involve addition, deletion or substitution of a single pair in a gene are referred to as

(a) point mutations

(b) lethal mutations

(c) silent mutations

(d) retrogressive mutations.

Answer: (a) point mutations

32. Sickle cell anaemia results from a single base substitution in a gene, thus it is an example of

(a) point mutation

(b) frame-shift mutation

(c) silent mutation

(d) both (a) and (b).

Answer: (a) point mutation

33. Select the incorrectly matched pair.

(a) Initation codons – AUG,GUG

(b) Stop codons – UAA, UAG, UGA

(c) Methionine – AUG

(d) Anticodons – mRNA

Answer: (d) Anticodons – mRNA

34. Amino acid acceptor end of tRNA lies at

(a) 5’ end

(b) 3’ end

(c) T VC loop

(d) DHUloop.

Answer: (b) 3’ end

35. Which RNA carries the amino acids from the amino acid pool to mRnA during protein synthesis ?

(a) rRNA

(b) mRNA

(c) tRNA

(d) hn RNA

Answer: (c) tRNA

36. During translation, activated amino acids get linked to tRNA. This process is commonly called as

(a) charging of tRNA

(b) discharging of tRNA

(c) aminoacylation of tRNA

(d) both (a) and (c)

Answer: (b) discharging of/RNA

37. To prove that DNA is the genetic material, which radioactive isotopes were used by Hershey and Chase (1952) in experiments ?

(a) 33S and 15N

(b) 32P and 35S

(c) 32P and 15N

(d) 14N and 15N

Answer: (d) 14N and 15N

38. RNA is the genetic material in

(a) prokaryotes

(b) eukaryotes

(c) Tobacco Mosaic Virus (TMV)

(d) E.coli.

Answer: (c) Tobacco Mosaic Virus (TMV)

39. Which one among the following was the first genetic material ?

(a) DNA

(b) RNA

(c) Protein

(d) Nuclein

Answer: (b) RNA

40. Which of the following life processes evolved around RNA ?

(a) Metabolism

(b) Translation

(c) Splicing

(d) All of these

Answer: (b) Translation

41. Chemically, RNA is (i) reactive and (ii) stable as compared to DNA.

(a) (i) equally, (ii) equally

(b) (i) less, (ii) more

(c) (i) more, (ii) less

(d) (i) more, (ii) equally

Answer: (c) (i) more, (ii) less

42. Which of the following phenomena was experimentally proved by Meselson and Stahl ?

(a) Transformation

(b) Transduction

(c) Semi-conservative DNA replication

(d) Central dogma

Answer: (c) Semi-conservative DNA replication

43. First experimental proof for semi-conservative DNA replication was shown in

(a) Streptococcus pneumoniae

(b) Escherichia coli

(c) Neurospora crassa

(d) Rattus rattus.

Answer: (b) Escherichia coli

44. Select the correct match of enzyme with its related function.

(a) DNA polymerase – Synthesis of DNA strands

(b) Helicase – Unwinding of DNA helix

(c) Ligase – Joins together short DNA segments

(d) All of these

Answer: (d) All of these

45. Other than DNA polymerase, which are the enzymes involved in DNA synthesis ?

(a) Topoisomerase

(b) Helicase

(c) RNA primase

(d) All of these

Answer: (d) All of these

46. DNA replication takes place at _____ phase of the cell-cycle

(a) G_1

(b) S

(c) G_2

(d) M

Answer: (b) S

47. The process of copying genetic information from one strand of DNA to RNA is termed as _____ .

(a) replication

(b) transcription

(c) translation

(d) reverse transcription

Answer: (b) transcription

48. The enzyme DNA dependent RNA polymerase catalyses the polymerisation reaction in _____direction.

(a) only 5’ → 3’

(b) only 3’ → 5’

(c) both (a) and (b)

(d) none of these

Answer: (a) only 5’ → 3’

49. If the sequence of bases in coding strand of DNA is ATTCGATG, then the sequence of bases in mRNA will be

(a) TAAGCTAC

(b) UAAGCUAC

(c) ATTCGATG

(d) AUUCGAUG.

Answer: (d) AUUCGAUG.

50. If the sequence of bases in DNA is GCTTAGGCAA then the sequence of bases in its transcript will be

(a) GCTTAGGCAA

(b) CGAATCCGTT

(c) CGAAUCCGUU

(d) AACGGAUUCG.

Answer: (c) CGAAUCCGUU

51. Transcription unit

(a) starts with TATA box

(b) starts with palledorous regions and ends with rho factor.

(c) starts with promoter region and ends in terminator region

(d) starts with the CAAT region.

Answer: (c) starts with promoter region and ends in terminator region

52. During transcription, the site of DNA molecule at which RNA polymerase binds is called

(a) promoter

(b) regulator

(c) receptor

(d) enhancer.

Answer: (a) promoter

53. Polycistronic messenger RNA (mRNA) usually occurs in

(a) bacteria

(b) prokaryotes

(c) eukaryotes

(d) both (a) and (b)

Answer: (d) both (a) and (b)

54. In transcription in eukaryotes, heterogenous nuclear RNA (hnRNA) is described by

(a) RNA polymerase I

(b) RNA polymerase II

(c) RNA polymerase II

(d) all of these.

Answer: (b) RNA polymerase II

55. Methyl guanosine triphosphate is added to the 5' end of hnRNA in a process of

(a) splicing

(b) capping

(c) tailing

(d) none of these

Answer: (b) capping

56. In eukaryotes, the process of processing of primary transcript involves

(a) removal of introns

(b) capping at 5'end

(c) tailing (polyadenylation) at 3' end

(d) all of these.

Answer: (b) capping at 5'end

57. In a n/RNA molecule, untranslated regions (UTRs) are present at

(a) 5' – end (before start codon)

(b) 3' – end (after stop codon)

(c) both (a) and (b)

(d) 3'- end only.

Answer: (c) both (a) and (b)

58. UTRs are the untranslated regions present on

(a) rRNA

(b) hnRNA

(c) mRNA

(d) hnRNA.

Answer: (c) mRNA

59. Which of the following statements is correct regarding ribosomes ?

(a) Most of a cell's DNA molecules are stored there.

(b) Complete polypeptide is released from there.

(c) mRNAs are produced there.

(d) DNA replication takes place there.

Answer: (b) Complete polypeptide is released from there.

60. Regulation of gene expression occurs at the level of

(a) transcription

(b) processing/splicing

(c) translation

(d) all of these.

Answer: (d) all of these.

61. During expression of an operon, RNA polymerase binds to

(a) structural gene

(b) regulator gene

(c) operator

(d) promoter.

Answer: (d) promoter.

62. The sequence of structural genes in lac operon is

(a) Lac A, Lac Y, Lac Z

(b) Lac A, Lac Z, Lac Y

(c) Lac Y, Lac A, Lac A

(d) Lac Z, Lac Y, Lac A

Answer: (d) Lac Z, Lac Y, Lac A

63.Which of the following cannot act as an inducer ?

(a) Glucose

(b) Lactose

(c) Galactos

(d) Both (a) and (c)

Answer: (d) Both (a) and (c)

64. Human genome consists of approximately

(a) 3×10^9 bp

(b) 6×10^9 bp

(c) 20,000 – 25,000 bp

(d) 2.2×10^4 bp.

Answer: (a) 3×10^9 bp

65. Estimated number of genes in human beings is

(a) 3,000

(b) 80,000

(c) 20,500

(d) 3×10^9

Answer: (c) 20,500

CASE STUDY

CASE-1

Read the following passage and answer the questions given below:

RNA or Ribo Nucleic Acid is a single chain polynucleotide which functions as carrier of coded genetic or hereditary information from DNA to cytoplasm for taking part in protein and enzyme synthesis. Six types of RNA are ribosomal. transfer, messenger, genomic, small nuclear and small cytoplasmic RNA. Out of these r RNA and m RNA are major classes of RNA, that are involved in gene expression.

1. Which one is referred to as a soluble RNA
   a) m RNA
   b) t RNA
   c) r RNA
   d) hn RNA
2. The RNA that picks up specific amino acid from amino acid pool in the cytoplasm to ribosome during protein synthesis is
   a) r RNA
   b) m RNA

c) t RNA
d) hn RNA

3. Which of the following is found in both DNA and messenger RNA?
   a) Double helix structure
   b) Ribose
   c) Thymine
   d) Sugar-phosphate chain
4. Which of the following statements regarding RNA is correct?
   a) Genomic RNA is always single stranded
   b) Messenger RNA carries coded information for synthesis of polypeptide
   c) Ribosomal RNA binds with tRNA to catalyse the formation of phospho diester bonds
   d) Synthesis of r RNA occurs in cytoplasm by RNA polymerase III

5. In studying a virus, you find the following proportions of nitrogenous base present: adenine 23%, guanine 37%cytosine:23% and uracil 17%. Which of the following statement (s) regarding this virus is/are correct?
   I. It probably uses RNA as its genetic material
   II. The genetic material of this virus is probably single stranded
   III. Base pairing rules in virus include adenine: cytosine
      a) I only
      b) I and II only
      c) II and III only
      d) All of the above

Answer key:

1 t RNA
2 t RNA
3 Sugar-phosphate chain
4 Messenger RNA carries coded information for synthesis of polypeptide
5 I and II only

CASE- 2

Read the following passage and answer the following questions

DNA replication is a complex multistep process that requires enzymes, protein factors and metal ions. DNA replication in eukaryotes occurs in the nucleus during the S phase of the cell cycle. It is semi discontinuous in eukaryotes. In prokaryotes replication takes place in the cytoplasm. DNA replication in

bacteria occurs prior to fission. Nucleoid or viral chromosome is a single molecule of nucleic acid, it may be linear or circular. Nucleic acid in a virus is either DNA or RNA but never both.

1. In Viral DNA how many origin of replication are present?
    a) Single
    b) Two
    c) Multiple
    d) None

2. Select the main enzyme involved in DNA replication.
    a) DNA ligase
    b) Helicase
    c) DNA dependant DNA polymerase
    d) Topoisomerase
3. Read the given statement and select the option that correctly fill in the blanks. Enzyme ----------(i) acts over the ori site and unwind the two strands of DNA by destroying -------(ii) bonds
    a) (i)Helicase, (ii)glycosidic
    b) Helicase (ii) Hydrogen
    c) (i)Unwindase (ii) glycosidic
    d) (i) helicase (ii) phosphodiester
4. DNA strand build-up of Okazaki fragments is called
    a) lagging strand
    b) leading strand
    c) complementary strand
    d) parental strand

    Answer key:

    1. Single
    2. **DNA dependant DNA polymerase**
    3. Helicase (ii) Hydrogen
    4. lagging strand

CASE-3

DNA fingerprinting is a technique of determining nucleotide sequences of certain areas of DNA which are unique to each individual. Each person has a unique DNA finger print. Each fingerprint is the same for every cell, tissue and organ of a person. DNA fingerprinting is the basis of paternity testing in case of disputes.

1. The technique developed to identify a person with the help of DNA restriction analysis is known as

a) DNA profiling
b) RFLP
c) DNA finger printing
d) Both (a) and (b)

2. For DNA finger printing, DNA is obtained from
    a) Blood
    b) Hair root cells
    c) Semen
    d) All of the above
3. During DNA finger printing radioactive probes
    a) Hybridise with DNA sample to form double stranded structure
    b) Degrade the DNA
    c) Create positive charge on DNA
    d) Cut the DNA sample at various sites
4. In India DNA finger printing technique was developed by
    a) Dr Lalji Singh
    b) Alec Jeffreys
    c) Dr Khorana
    d) None of the above

Answer key:

1. DNA finger printing
2. All of the above
3. Hybridise with DNA sample to form double stranded structure
4. Dr Lalji Singh

CASE-4

Mutation explains relationship between gene and DNA. The effects of large deletions and rearrangement in a segment of DNA results in loss or gain of gene and its function . Insertion or deletion of one or two bases changes the reading frame from the point of insertion or deletion. A classical example of point mutation is a change of single base pair in the gene for beta globin that results in change of amino acid residue glutamate to valine and results into a diseased condition called sickle cell anaemia.

1. A mutation is a change produced by an alteration in the genetic mechanism and
    a) may arise spontaneously
    b) Is always induced by the environment
    c) Is never advantageous
    d) Is not inherited

2. The DNA code for glutamic acid is CTC or CTT. The code for valine is CAA or CAT. In sickle cell haemoglobin, valine is present instead of glutamic acid.
   Assuming a single base pair substitution has occurred, what is the mRNA code in the affected mutant?
   a) CUU
   b) GAA
   c) GAG
   d) GUA
3. A mutation involving the substitution of one nitrogenous base for another has altered the base sequence of a DNA molecule ,coding for four amino acids ,a shown below:
   Normal: A-G-C-A-T-G-G-A-T-C-C-T
   Mutant: A-G-C-A-T-G-C-A-T-C-C-T
   The table shows six codons and the corresponding amino acids into which each is translated.

M RNA codon	Amino acid
AAG	Lysine
CUA	Leucine
GGA	Glycine
GUA	Valine
UAC	Tyrosine
UCG	Serine

   The mutation has changed amino acid
   a) Leucine to valine
   b) Lysine to glycine
   c) Serine to leucine
   d) Tyrosine to lysine
4. Assertion: Insertion or deletion of three or its multiple bases, insert or delete one or multiple codons and so one or multiple amino acids
   Reason: Reading frame remains unaltered with insertion or deletion of three or its multiple bases.
   (a) Both assertion and reason are true and reason is the correct explanation of the assertion
   (b) Both assertion and reason are true and reason is not the correct explanation of the assertion
   (c) Assertion is true but reason is false

(d) Both assertion and reason are false

5. Part of the amino acid sequence in normal and sickle cell haemoglobin are shown

Normal haemoglobin	Sickle cell haemoglobin
Thr-Pro-Glu-Glu	Thr-Pro-Val-Glu

mRNA codons for these amino acids are
Glutamine (Glu) GAA GAG
Proline (Pro) CCU CCC
Threonine (Thr) ACU ACC
Valine (Val) GUA GUG
Which transfer RNA molecule is involved in the formation of this part of the sickle cell haemoglobin?

a. tRNA with anticodon GUG
b. tRNA with anticodon CAU
c. t RNA with anticodon UGC
d. t RNA with anticodon GAG

Answer key:

1. may arise spontaneously
2. GUA
3. Leucine to valine
4. Both assertion and reason are true and reason is the correct explanation of the assertion
5. tRNA with anticodon CAU

CASE-5

In prokaryotes, DNA is circular and present in cytoplasm but in eukaryotes, DNA is linear and mainly confined to the nucleus, DNA or deoxyribonucleic acid is a long polymer of nucleotides, In 1953,the first correct double helical structure of DNA was worked out by Watson and Crick. Based on X ray diffraction data produced by Maurice Wilkins and Rosalind Franklin It is composed of three componentise A phosphate group, a deoxy ribose sugar and a nitrogen base, Different forms of DNA are B-DNA, Z-DNA, A-DNA, C-DNA, and D-DNA

1. Name the linkage present between the nitrogen base and pentose sugar in DNA
   a) Phospho-diester bond
   b) Glycosidic bond

c) Hydrogen bond
d) None of the above

2. The double chain of B -DNA is coiled in helical fashion. The spiral twisting of B DNA duplex produces
   a) right and left part
   b) major and minor grooves
   c) upper and lower sides
   d) linear and circular part
3. Assertion: The two strands of DNA helix have uniform distance between them.
   Reason: A large sized purine always paired opposite to a small sized pyrimidine
   a) Both assertion and reason are true and reason is the correct explanation of the assertion
   b) Both assertion and reason are true but reason is not the correct explanation of the assertion
   c) Assertion is true but reason is false
   d) Both assertion and reason are false
4. Which of the following describes the structure of B –DNA
   a) Polynucleotide chains are parallel, 5 base pairs per complete turn of helix
   b) Polynucleotide chains are antiparallel, 10 base pairs per complete turn of the helix
   c) Polynucleotide chains are parallel, 15 base pairs pr turn of helix
   d) Polynucleotide chains are antiparallel, 20 base pairs per complete turn of the helix

Answer key:

1. Glycosidic bond
2. major and minor grooves
3. Both assertion and reason are true and reason is the correct explanation of the assertion
4. Polynucleotide chains are antiparallel, 10 base pairs per complete turn of the helix

CASE 6

Read the following passage and answer the questions given below:

The process of translation requires transfer of genetic information from a polymer of nucleotides to synthesise a polymer of amino acids. The relationship between the sequence of amino acids in a polypeptide and

nucleotide sequence of DNA or mRNA is called genetic code. George Gamow suggested that in order to code for all the 20 amino acids, code should be made up of three nucleotides.

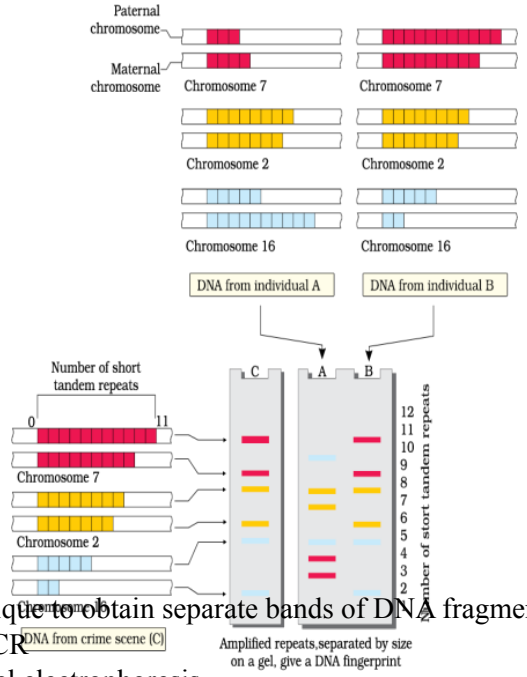
1. What is a codon?
    a) A length of DNA which codes for a particular protein
    b) A part of the tRNA molecule to which specific amino acid is attached
    c) A part of the tRNA molecule which recognises the triplet code on the messenger RNA
    d) A part of the messenger RNA molecule that has sequence of bases coding for an amino acid
2. Three consecutive bases in the DNA molecule provide the code for each amino acid in a protein molecule. What is the maximum number of different triplet that could occurs?
    a) 16
    b) 20
    c) 24
    d) 64
3. Identify the stop codon among the following
    a) UCG
    b) AUG
    c) UAA
    d) UGG
4. Listed below are some amino acids and their corresponding m RNA triplets. Phenyl alanine-UUU Lysine-AAG Arginine-CGA Alanine-GCA . Which DNA sequence would be needed to produce the following polypeptide sequence? Alanine-Arginine-Lysine-Phenyl alanine
    a) CGT GCT TTC AAA
    b) CGT GCT TTC TTT
    c) CGU GCU UUC AAA
    d) CGU GCU UUC TTT
5. A polypeptide is made using synthetic mRNA molecules as shown. Synthetic mRNA used is UUUAAAUUUAAA. The polypeptide produced is Phenyl alanine-lysine-phenyl alanine-lysine. What are the DNA segment codes for amino acids phenyl alanine and lysine?
    a) Phenyl alanine -AAA , Lysine-UUU
    b) Phenyl alanine-AAA , Lysine- TTT
    c) Phenyl alanine- GGG , Lysine- CCC
    d) Phenyl alanine- TTT , Lysine- GGG

Answer key:

1. A part of the messenger RNA molecule that has sequence of bases coding for an amino acid
2. 64
3. UAA
4. CGT GCT TTC AAA
5. Phenyl alanine-AAA , Lysine- TTT

DIAGRAM BASED CASE STUDY

1. Study the following crime case in which DNA finger print of two individual suspects A and B obtained from their DNA sample and DNA sample from the crime scene has the DNA fingerprint C to answer the following questions

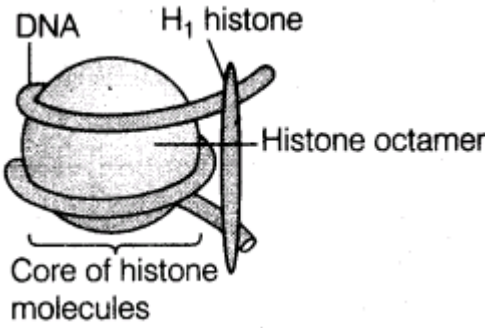


1. The technique to obtain separate bands of DNA fragments
   a) PCR
   b) Gel electrophoresis
   c) Southern blotting
   d) DNA finger printing
2. These short tandem repeats are present in
   a) Satellite DNA
   b) any part of DNA
   c) Homologous DNA
   d) Single strand DNA
3. This technique relies on which characteristics of DNA polymorphisms:
   i. they are variable
   ii. they are inheritable
   iii. they are different from individual to individual
   iv. they are short DNA fragments
   a) only a
   b) b, c and d
   c) b and c
   d) all of the above

Answer key:

1. Gel electrophoresis
2. Satellite DNA
3. all of the above

2.



1. The number of nucleosomes present in human cell is

a) $3.3X10^7$

b) $1.1 X 10^7$

c) $6.6X10^7$

d) indefinite

2. Which amino acids are present in histones?
    a) Lysine and histidine
    b) Valine and histidine
    c) Arginine and Lysine
    d) Arginine and histidine
3. Linker DNA is
    (a) a part of nucleosome
    (b) a part that joins two octamer cores
    (c) ss DNA
    (d) Both (a) and (b)
4. The association of histone H1 with a nucleosome indicates
    a) transcription is occurring
    b) DNA replication is occurring
    c) the DNA condensed into a chromatin fibre
    d) the DNA double helix is exposed.

Answer key:

1. $3.3X10^7$
2. Arginine and Lysine
3. Both (a) and (b)

4. the DNA condensed into a chromatin fibre

ASSERTION REASONING TYPE

These questions consist of two statements each, typed as Assertion and Reason. While answering these questions you are required to choose any one of the following four options.

A. If both Assertion and Reason are true and Reason is a correct explanation of the Assertion

B. If both Assertion and Reason are true but Reason is not a correct explanation of assertion

C. If Assertion is true and the Reason is false

D. If both assertion and Reason are false.

1. Assertion: hn RNA is larger than mRNA
   Reason: hn RNA has non-translating introns which are not required for translation
   Ans: Option A

2. Assertion: DNA is considered to be better genetic material than RNA for most organisms
   Reason: 2'OH group present in DNA makes it labile and less reactive
   Ans: Option C

3. Assertion: Replication and transcription occurs in Nucleus but translation occurs in cytoplasm.
   Reason: mRNA transferred from nucleus to cytoplasm where ribosomes and amino acids are available for protein synthesis
   Ans: Option A

4. Assertion: For DNA replication RNA primer is needed
   Reason: Synthesis of new DNA chain is initiated by DNA polymerase
   Ans: Option C

5. Assertion: Synthesis of daughter or new strand occurs continuously along the parent 3'---5' strand
   Reason: DNA polymerase can polymerase nucleotides in 3'--5' direction on 5'--3'strand
   Ans: Option C

6. Assertion: UAA, UAG, UGA terminate protein synthesis
   Reason: They are not recognized by t RNA.
   Ans: Option A

7. Assertion: Lac operon is seen in E.coli
   Reason: E. coli lacks a definite nucleus
   Ans: Option B

8. Assertion: Constitutive genes are continuously being expressed
   Reason: Constitutive genes are frequently needed for various metabolic functions.
   Ans: Option A

9. Assertion: No lac mRNA is made in the presence of glucose.
   Reason: In the presence of glucose, activity of lac operon is not needed.
   Ans: Option A

10. Assertion: Lac operon is an inducible operon
    Reason: Lac operon Can be switched off due to non-requirement of metabolite.
    Ans: Option C

11. Assertion: a very low level expression of lac operon has to be present in the cell always
    Reason: In Lac operon, lactose when added enters the cells by the action of enzyme permease
    Ans: Option A

12. Assertion: Polycistronic mRNA, found in prokaryotes specify a number of polypeptides
    Reason: Monocistronic mRNA ,found in eukaryotes specify only a single polypeptide
    Ans: Option B

13. Assertion: In Hershey and Chase experiment, absence of 32P radioactivity in the supernatant proves that DNA is the genetic material.
    Reason: DNA contains phosphorus but proteins does not.
    Ans: Option A

14. Assertion: The DNA strand having polarity 3'-5' replicated continuously whereas the strand with polarity 5'- 3; replicated discontinuously.
    Reason: The DNA polymerase catalyses the polymerisation only in one direction
    Ans: Option A

15. Assertion: In Prokaryotes the DNA is localised at the specific place in the cytoplasm called nucleoid.
    Reason: Histone proteins play an important role in the packaging of DNA
    Ans: Option B

16. Assertion: VNTRs are used as probes for hybridisation in DNA Fingerprinting.
    Reason: DNA fingerprinting is based on the principle of Polymorphism in DNA sequences
    Ans: Option A

17. Assertion: Histones are basic in nature.
    Reason: Histones are rich in amino acids lysine and arginine
    Ans: Option A

18. Assertion: Heterochromatin is transcriptionally inactive.
    Reason: It is loosely packed.
    Ans: Option C

19. Assertion: In a DNA molecule, A–T rich parts melt before G–C rich parts.
    Reason: In between A and T there are three H–bond, whereas in between G and C there are two H-bonds
    Ans: Option C

20. Assertion: Genetic code is polar
    Reason: Each codon has its specific 5' end and 3'end
    Ans: Option A

21. Assertion: Sequence of bases in one polynucleotide chain of DNA can determine the sequence of bases in the other chain

Reason: In a DNA amount of adenine equals that of thymine and amount of guanine equals that of cytosine i.e., A=T and C=G
Ans: Option B

22. Assertion: The subunits of ribosome come together only at the time of protein formation.
Reason: Mg 2+ causes their association and dissociation.
Ans: Option B

23. Assertion: For every cell, tissue and organ of a person, the DNA fingerprint is the same
Reason: For treatment of inherited disorders like Huntington's disease, Alzheimer's and Sickle cell anaemia DNA fingerprint is used.
Ans: Option C

24. Assertion: Heterochromatin is genetically inactive.
Reason: Heterochromatin lacks genes
Ans: Option C

25. Assertion: Viruses having RNA genome have shorter life span and mutate faster.
Reason: RNA is unstable and thus mutates faster
Ans: Option A

26. Assertion: An organism with lethal mutation may not even develop beyond the zygote.
Reason: All types of gene mutations are lethal
Ans: Option C

27. Assertion: The sugar phosphate backbone of two chains in DNA double helix show anti-parallel polarity.
Reason: The phosphodiester bonds in one strand go from a 3' carbon of one nucleotide to a 5' carbon of adjacent nucleotide, whereas those in complementary strand go vice versa
Ans: Option A

28. Assertion: A Lac operon given by Jacob and Monad is repressible operon.
Reason: The system of regulation in lac operon is always a negative control.
Ans: Option D

29. Assertion: The genetic code is degenerate.
Reason: Most amino acids are coded by more than one codon.
Ans: Option A

30. Assertion: DNA fingerprinting is applied in paternity testing in case of disputes.
Reason: It employs the principle of polymorphism in DNA sequences as the polymorphisms are inheritable from parent to children.
Ans: Option A

31. Assertion: In transcription, the strand with 3'-5' polarity acts as the template strand. Reason: The RNA polymerase catalyses the polymerisation in only one direction that is 5'-3'
Ans: Option A

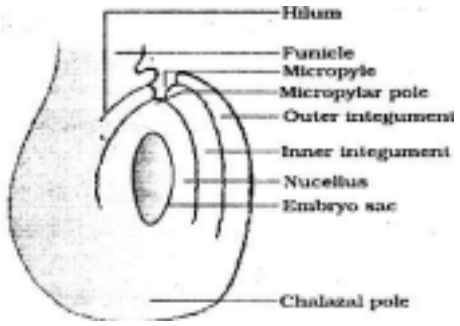
SAMPLE QUESTION PAPER (TERM I) 2021-22

Time: 90 Minutes

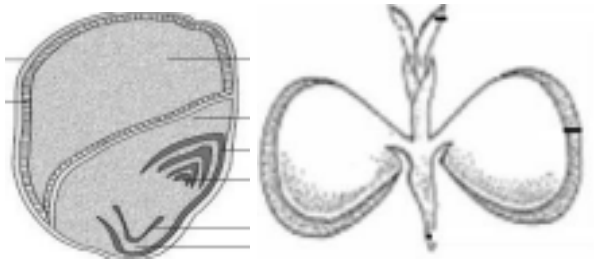
General Instructions:

1. The Question Paper contains three sections.
2. Section A has 24 questions. Attempt any 20 questions.
3. Section B has 24 questions. Attempt any 20 questions.
4. Section C has 12 questions. Attempt any 10 questions.
5. All questions carry equal marks.
6. There is no negative marking.

SECTION - A Section – A consists of 24 questions. Attempt any 20 questions from this section. The first attempted 20 questions would be evaluated.	
1	The structure of bilobed anther consists of A. 2 thecae, 2 sporangia B. 4 thecae, 4 sporangia C. 4 thecae, 2 sporangia D. 2 thecae, 4 sporangia

2	In the figure of anatropous ovule given below, choose the correct option for the characteristic distribution of cells within the typical embryo sac  Number of cells at chalazal end Number of cells at micropylar end Number of nuclei left in central cell A 3 2 3 B 3 3 2 C 2 3 3 D 2 2 4

3	The coconut water from tender coconut is A. cellular endosperm. B. free nuclear endosperm. C. both cellular and nuclear endosperm. D. free nuclear embryo.
4	Pollen grains are well preserved as fossils because of presence of A. sporopollenin B. cellulose C. lignocellulose D. pectocellulose

5	Which of the following statements are true related to Seed X and Y?  SEED X SEED Y (i) Seed X is dicot and endospermic or albuminous. (ii) Seed X is dicot and non-endospermic or non-albuminous. (iii) Seed Y is monocot and endospermic or albuminous. (iv) Seed Y is monocot and non-endospermic or non-albuminous. Choose the correct option with respect to the nature of the seed A. (i), (iii) B. (ii), (iii) C. (i), (iv) D. (ii), (iv)
6	Which of the following statements are correct with respect to hormones secreted by placenta? (i) Placenta secretes relaxation during later stages of pregnancy. (ii) Placenta secretes a high amount of FSH during pregnancy. (iii) Placenta secretes relaxation during the initial stage of pregnancy. (iv) Placenta secretes hCG and hPL during pregnancy. A. (i) and (iv) B. (i), (ii) and (iv) C. (iii) and (iv) D. (ii), (iii) and (iv)

7. Figure A shows the front view of the human female reproductive system and Figure B shows the development of a fertilized human egg cell

Figure A

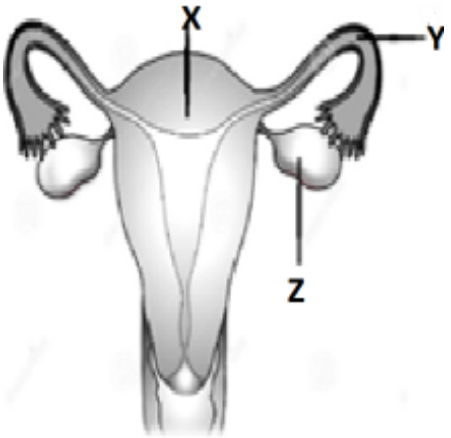
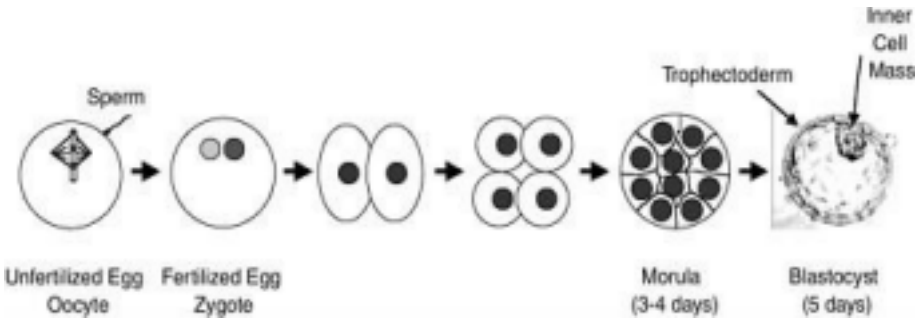


Figure B.



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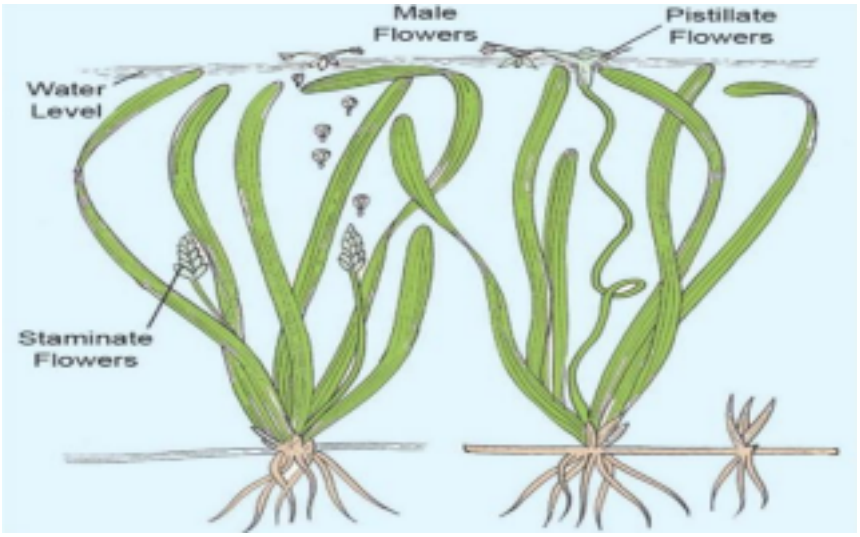
Identify the correct stage of development of human embryo (Figure B) that takes place at the site X, Y and Z respectively in the human female reproductive system (Figure A). Choose the correct option from the table below:

	X	Y	Z
A	Morula	Fertilized egg	Blastocyst
B	Unfertilized egg	Fertilized egg	Morula
C	Blastocyst	Fertilized egg	Unfertilized egg
D	Fertilized egg	Morula	Blastocyst

8	Penetration of the sperm in the ovum is followed by A. formation of first polar body. B. completion of meiosis II. C. first meiosis. D. dissolution of zona pellucida.
9	The correct sequence of hormone secretion from beginning of menstruation is A. FSH, progesterone, estrogen. B. estrogen, FSH, progesterone. C. FSH, estrogen, progesterone. D. estrogen, progesterone, FSH.
10	In the dioecious aquatic plant shown, identify the characteristics of the male flowers that reach the female flowers for pollination:  Size of the flower Colour of pollen grain Characteristic feature of flower A. Small brightly light weight and non-sticky coloured B. Large colourless large and sticky C. Small white small, covered with mucilage D. Large colourless non sticky

11	The thalamus contributes to the fruit formation in A. Banana. B. Orange. C. Strawberry. D. Guava.

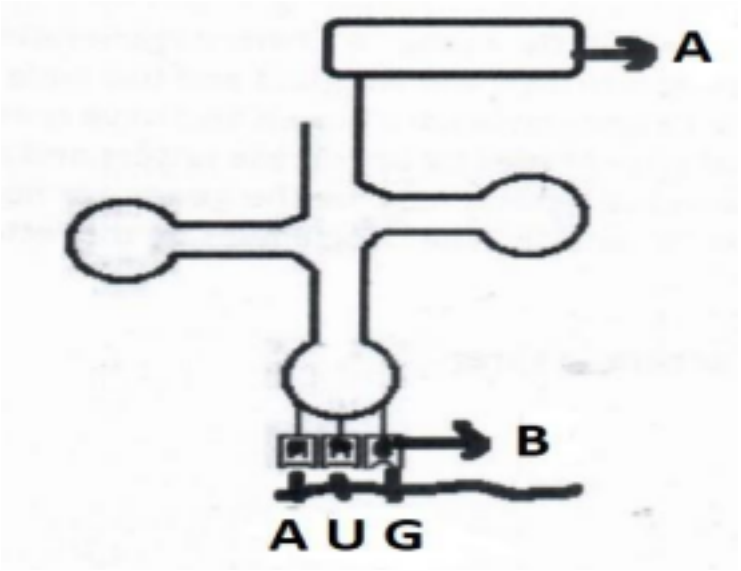
12	How many types of gametes would be produced if the genotype of a parent is AaBB? A. 1 B. 2 C. 3 D. 4
13	Which of the following statements indicates parallelism in genes and chromosomes? (i) They occur in pairs (ii) They segregate during gamete formation (iii) They show linkage (iv) Independent pairs segregate independently A. (i) and (iii) B. (ii) and (iii) C. (i), (ii) and (iii) D. (i), (ii) and (iv)
14	Which of the following amino acid substitution is responsible for causing sickle cell anemia? A. Valine is substituted by Glutamic acid in the α globin chain at the sixth position B. Valine is substituted by Glutamic acid in the β globin chain at seventh position C. Glutamic acid is substituted by Valine in the α globin chain at the sixth position D. Glutamic acid is substituted by Valine in the β globin chain at the sixth position

15	In human beings, where genotype AABBCC represents dark skin colour, aabbcc represents light skin colour and AaBbCc represents intermediate skin colour; the pattern of genetic inheritance can be termed as: A. Pleiotropy and codominance B. Pleiotropy and incomplete dominance C. Polygenic and qualitative inheritance D. Polygenic and quantitative inheritance
16	Which of the following combination of chromosome numbers represents the correct sex determination pattern in honey bees? A. Male 32, Female 16 B. Male 16, Female 32 C. Male 31, Female 32 D. Female 32, Male 31

17	Rajesh and Mahesh have defective haemoglobin due to genetic disorders. Rajesh Has too few globin molecules while Mahesh has incorrectly functioning globin molecules.Identify the disorder they are suffering from.

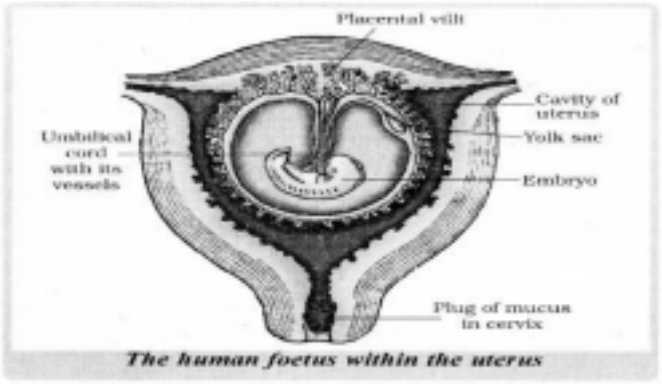
	Rajesh	Mahesh
A.	Sickle cell anaemia - an autosome linked recessive trait	Thalassemia – an autosome linked dominant trait
B	Thalassemia – an autosome linked recessive blood disorder	Sickle cell anaemia - an autosome linked recessive trait
C.	Sickle cell anaemia - an autosome linked recessive trait	Thalassemia – an autosome linked recessive blood disorder
D.	Thalassemia – an autosome linked recessive blood disorder	Sickle cell anaemia - an autosome linked dominant trait

18	Which of the following criteria must a molecule fulfil to act as a genetic material? (i) It should not be able to generate its replica (ii) It should chemically and structurally be stable (iii) It should not allow slow mutation (iv) It should be able to express itself in the form of Mendelian Characters A. (i) and (ii) B. (ii) and (iii) C. (iii) and (iv) D. (ii) and (iv)
19	The promoter site and the terminator site for transcription are located at A. 3′ (downstream) end and 5′ (upstream) end, respectively of the transcription unit B. 5′ (upstream) end and 3′ (downstream) end, respectively of the transcription unit C. the 5′ (upstream) end of the transcription unit D. the 3′ (downstream) end of the transcription unit
20	Which of the following is correct about mature RNA in eukaryotes? A. Exons and introns do not appear in the mature RNA. B. Exons appear, but introns do not appear in the mature RNA. C. Introns appear, but exons do not appear in the mature RNA. D. Both exons and introns appear in the mature RNA.
21	In *E.coli*, the lac operon gets switched on when A. lactose is present and it binds to the repressor. B. repressor binds to operator. C. RNA polymerase binds to the operator. D. lactose is present and it binds to RNA polymerase.

22	Oswald Avery, Colin MacLeod and Maclyn McCarty used enzymes to purify biochemicals such as proteins, DNA and RNA from the heat-killed S cells to see which ones could transform live R cells into S cells in Griffith's experiment. They observed that A. Proteases and RNases affected transformation. B. DNase inhibited transformation. C. Proteases and Lipases affect transformation. D. RNases inhibited transformation.
23	 AUG on the mRNA will result in the activation of which of the following RNA having correct combination of amino acids: Site A Site B A. UAC Methionine B. Methionine UAC C. Methionine AUG D. AUG Methionine
24	Short stretches of DNA used to identify complementary sequence in a sample are called A. probes B. markers

	C. VNTRs D. primers

SECTION - B Section - B consists of 24 questions (Sl. No.25 to 48). Attempt any 20 questions from this section. The first attempted 20 questions would be evaluated.	
	Question No. 25 to 28 consist of two statements – Assertion (A) and Reason (R). Answer these questions selecting the appropriate option given below: A. Both A and R are true and R is the correct explanation of A B. Both A and R are true and R is not the correct explanation of A C. A is true but R is false D. A is False but R is true
25	Assertion: Lactational amenorrhea is the natural method of contraception. Reason: It increases the phagocytosis of sperm.
26	Assertion: Saheli, an oral contraceptive for females, contains a steroidal preparation. Reason: It is a "once a week" pill with very few side effects.
27	Assertion: Parturition is induced by a complex neuro endocrine mechanism. Reason: At the end of gestation period, the maternal pituitary releases prolactin which causes uterine contractions.
28	Assertion: When the two genes in a dihybrid cross are situated on the same chromosome, the proportion of parental gene combinations is much higher than non parental type. Reason: Higher parental gene combinations can be attributed to crossing over between two genes.

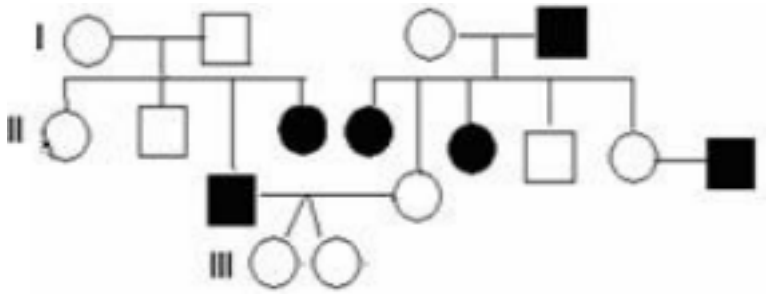
	Concentration of which of the following substances will decrease in the maternal blood as it flows from embryo to placenta through the umbilical cord?  *The human foetus within the uterus* i. Oxygen ii. Amino Acids iii. Carbon dioxide iv. Urea A. i and ii B. ii and iv C. iii and iv D. i and iv

30	In a fertilized ovule, n, 2n and 3n conditions occur respectively in A. antipodal, zygote and endosperm B. zygote, nucellus and endosperm C. endosperm, nucellus and zygote. D. antipodals, synergids and integuments

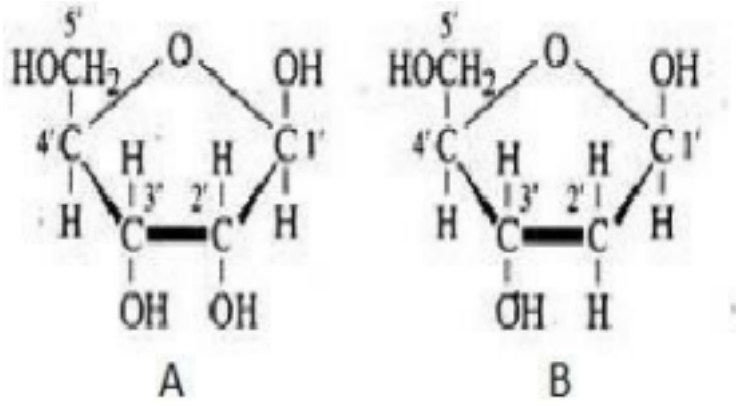
31	A botanist studying *Viola* (common pansy) noticed that one of the two flower types withered and developed no further due to some unfavorable condition, but the other flower type on the same plant survived and it resulted in an assured seed set. Which of the following will be correct? A. The flower type which survived is Cleistogamous and it always exhibits autogamy B. The flower type which survived is Chasmogamous and it always exhibits geitonogamy. C. The flower type which survived is Cleistogamous and it exhibits both autogamy and geitonogamy. D. The flower type which survived is Chasmogamous and it never exhibits autogamy.
32	During parturition, a pregnant woman is having prolonged labour pains and child birth has to be fastened. It is advisable to administer a hormone that can A. increase the metabolic rate. B. release glucose in the blood. C. stimulate the ovary. D. activate smooth muscles.
33	A female undergoing IVF treatment has blocked fallopian tubes. The technique by which the embryo with more than 8 blastomeres will be transferred into the female for further development is A. ZIFT B. GIFT C. IUT D. AI
34	The mode of action of the copper ions in an IUD is to A. increase the movement of sperms. B. decrease the movement of the sperms. C. make the uterus unsuitable for implantation. D. make the cervix hostile to the sperms.

35	To produce 400 seeds, the number of meiotic divisions required will be A. 400 B. 200 C. 500 D. 800

36	A cross is made between tall pea plants having green pods and dwarf pea plants having yellow pods. In the F2 generation, out of 80 plants how many are likely to be tall plants? A. 15 B. 20 C. 45 D. 60
37	In *Antirrhinum,* RR is phenotypically red flowers, rr is white and Rr is pink. Select the correct phenotypic ratio in F1 generation when a cross is performed between RR X Rr: A. 1 red: 2 Pink: 1 white B. 2 Pink: 1 white C. 2 Red: 2 Pink D. All Pink
38	What would be the genotype of the parents if the offspring have the phenotypes in 1:1 proportion? A. Aa X Aa B. AA X AA C. Aa X AA D. Aa x aa

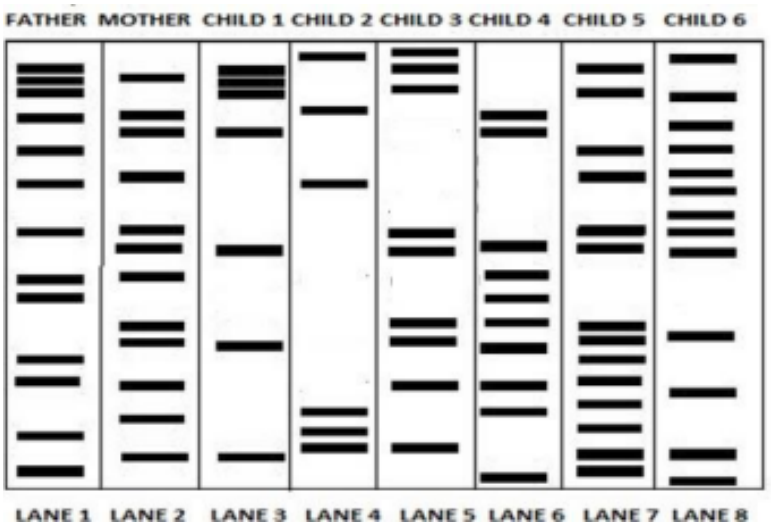
39	 What is the pattern of inheritance in the above pedigree chart? A. Autosomal dominant B. Autosomal recessive C. Sex -linked dominant D. Sex -linked recessive
40	A couple has two daughters. What is the probability that the third child will also be a female? A. 25% B. 50% C. 75% D. 100%

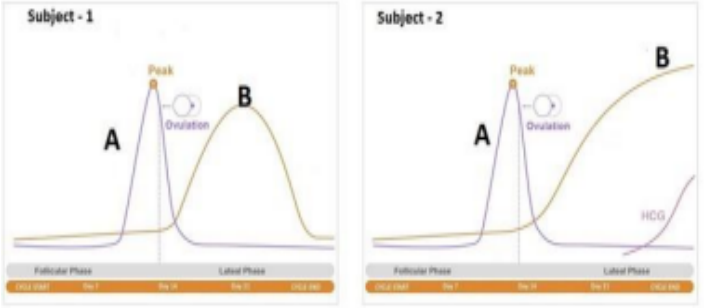
41	Genotypic ratio of 1:2:1 is obtained in a cross between A. AB X AB B. Ab X Ab C. Ab X ab D. ab X ab

42	Total number of nucleotide sequences of DNA that codes for a hormone is 1530. The proportion of different bases in the sequence is found to be Adenine = 34%, Guanine = 19%, Cytosine = 23%, Thymine = 19%. Applying Chargaff's rule, what conclusion can be drawn? A. It is a double stranded circular DNA. B. It is a single stranded DNA. C. It is a double stranded linear DNA. D. It is a single stranded DNA coiled on Histones.
43	A stretch of an euchromatin has 200 nucleosomes. How many bp will there be in the stretch and what would be the length of the typical euchromatin? A. 20,000 bp and 13,000 $x10^{-9}$ m B. 10,000 bp and 10,000 $x10^{-9}$ m C. 40,000 bp and 13,600 $x10^{-9}$ m D. 40,000 bp and 13,900 $x10^{-9}$ m
44	Observe structures A and B given below. Which of the following statements are correct?  A B A. A is having 2′-OH group which makes it less reactive and structurally stable, whereas B is having 2′-H group which makes it more reactive and unstable. B. A is having 2′-OH group which makes it more reactive and structurally unstable, whereas B is having 2′-H group which makes it less reactive and structurallystable. C. A and B both have -OH groups which make it more reactive and structurally stable. D. A and B both are having -OH groups which make it less reactive and structurally

	stable

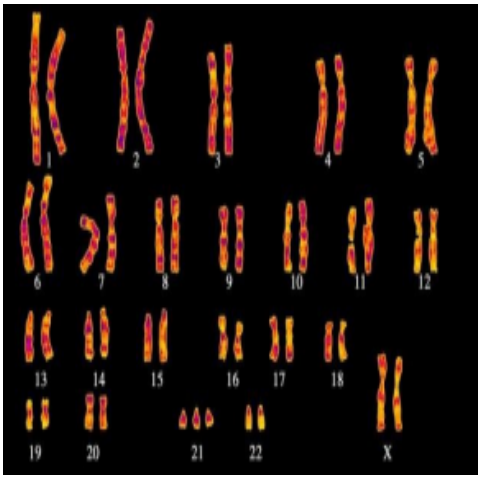
45	If Meselson and Stahl's experiment is continued for sixth generations in bacteria, the ratio of Heavy strands $^{15}N/^{15}N$:Hybrid$^{15}N/^{14}N$: light $^{14}N/^{14}N$ containing DNA in the sixth generation would be A. 1:1:1 B. 0:1:7 C. 0:1:15 D. 0:1:31
46	Two important RNA processing events lead to specialized end sequences in most human mRNAs: (i) at the 5' end, and (ii) at the 3' end. At the 5'end the most distinctive specialized end nucleotide, (iii) is added and a sequence of about 200 (iv) is added to the 3' end. A. (i) Initiator codon (ii) Promotor (iii) Terminator codon (iv) Release factors B. (i). Promotor (ii) Elongation (iii) Regulation (iv) Termination. C. (i) Capping (ii) Polyadenylation (iii) $^{m}G_{ppp}$ (iv) Poly(A). D. (i) Repressor (ii) Co repressor (iii) Operon (iv) sRelease factors
47	What are minisatellites? A. 10-40 bp sized small sequences within the genes B. Short coding repetitive region on the eukaryotic genome C. Short non-coding repetitive sequence forming large portion of eukaryotic genome D. Regions of coding strands of the DNA

48	There was a mix-up at the hospital after a fire accident in the nursery division. Which of these children belong to the parents?  A. All of the children B. Children 2, 3 & 6 C. Children 1 & 3 D. Children 2 & 4

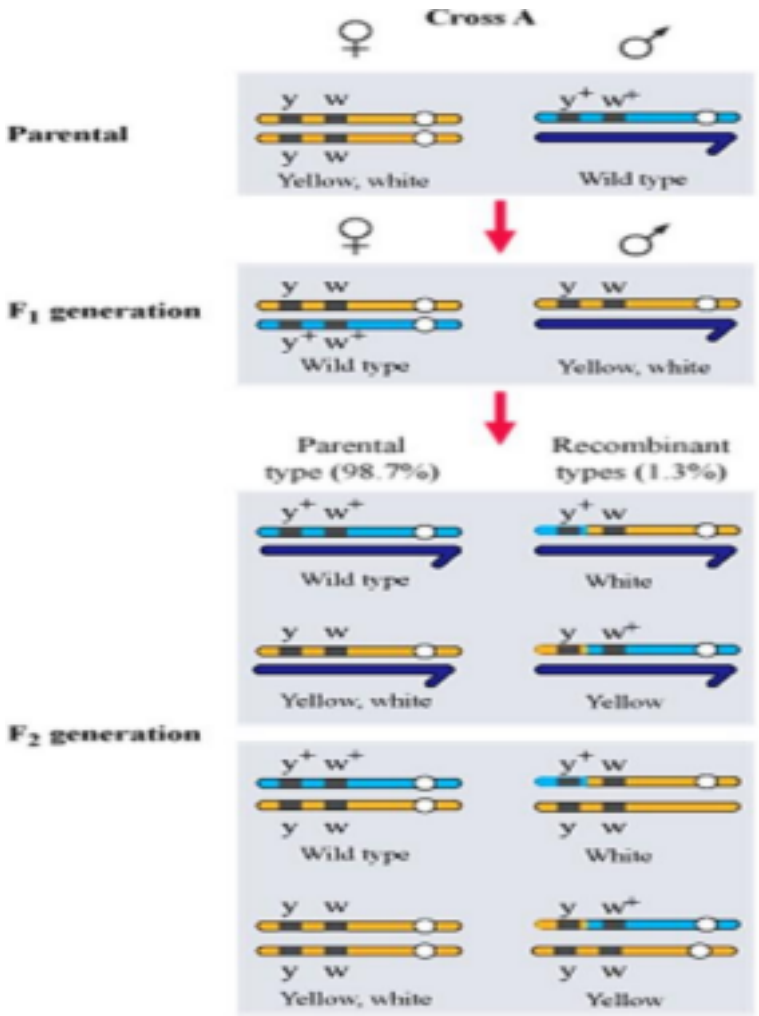
SECTION - C Section-C consists of one case followed by 6 questions linked to this case (Q.No.49 to 54). Besides this, 6 more questions are given. Attempt any 10 questions in this section. <u>The first attempted 10 questions would be evaluated.</u>	
Case	To answer the questions, study the graphs below for Subject 1 and 2 showing differentlevels of certain hormones. 

49	The peak observed in Subject 1 and 2 is due to A. estrogen B. progesterone C. luteinizing hormone D. follicle stimulating hormone
50	Subject 2 has higher level of hormone B, which is A. estrogen B. progesterone C. luteinizing hormone D. follicle stimulating hormone
51	If the peak of Hormone A does not appear in the study for Subject 1, which of the following statements is true? A. Peak of Hormone B will be observed at a higher point in the graph B. Peak of Hormone B will be observed at a point lower than what is given in the graph C. There will be no observed data for Hormone B D. The graph for Hormone B will be a sharp rise followed by a plateau
52	Which structure in the ovary will remain functional in subject 2? A. Corpus Luteum B. Tertiary follicle C. Graafian follicle D. Primary follicle

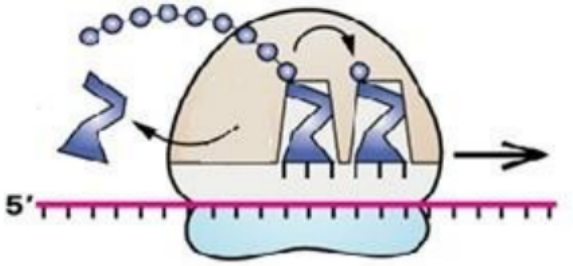
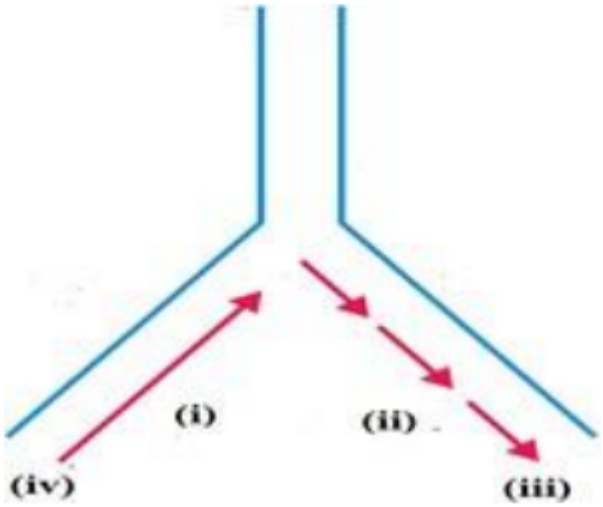
53	For subject 2 it is observed that the peak for hormone B has reached the plateau stage.After approximately how much time will the curve for hormone B descend? A. 28 days B. 42 days C. 180 days D. 280 days

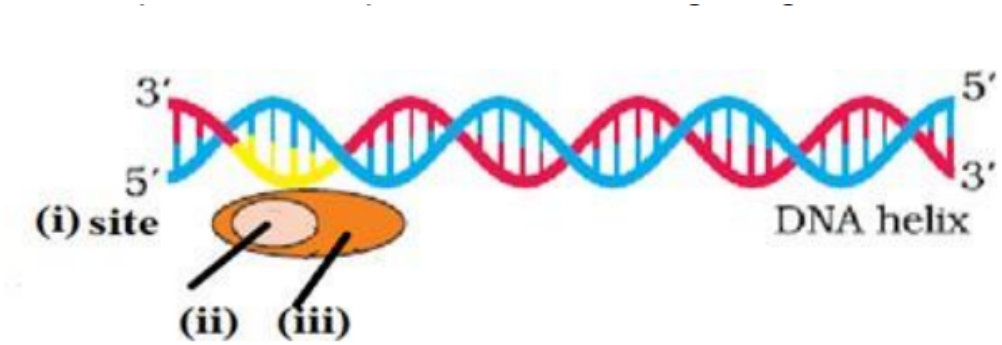
54	Which of the following statements is true about the subjects? A. Subject 1 is pregnant B. Subject 2 is pregnant C. Both subject 1 and 2 are pregnant D. Both subject 1 and 2 are not pregnant
55	The gene that controls the ABO blood group system in human beings has three alleles -I^A, $I^B$and i. A child has blood group O. His father has blood group A and mother has blood group B. Genotypes of other offsprings can be: i. I^BI^B ii. I^Ai iii. I^Bi iv. I^AI^B v. ii A. i, ii, iii, v B. ii, iii ,iv, v C. iii, iv, v D. iv, iii, i
56	Placed below is a karyotype of a human being..  On the basis of this karyotype, which of the following conclusions can be drawn: A. Normal human female B. Person is suffering from Colour Blindness

	C. Affected individual is a female with Down's syndrome D. Affected individual is a female with Turner's syndrome

57	Given below is a dihybrid cross performed on *Drosophila.*  Which of the following conclusions can be drawn on the basis of this cross? When yellow bodied (y), white eyed (w) Drosophila females were hybridized with brown bodied (y+), red eyed males (w+) and F1 progenies were intercrossed, F2 generation would have shown the following ratio: A. 1:2:1 because of linkage of genes B. 9:3:3:1 because of recombination of genes C. Deviation from 9:3:3:1 ratio because of segregation of genes

	D. Deviation from 9:3:3:1 ratio because of linkage of genes

58	Which cellular process is shown below?  A. DNA Replication B. Translation - Initiation C. Translation - Elongation D. Translation – Termination
59	Origin of replication of DNA in *E. coli* is shown below, Identify the labelled parts (i),(ii), (iii) and (iv)  A. (i)- discontinuous synthesis , (ii)- continuous synthesis (iii) 3' end (iv) 5'end B. (i)- continuous synthesis , (ii)- discontinuous synthesis (iii) 5' end (iv) 3'end C. (i)- discontinuous synthesis, (ii)- continuous synthesis

	(iii) 5’ end (iv) 3’end D. (i)- continuous synthesis , (ii)- discontinuous synthesis (iii) 3’ end (iv) 5’end
60	Transcription unit is represented in the diagram given below.  Identify site (i), factor (ii) and Enzyme (iii) responsible for carrying out the process. A. (i) Promoter Site, (ii) Rho factor (iii) RNA polymerase B. (i) Terminator Site, (ii) Sigma factor (iii) RNA polymerase C. (i) Promoter Site, (ii) Sigma factor (iii) RNA polymerase D. (i) Promoter Site, (ii) Sigma factor (iii) DNA polymerase

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Questions in lieu of diagram based questions for VI candidates Total Alternative Questions - 20	
Section - A	
2.	During megasporogenesis, potential megaspore mother cell undergoes following cell divisions to form gametophyte female A. two meiotic divisions and three mitotic division B. one meiotic and one mitotic divisions C. one meiotic and three mitotic divisions D. one meiotic and two mitotic divisions
5.	Apomictic embryos in Citrus arise from: A. diploid Egg B. synergids

	C. nucellus D. antipodal cells
7.	Choose the correct option wherein, the correct stages of the development of human embryo takes place. **Ovary** / **Fallopian Tube** / **Uterus** A: Morula / Fertilized egg / Blastocyst B: Unfertilized egg / Fertilized egg / Morula C: Unfertilized egg / Fertilized egg / Blastocyst D: Fertilized egg / Morula / Blastocyst
10.	On observing the pollen grain under the microscope, it was found to be long and ribbon shaped. The flower bearing these pollen grain will be pollinated by: A. Insects B. Water C. Air D. Birds
23.	Which one of the following is an incorrect statement for a t RNA molecule? i. It is an adapter molecule ii. Previously called as sRNA (soluble RNA) iii. tRNA has a codon loop that has bases complementary to the code, iv. It also has an amino acid acceptor end to which it binds to amino acids. v. It is non-specific for each amino acid. A. i , ii and iii B. ii, iii and iv C. i, ii, and iv D. i, iv and v

Section - B

29.	Which of the following is not a function of placenta? A. secretes relaxin B. facilitates removed of Co_2 and waste products C. secretes oxytocin D. supplies oxygen and nutrients
39.	Which one of the following is an incorrect statement with regard to pedigree analysis? A. It verifies that DNA is the carrier of genetic information. B. It helps to understand whether the trait depicted in the chart is dominant or recessive. C. It confirms that the trait is linked to one of the autosome. D. It helps to trace the inheritance of a specific trait.
44.	In order to form a dinucleotide during DNA synthesis which functional group at 3' must be free? A. Methyl group B. Phosphate group C. Carboxylic acid D. Hydroxyl
48..	The DNA fingerprinting pattern of child is A. Exactly similar to that of both the parents B. 100% similar to the father's DNA print C. 100% similar to the mother's DNA print D. 50% bands similar to father and rest similar to mother
Section – C	

Case	A biology student after studying about the different levels of hormones during the menstrual cycle was comparing 2 subjects (Patients). A table was created after looking at the levels of hormones A and B for Subject 1 and 2. Read the information in the table and answer the questions that follow (Q49 to 54):

	HORMONE A	HORMONE B
Subject 1	Shows a peak on the 14th Day of the menstrual cycle	Falls down during the luteal phase
Subject 2	Shows a peak on the 14th Day of the menstrual cycle	Level is maintained high in the luteal phase

49.	The peak observed in Subject 1 and 2 is due to A. Estrogen B. Progesterone C. Luteinizing Hormone D. Follicle Stimulating Hormone

50.	The Subject 2 has higher level of hormone B, which is A. Estrogen B. Progesterone C. Luteinizing Hormone D. Follicle Stimulating Hormone
51.	If the peak of Hormone A does not appear in the study for Subject 1, which of the following statement is true A. Peak of Hormone B will be observed at a higher point in the graph B. Peak of Hormone B will be observed at a point lower than what is given in the graph C. There will be no observed data for Hormone B D. The Hormone B will show a sharp rise followed by a plateau

52.	Which structure in the ovary will remain functional in subject 2? A. Corpus Luteum B. Tertiary follicle C. Graafian follicle D. Primary follicle
53.	For subject 2 it is observed that the peak for hormone B has reached the plateau stage. After approximately how much time will the curve for hormone B descend? A. 28 days B. 42 days C. 180 days D. 280 days
54.	Which of the following statements is true about the subjects? A. Subject 1 is pregnant B. Subject 2 is pregnant C. Subject 1 and 2 both are pregnant D. Subject 1 and 2 both are not pregnant
56.	Domestic wheat, which has 42 chromosomes, is probably hexaploid (6n), whereas the haploid number in the ancestral ones was 7. Find out the right reason as to how such plants are produced? A. Due to failure of segregation of chromatids during cell division cycle B. Due to the gain of extra copy of chromosome C. Due to failure of cytokinesis after telophase stage of cell division D. Due to the loss of extra copy of chromosome

57.	The following are results of crossing a female fly (AaBb) with a male fly (aabb). AaBb 1005 aabb 1000 Aabb 200 aaBb 210 Which two genotypes are the recombinant offspring? A. AaBb & Aabb B. AaBb & aaBb C. Aabb & aaBb D. AaBb & aabb
58.	On the ribosome, mRNA binds _____ and two sites in the _____ for subsequent amino acids to bind to be close enough to each other for the formation of a peptide bond. A. between the subunits; on the large subunit. B. to the large subunit; on the small subunit. C. to the small subunit; on the large subunit. D. to the small subunit; between the subunits.
59.	The main reason for the presence of both a leading and a lagging strand during DNA replication is, A. DNA polymerase can read and synthesize only in the direction of 3'-to-5' B. DNA polymerase can only synthesize one strand at a time C. Only one strand is available to be read at any given time D. There are not enough RNA primers to have both strands be synthesized simultaneously
60.	In a cell, DNA transcription is halted when A. RNA polymerase falls off of the DNA. B. The end of the DNA is reached. C. When a rho site is reached. D. When a stop codon is reached.

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