# CHAPTER 2 – HUMAN REPRODUCTION
## TEXTUAL EVALUATION

1. The mature sperms are stored in the
   a. Seminiferous tubules b.Vas deferens c. **Epididymis** d. Seminal vesicle
2. The male sex hormone testosterone is secreted from
   a. Sertoli cells b. **Leydig cell** c. Epididymis d. Prostate gland
3. The glandular accessory organ which produces the largest proportion of semen is
   a. **Seminal vesicle** b. Bulbourethral gland c. Prostate gland d. Mucous gland
4. The male homologue of the female clitoris is
   a. Scrotum b. **Penis** c. Urethra d.Testis
5. The site of embryo implantation is the
   a. **Uterus** b. Peritoneal cavity c. Vagina d. Fallopian tube
6. The foetal membrane that forms the basis of the umbilical cord is
   a. **Allantois** b. Amnion c. Chorion d. Yolk sac
7. The most important hormone in intiating and maintaining lactation after birth is
   a. Oestrogen b. FSH c. **Prolactin** d. Oxytocin
8. Mammalian egg is
   a. Mesolecithal and non cleidoic b. Microlecithal and non cleidoic
   c. **Alecithal and non cleidoic** d. Alecithal and cleidoic
9. The process which the sperm undergoes before penetrating the ovum is
   a. Spermiation b. Cortical reaction c. Spermiogenesis d. **Capacitation**
10. The milk secreted by the mammary glands soon after child birth is called
    a. Mucous b. **Colostrum** c. Lactose d. Sucrose
11. Colostrum is rich in
    a. Ig E b. **Ig A** c. Ig D d. Ig M
12. The Androgen Binding Protein (ABP) is produced by
    a. Leydig cells b. Hypothalamus c. **Sertoli cells** d. Pituitary gland
13. Which one of the following menstrual irregularities is correctly matched?
    a. Menorrhagia - excessive menstruation b. **Amenorrhoea - absence of menstruation**
    c. Dysmenorrhoea - irregularity of menstruation d. Oligomenorrhoea - painful menstruation
14. Find the wrongly matched pair

| | |
|---|---|
| a. Bleeding phase | - fall in oestrogen and progesterone |
| b. Follicular phase | - rise in oestrogen |
| c. **Luteal phase** | **- rise in FSH level** |
| d. Ovulatory phase | - LH surge |

15. **A** – In human male, testes are extra abdominal and lie in scrotal sacs.
    **R** – Scrotum acts as thermoregulator and keeps temperature lower by 2oC for normal sperm production . **(a) A and R are true, R is the correct explanation of A**
16. **A** – Ovulation is the release of ovum from the Graafian follicle.

**R** – It occurs during the follicular phase of the menstrual cycle. **(c) A is true, R is false**

17. **A** – Head of the sperm consists of acrosome and mitochondria.
**R** – Acrosome contains spiral rows of mitochondria. **(d) Both A and R are false**

18. Mention the differences between spermiogenesis and spermatogenesis.

| Spermiogenesis | Spermatogenesis |
|---|---|
| The spermatids are transformed into mature spermatozoa (sperms) by the process called spermiogenesis. | Spermatogenesis is the sequence of events in the seminiferous tubules of the testes that produce the male gametes, the sperms. |
| Follicle Stimulating Hormone (FSH) and Lutenizing Hormone (LH). FSH stimulates testicular growth and enhances the production of Androgen Binding Protein (ABP) by the sertoli cells and helps in the process of spermiogenesis. | LH (Leutenizing Hormone) acts on the Leydig cells and stimulates the synthesis of **testosterone** which in turn stimulates the process of spermatogenesis. |

19. At what stage of development are the gametes formed in new born male and female?
**Answer:** (i) In a new born male, spermatogenesis (formation of sperms) starts at the age of puberty. It is initiated due to the increase in the release of Gonadotropin Releasing hormone.
(ii) Oogenesis is the process of development of the female gamete or egg in the ovaries. During foetal development, certain cells in the germinal epithelium of foetal ovary divide by mitosis and produce millions of oogonia or egg mother cells.
(iii) No more oogonia are added after birth. The oogonial cells enter into prophase I of meiosis to form primary oocytes which are temporarily arrested at this stage.
(iv) The primary oocytes then become primary follicles. From birth to puberty, a large number of follicles degenerate. At puberty the primary follicle undergoes further development and finally releases the ovum.

20. Expand the acronyms a. FSH b. LH c. hCG d. hPL
**Answer:** (a) FSH - Follicular Stimulating Hormone
(b) LH - Leutinising Hormone
(c) hCG - Human Chorionic Gonadotropin
(d) hPL - Human Placental Lactogen.

21. How is polyspermy avoided in humans?
**Answer:** (i) During the process of fertilization in humans, the acrosome of the sperm enters through the corona radiata and zona pellucida layers of the ovum by releasing a enzyme called hyaluronidase which is called acrosomal reaction.
(ii) Once fertilization is accomplished, cortical granules from the cytoplasm of the ovum form a barrier called the fertilization membrane around the ovum. This prevents further penetration of other sperms. Thus polyspermy (entry of more than one sperm into an egg) is prevented.

22. What is colostrum? Write its significance.

**Answer:** The mammary glands of a female secrete a yellowish fluid called colostrum during the initial days after parturition.

**Significance:**

(i) It has less lactose than milk and almost no fat, but it contains more proteins, vitamin A and minerals.

(ii) It is rich in IgA antibodies. It helps to protect the infants digestive tract against bacterial infections.

(iii) It is the ideal food for infants since it contains all constituents in suitable concentration and is easily digestable.

(iv) It is loaded with immune, growth and tissue repair factors.

(v) It acts as a natural antimicrobial agent to actively stimulate the maturation of the infant's immune system.

(v) It is fully sufficient till 6 months of age for all infants.

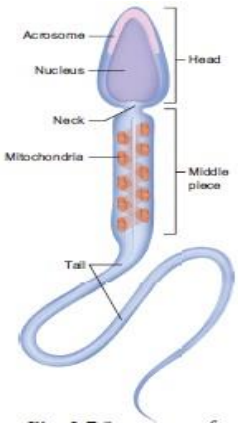
23. Placenta is an endocrine tissue. Justify.

**Answer:** (i) Human embryo is surrounded by 3 embryonic membranes. The chorionic villi and uterine tissues form the disc shaped placenta. It is a temporary endocrine organ formed during pregnancy and connects the foetus to the uterine wall through the umbilical cord.

(ii) During pregnancy, the placenta acts as a temporary endocrine gland and produces large quantities of human Chorionic Gonadotropin (hCG), human Chorionic Somatomammotropin (hCS) or human Placental Lactogen (hPL), oestrogens and progesterone which are essential for a normal pregnancy.

(iii) A hormone called relaxin is also secreted during the later phase of pregnancy which helps in relaxation of the pelvic ligaments at the time of parturition. It should be noted that hCG, hPL and relaxin are produced only during pregnancy. Thus placenta is an endocrine tissue.

24. Draw a labeled sketch of a spermatozoan.



25. What is inhibin? State its functions.

**Answer:** (i) Inhibin is a hormone secreted by the sertoli cells in the stratified epithelium of the seminiferous tubule in the testis.

(ii) Function: It is involved in the negative feedback control of sperm production.

26. Mention the importance of the position of the testes in humans.

**Answer:** Testes are the primary male sex organs. They are a pair of ovoid bodies lying in the scrotum. The scrotum is a sac of skin that hangs outside the abdominal cavity. Since viable sperms cannot be produced at normal body temperature, the scrotum is placed outside the abdominal cavity to provide a temperature 2-3°C lower than the normal internal body temperature. Thus, the scrotum acts as a thermoregulator for spermatogenesis.

27. What is the composition of semen?

**Answer:** (i) Semen is a milky white fluid which contains sperms and the seminal plasma secreted from the seminal vesicles, prostrate gland and bulbourethral glands.

(ii) The seminal plasma contains fructose sugar, ascorbic acid, prostaglandins and a coagulating enzyme called vesiculase which enhance sperm mobility. It also contains citrate, several enzymes and prostate specific antigens. It also provides nutrients and contains chemicals that protect and activate the sperms.

(iii) It acts as a transport medium for the sperms.

28. Name the hormones produced from the placenta during pregnancy.

**Answer:** Hormones produced by the placenta during pregnancy are:

(i) human Chorionic Gonadotropin (hCG)
(ii) human Chorionic Somatomammotropin (hCS)
(iii) human Placental Lactogen (hPL)
(iv) Oestrogens
(v) Progesterone
(vi) Relaxin

29. Define gametogenesis.

**Answer:** Gametogenesis is the process of formation of gametes i.e., sperms and ovary from the primary sex organs in all sexually reproducing organisms. Meiosis plays the most significant role in the process of gametogenesis.

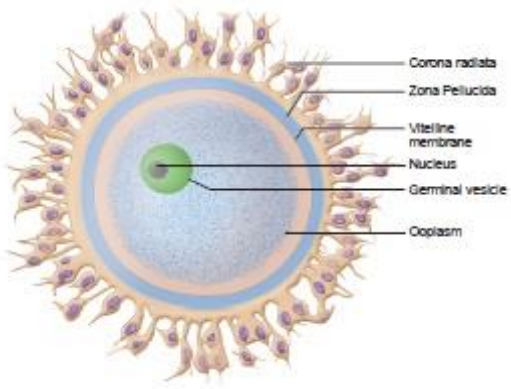
30. Describe the structure of the human ovum with a neat labelled diagram.

**Answer:** (i) Human ovum is non-cleidoic, alecithal and microscopic in nature.

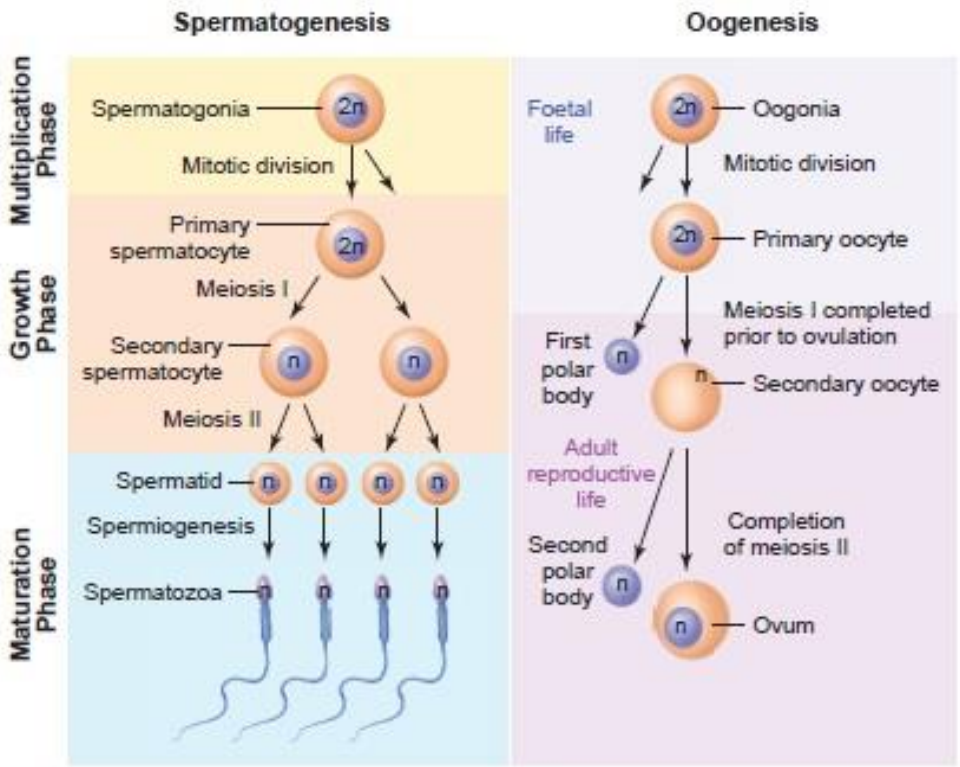
(ii) Its cytoplasm called ooplasm contains a large nucleus called the germinal vesicle.

(iii) The ovum is surrounded by three coverings namely an inner thin transparent vitelline membrane, middle thick zona pellucida and outer thick coat of follicular cells called corona radiata.

(iv) Between the vitelline membrane and zona pellucida is a narrow perivitelline space.




31. Give a schematic representation of spermatogenesis and oogenesis in humans.




32. Explain the various phases of the menstrual cycle.

**Answer:** Menstrual cycle comprises of the following phases

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

**1. Menstrual phase:**

(i) The cycle starts with the menstrual phase when menstrual flow occurs and lasts for 3-5 days.

(ii) Menstrual flow is due to the breakdown of endometrial lining of the uterus, and its blood vessels due to decline in the level of progesterone and oestrogen.

(iii) Menstruation occurs only if the released ovum is not fertilized.

**2. Follicular or proliferative phase:**

(i) The follicular phase extends from the 5th day of the cycle until the time of ovulation

(ii) During this phase, the primary follicle in the ovary grows to become a fully mature Graafian follicle and simultaneously, the endometrium regenerates through proliferation.

(iii) These changes are induced by the secretion of gonadotropins like FSH and LH, which increase gradually during the follicular phase.

(iv) It stimulates follicular development and secretion of oestrogen by the follicle cells.

**3. Ovulatory phase:**

(i) Both LH and FSH attain peak level in the middle of the cycle (about the $14^{th}$ day).

(ii) Maximum secretion of LH during the mid cycle called LH surge induces the rupture of the Graafian follicle and the release of the ovum (secondary oocyte) from the ovary wall into the peritoneal cavity. This process is called as ovulation.

**4. Luteal or secretory phase:**

(i) During luteal phase, the remaining part of the Graafian follicle is transformed into a transitory endocrine gland called corpus luteum.

(ii) The corpus luteum, secretes large amount of progesterone- which is essential for the maintenance of the endometrium.

(iii) If fertilisation takes place, it paves way for the impla,ntation of the fertilized ovum.

(iv) The uterine wall secretes nutntious fluid in the uterus for the foetus.So, this phase is also called as secretory phase.

(v) During pregnancy all events of menstrual cycle stop and there is no menstruation.

33. Explain the role of oxytocin and relaxin in parturition and lactation.

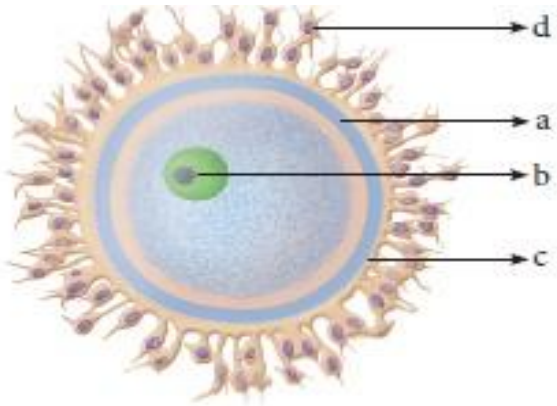
**Answer:** Relaxin - It is a hormone secreted by the placents and also found in corpus luteum. It helps in relaxation of the pelvic ligaments at the time of parturition.

(i) Oxytocin - It is a hormone produced by posterior lobe of pituitary gland. As pregnancy progresses, increase in oxytocin concentration promotes, uterine contractions which facilitale downward movement of' the foetus. The powerful concentration of the uterine muscles leads to the expulsion of the baby through birth canal resulting in child birth or parturition.

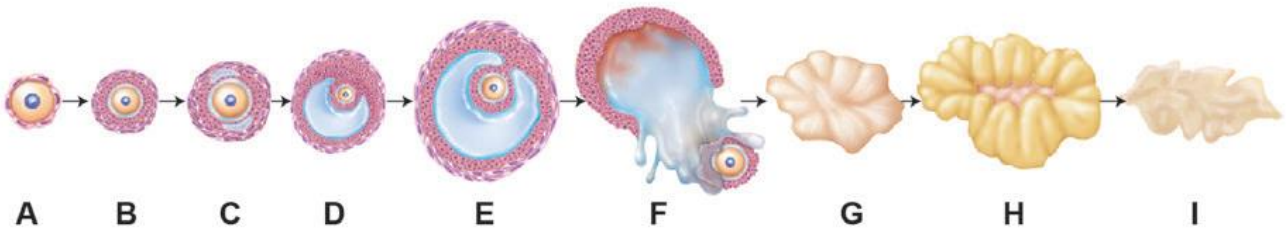
(ii) It causes the "Let-Down" reflex - the actual ejection of milk from the alveoli of the mammary glands. During lactation, oxytocin also stimulates the recently emptied uterus to contract, helping it to return to pre - pregnancy size.

34. Identify the given image and label its parts marked as a, b, c and d

**Answer:** Human Ovum
a - Vitelline membrane
b - Nucleus
c - Zona Pellucida
d - Corona radiata




35. The following is the illustration of the sequence of ovarian events (a-i) in a human female.




a) Identify the figure that illustrates ovulation and mention the stage of oogenesis it represents.

b) Name the ovarian hormone and the pituitary hormone that have caused the above-mentioned events.

c) Explain the changes that occurs in the uterus simultaneously in anticipation.

d) Write the difference between C and H.

**Answer:** (a) The figure 'F' illustrates ovulation. It represents the maturation stage of oogenesis.

(b) The pituitary hormone leutinising hormone and the ovarian hormone oestrogen are responsible for the above mentioned events.

(c) (i) The -endometrium of the uterus becomes thicker to receive the fertilized ovum in anticipation. (Implantation)

(ii) The uterine wall secretes nutritious fluid in the uterus for the foetus.

(d) 'C' indicates developmental stage of follicle in the Ovary when the ovum has not been released. 'H' indicates a stage where the ovum has been released and the remaining part of the ruptured graafian follicle has transformed into a temporary endocrine gland called corpus luteum to produce additional hormones for pregnancy.

**BOOK INTERIOR:-**

1. Testosterone is secreted by ____
   (a) spermatocytes (b) sperm (c) polar bodies **(d) leydig cells**
2. _____ is not a part of female reproductive system in human.
   (a) Cervix (b) Infundibulum (c) Isthmus **(d) Prostate gland**
3. _____ is popularly known as sperm lysin.
   (a) Inhibitin **(b) Hyaluronidase** (c) Androgen (d) Acrosome
4. The whole process of spermatogenesis takes about _____ days.
   (a) 25 (b) 42 **(c) 64** (d) 72
5. The _____ is the smallest human cell.
   **(a) sperm** (b) neuron (c) nephron (d) alveoli
6. The corpus luteum secretes large amount of _____
   (a) testosterone (b) relaxin (c) oestrogen **(d) progesterone**
7. _____ is not linked to polymenorrhoea
   (a) Shorter cycle (b) Gland activity (c) Malnutrition **(d) Pain**
8. _____ may be due to cancer of the ovary.
   (a) Amenorrhoea (b) Dysmenorrhoea **(c) Menorrhagia** (d) Oligomenorrhoea
9. _____ is a berry shaped duster of cells.
   (a) Blastula (b) Gastrula **(c) Morula** (d) Zygote
10. The term after birth refers to _____
    (a) Parturition (b) Lactation **(c) Remains of placenta** (d) Corpus albicans
11. 'Let Down' reflex for lactation is caused by _____
    (a) Prolactin **(b) Oxytocin** (c) Lactogenic hormone (d) Progesterone
12. Among the extra embryonic membranes the _____ is the outer most membrane.
    (a) amnion **(b) chorion** (c) allantois (d) vitelline membrane
13. The dividing embryo takes _____ days to move to the uterus from the fallopian tube.
    **(a) 10** (b) 15 (c) 4-5 (d) 2
14. Capacitation is a _____ event.
    (a) physical **(b) biochemical** (c) both a and c (d) Enzyme mediated
15. The transfer of sperms by the male into the female genital tract is called _____
    (a) implantation (b) parturition **(c) insemination** (d) gastrulation
16. Attachment of blastocyst to the uterine wall is called _____
    **(a) Implantation** (b) Parturition (c) Insemination (d) gastrulation
17. Expulsion of baby from the mother's womb is called _____
    (a) implementation **(b) parturition** (c) insemination (d) gestation
18. _____ cells nourish the sperms.
    (a) Leydig cells (b) Interstitial cells (c) Spermatogonic cells **(d) Sertoli cells**
19. _____ is a hormone produced by sertoli cells.
    **(a) Inhibin** (b) Progesterone (c) Testosterone (d) Oestrogen

20. The _____ cells of the testis are endocrine in nature.
(a) sertoli **(b) Leydig** (c) nurse (d) spermatogonic
21. The male hormones are called _____
(a) estrogen (b) progesterone (c) relaxin **(d) androgens**
22. _____ stores the sperms temporarily until they mature.
(a) testis **(b) epididymis** (c) vasa efferentia (d) vas deferens
23. Bulbourethral glands are also called _____
(a) prostate gland **(b) Cowper's gland** (c) Skene's glands (d) Bartholin's glands
24. The seminal fluid has a coagulating enzyme called _____
**(a) vesiculase** (b) hyaluronidase (c) amylase (d) lactase
25. The proximal part of the fallopian tube bears a funnel shaped _____
(a) Graafian follicle (b) Oogonia **(c) Infundibulum** (d) corpus luteum
26. The fmger shaped _____ in the female reproductive system collect the ovum after ovulation.
(a) Infundibulum **(b) Fimbriae** (c) Ampulla (d) Isthmus
27. _____ is the birth canal.
(a) Cervix (b) Cervical canal (c) Uterus **(d) Vagina**
28. A mature follicle produces _____ polar bodies during oogenesis.
(a) four **(b) three** (c) two (d) one
29. The _____ glands occur posterior to the vagina.
(a) Skene's glands (b) Cowper's gland (c) prostate gland **(d) Bartholin's glands**
30. The _____ glands are located on the anterior wall of vagina.
**(a) Skene's glands**(b) Bartholin's glands(c) prostate gland(d) Cowper's gland
31.The thin ring of tissue that particularly closes the vaginal opening ____
(a) labia majora **(b) hymen** (c) labia minora (d) clitoris
32. _____ is a hormone secreted by the placenta and also found in the corpus luteum
(a) Oxytocin **(b) Relaxin** (c) Inhibin (d) Testosterone
33. The hormone ____ brings about powerful contraction of uterine muscles during child birth.
(a) Relaxin (b) Oestrogen (c) Progesterone **(d) Oxytocin**
34. The hormone _____ produced by anterior pituitary plays a major role in lactation.
(a) oxytocin **(b) prolactin** (c) progesterone (d) oestrogen
35. Colostrum has less _____ than milk.
(a) protein (b) minerals **(c) lactose** (d) vitamin A
36. _____ is a natural antimicrobial agent to stimulate the maturation of infants immune system.
(a) IgA antibodies (b) Amniotic fluid (c) Milk **(d) Colostrum**

**MATCH THE FOLLOWING:**

1) Hyaluronidase - **Acrosomal reaction**
2) Vesiculase - **Seminal vesicle**
3) Testosterone - **Interstitial cells**
4) Inhibin - **Sertoli cells**
5) Corpus luteum – **follicle**
6) Skene's gland - **Prostate gland**
7) Uterus - **secretory phase**
8) Ovulation - **Leutinising hormone**
9) Ley dig cell – **Testosterone**
10) Sertoli cells –**Inhibin**
11) Corpus luteum – **progesterone**
12) Placenta –**Relaxin**

**ASSERTION & REASON:-**

1) Assertion: The primary germ layers are formed during gastrulation.

Reason: The body organs are formed from primary germ layers.

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

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

C. A is true, R is false

D. Both A and R are false

**Answer: A and R are true, R is the correct explanation of A**

2) Assertion: The process of oogenesis must get completed before fertilization

Reason: The egg after II Meiosis is ready for fertilization.

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

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

C. A is true, R is false

D. Both A and R are false

**Answer: Both A and R are false**

3) Assertion: By 36 week, the baby is positioned into pelvis for parturition

Reason: The Braxter -Hick's contractions will begin for parturition.

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

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

C. A is true, R is false

D. Both A and R are false

**Answer: A is true, R is false**

1) The inner glandular layer of the uterus is called _____ **Answer:** endometrium
2) The acrosome is formed from _____**Answer:** Golgi body
3) 3)The cap like pointed tip of a sperm is called ____ **Answer:** acrosome
4) The middle piece of the sperm contains _____ **Answer:** mitochondria
5) The acrosome contains the enzyme _____ **Answer:** Hyaluronidase
6) A mature ovarion follicle is called _____ **Answer:** graafian follicle
7) The outer thick coat covering ovum is called _____ **Answer:** corona radiata
8) Puberty is also called ____ **Answer:** menarche
9) Menstruation does not occur during _____ **Answer:** pregnancy
10) Release of ovum from follicle is called _____ **Answer:** ovulation
11) When the corpus luteum. degenerates it leaves a scar tissue called _____ **Answer:** corpus albicans
12) Absence of menstruation is called _____ **Answer:** Amenorrhoea
13) A menstrual cycle that is shorter is called _____ **Answer:** Polymenorrhoea
14) Pain associated with menstruation is called _____ **Answer:** Dysmenorrhoea
15) Heavy and prolonged menstrual period is called _____ **Answer:** Menorrhagia
16) Infrequent menstrual period is called _____ **Answer:** Oligomenorrhoea
17) The ecofriendly way to destroy sanitary napkins are by use of _____ **Answer:** Incinerator
18) Colostrum does not contain ____ **Answer:** fat
19) Failure of spermatogenesis is called _____ **Answer:** azospermia
20) Surgical removal of testis is called _____ **Answer:** Orchidectomy
21) The mitochandrial spiral in middle piece of sperm is called _____ **Answer:** Nebenkern

**TWO MARKS:-**

1) Define fertilisation.

**Answer:** Fusion of male and female gametes to form zygote, is called fertilisation.

2) Define Cleavage.

**Answer:** Cleavage refers to the rapid mitotic divisions of the zygote which convert the single celled zygote into a multicellular structure called blastocyst.

3) Define Implantation.

**Answer:** Attachment of blastocyst to the uterine wall is called Implantation.

4) What is Placentation?

**Answer:** The process of formation of placenta which is the intiraate connection between foetus and uterine wall of the mother for exchange of nutrients is called Placentation.

5) What is Gastrulation?

**Answer:** It is a process by which blastocyst is changed into a gastrula with three primary germ layers, namely ectoderm, endoderm and mesoderm.

6) What is Organogenesis?

**Answer:** Formation of specific tissues, organs and organ systems from three germ layers is called Organogenesis.

7) What is Parturition?

**Answer:** Expulsion of the baby from the mother's womb is called Parturition.

8) Name the types of cells found in seminiferous tubule.

**Answer:** (i) Sertoli cells or nurse cell
(ii) Spermatogonic cells

9) What are leydig cells?

**Answer:** (i) Leydig cells or Interstitial cells are found in soft connective tissue surrounding the seminiferous tubules of tests and are endocrine in nature.
(ii) They secrete androgens namely testosterone. Hormone which initiates the process of spermatogenesis.

10) Name the accessory ducts associated with male reproductive system.

**Answer:** The accessory ducts associated with the male reproductive system include rete testis, vasa efferentia, epididymis and vas deferens.

11) What is the significance of epididymis?
**Answer:** (i) The epididymis is a single highly coiled tube that temporarily stores the spermatozoa and they undergo physiological maturation and acquire increased motility and fertilizing capacity.
(ii) It is found in the testis.

12) What is ectopic pregnancy?
**Answer:** (i) If the fertilised ovum is implanted outside the uterus it results in ectopic pregnancy.
(ii) The growth of the embryo may cause internal bleeding, infection and in some cases even death due to rupture of the fallopian tube.

13) What is abdominal delivery or Caesarean section?
**Answer:** When normal vaginal delivery is not possible due to factors like position of the baby and nature of the placenta, the baby is delivered through a surgical incision in the woman's abdomen and uterus. It is also termed as abdominal delivery or Caesarean Section or 'C' Section.

14) What is "Let - Down" reflex?
**Answer:** The hormone oxytocin brings about the "Let - down" reflex which is the actual ejection of milk from the alveoli of the mammary glands.

15) What is acrosome?
**Answer:** (i) Acrosome is a small cap like pointed structure present at the tip of the nucleus -and is formed mainly from the Golgi body of the spermatid.
(ii) It contains hyaluronidase, a proteolytic enzyme, popularly known as sperm lysin which helps to penetrate the ovum during fertilisation.

16) What is LH surge?
**Answer:** During the ovulatory phase of the menstrual cycle, maximum secretion of leutinising hormone occurs during the mid cycle (about 14 day) which is called LH surge and induces ovulation.

17) What is corpus luteum?
**Answer:** (i) It is a temporary endocrine gland formed from the ruptured Graafian follicle.
(ii) It secretes a large amount of progesterone which is essential for maintenance of the endometrium of the uterus. If fertilization does not occur it degenerates.

18) What is polymenorrhoea?
**Answer:** It denotes a menstrual cycle that is shorter than 21 days which may be due to hyperactivity of anterior pituitary gland, psychological disturbances, malnutrition, sexually transmitted disease etc.

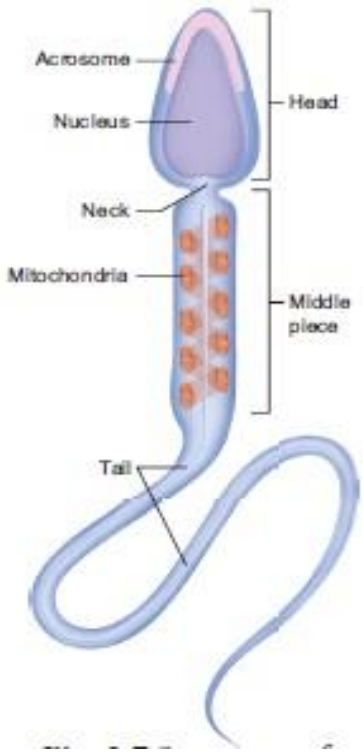
19) What is menorrhagia?
**Answer:** (i) Heavy and prolonged menstrual period that disrupts a woman's normal activities is referred to as menorrhagia.
(ii) Menorrhagia may be due to hormonal imbalance, ovarian dysfunction, uterine fibroids and may also be due to cancer of the ovary, uterus or cervix.

20) What is menopause?
**Answer:** (i) Menopause is the phase in a women's life when ovulation and menstruation stops.
(ii) The average age of menopause is 45-50 years. It indicates the permanent cessation of the primary functions of the ovaries.

21) What is Polycystic ovary syndrome (PCOS)?
**Answer:** PCOS is a complex endocrine system disorder that affects women in their reproductive years. Polycystic means 'many cysts'. It refers to many partially formed follicles on the ovaries, which contain an egg each. But they do not grow to maturity or produce eggs that can be fertilized. Women with PCOS may experience irregular menstrual cycles, increased androgen levels, excessive facial or body hair growth (hirsutism), acne, obesity, reduced fertility and increased risk of diabetes. Treatment for PCOS includes a healthy lifestyle,weight loss and targeted hormone therapy.

**FIVE MARKS:-**

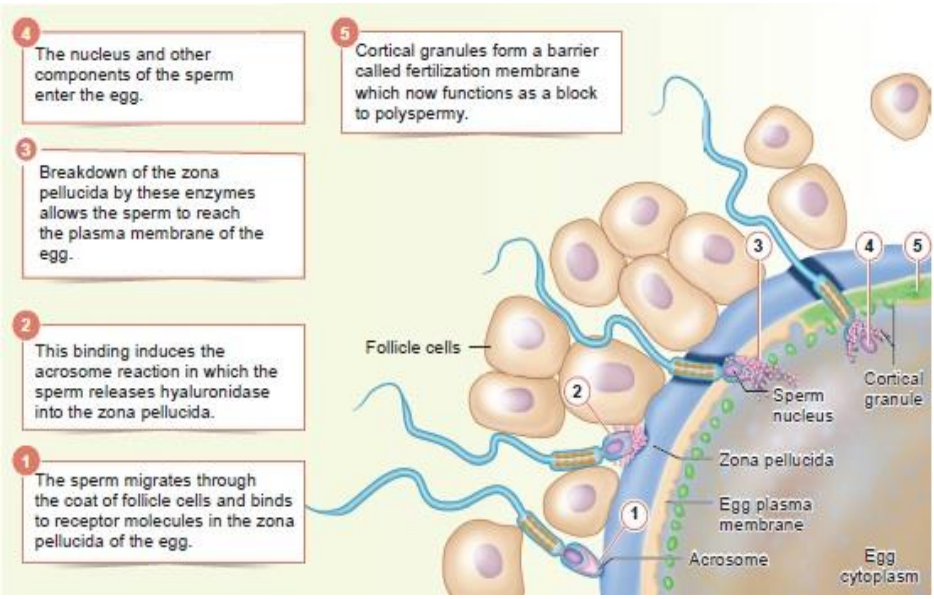
1) Describe the structure of a sperm.
**Answer:** Structure of human spermatozoan:
(i) The human sperm is a microscopic, flagellated and motile gamete. The whole body of the sperm is enveloped by plasma membrane and is composed of a head, neck and a tail.
(ii) The head comprises of two parts namely acrosome and nucleus.
(iii) Acrosome is a small cap like pointed structure present at the tip of the nucleus and is formed mainly from the golgi body of the spermatid.
(iv) It contains hyaluronidase, a proteolytic enzyme, popularly known as sperm lysin which helps to penetrate the ovum during fertilisation.
(v) The neck is very short and is present between the head and the middle piece. It contains the proximal centriole towards the nucleus which plays a role in the first division of zygote and the distal centriole gives rise to the axial filament of the sperm.
(vi) The middle piece possesses mitochondria spirally twisted around



the axial filament called mitochondrial spiral or nebenkern. It produces energy in the form of ATP molecules for the movement of sperms.

2) Explain the process of fertilization in human beings.

**Answer:** (i) Fertilization occurs when a haploid sperm fuses with a haploid ovum to form a fertilized egg or diploid zygote.




(ii) The sperms deposited in the female reproductive tract undergo capacitation, which is a biochemical event that enables the sperm to penetrate and fertilise the egg.

(iii) Fertilization occurs only if the ovum and sperms are transported simultaneously to the ampullary isthmic junction of the fallopian tube.

(Iv) Before a sperm can enter the egg, it must penetrate the multiple layers of granulosa (follicular) cells which are around the ovum forming the corona radiata. The follicular cells are held together by an adhesive cementing substance called hyaluronic acid.

(v) The acrosomal membrane disintegrates releasing the proteolytic enzyme, hyaluronidase during sperm entry through the corona radiata and zona pellucida. This is called acrosomal reaction.

(vi) Once fertilisation is accomplished, cortical granules from the cytoplasm of the ovum form a barrier called the fertilisation membrane around the ovum preventing further penetration of other sperms. Thus polyspermy is prevented. This is followed by cleavage.

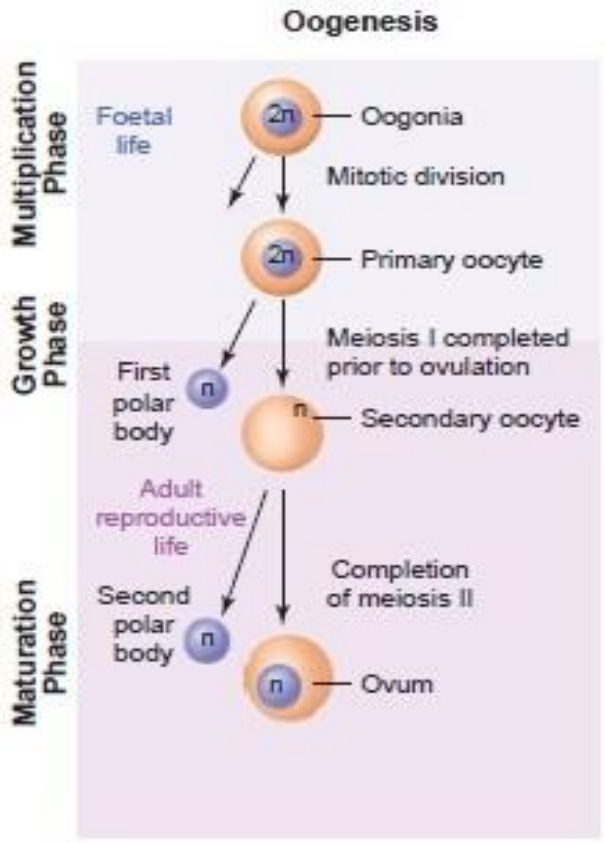
3. Explain the structure and function of mammary glands.

**Answer:** The mammary glands are modified sweat glands present in both sexes. It is rudimentary in the males and functional in the females. A pair of mammary glands is located in the thoracic region. It contains glandular tissue and variable quantities of fat with a median nipple surrounded by a pigmented area called the areola. Several sebaceous glands called the areolar glands are found on the surface and they reduce cracking of the skin of the nipple. Internally each mammary gland consists of 2-25 lobes, separated by fat and connective tissues. Each lobe is made up of lobules which contain acini or alveoli lined by epithelial cells. Cells of the alveoli secrete milk. The alveoli open into mammary tubules. The tubules of each lobe join to form a mammary duct. Several mammary ducts join to form wider mammary ampulla which is connected to the lactiferous duct in the nipple. Under the nipple, each lactiferous duct expands to form the lactiferous sinus which serves as a reservoir of milk. Each lactiferous duct opens separately by a minute pore on the surface of the

nipple. Normal development of the breast begins at puberty and progresses with changes during each menstrual cycle. In non-pregnant women, the glandular structure is largely underdeveloped and the breast size is largely due to amount of fat deposits. The size of the breast does not have an influence on the efficiency of lactation.

4. Explain the process of oogenesis.

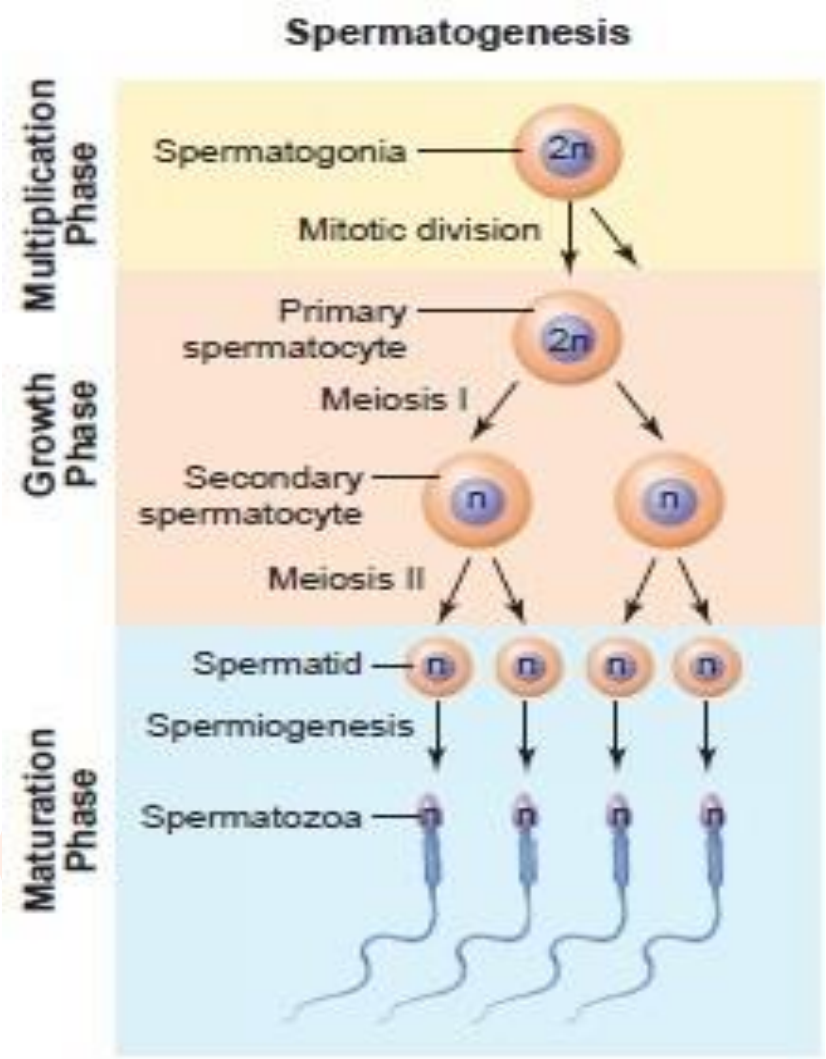
**Answer:** Oogenesis is the process of development of the female gamete or ovum or egg in the ovaries. During foetal development, certain cells in the germinal epithelium of the foetal ovary divide by mitosis and produce millions of egg mother cells or oogonia. No more oogonia are formed or added after birth. The oogonial cells start dividing and enter into Prophase- I of meiotic division-I to form the primary oocytes which are temporarily arrested at this stage. The primary oocytes then get surrounded by a single layer of granulose cells to form the primordial or primary follicles. A large number of follicles degenerate during the period from birth to puberty, so at puberty, only 60,000 to 80,000 follicles are left in each ovary. The primary follicle gets surrounded by many layers of granulosa cells and a new theca layer to form the secondary follicle. A fluid filled space, the antrum develops in the follicle and gets transformed into a tertiary follicle. The theca layer gets organized into an inner theca intema and an outer theca extema. At this time, the primary oocyte within the tertiary follicle grows in size and completes its first meiotic division and forms the secondary oocyte. It is an unequal division resulting in the formation of a large haploid secondary oocyte and a first polar body. The first polar body disintegrates. During fertilization, the secondary oocyte undergoes second meiotic division and produces a large cell, the ovum, and a second polar body. The second polar body also degenerates. The tertiary follicle eventually becomes a mature follicle or Graffian follicle. If fertilization does not take place, the second meiotic division is never completed and the egg disintegrates. At the end of gametogenesis in females, each primary oocyte gives rise to only one haploid ovum.




5. Describe the spermatogenesis with diagram.

**Answer:** Spermatogenesis is the sequence of events in the seminiferous tubules of the testes that produce the male gametes, the sperms. During development, the primordial germ cells migrate into the testes and become immature germ cells called sperm mother cells or spermatogonia in the inner

surfaces of the seminiferous tubules. The spermatogonia begin to undergo mitotic division at puberty and continue throughout life. In the first stage of spermatogenesis, the spermatogonia migrate among Sertoli cells towards the central lumen of the seminiferous tubule and become modified and enlarged to form primary spermatocytes which are diploid with 23 pairs i.e., 46 chromosomes. Some of the primary spermatocytes undergo first meiotic division to form two secondary spermatocytes which are haploid with 23 chromosomes each. The secondary spermatocytes undergo second meiotic division to produce four haploid spermatids. The spermatids are transformed into mature spermatozoa (sperms) by the process called spermiogenesis. Sperms are finally released into the cavity of seminiferous tubules by a process called spermiation. The whole process of spermatogenesis takes about 64 days. At any given time, different regions of the seminiferous tubules contain spermatocytes in different stages of development. The sperm production remains nearly constant at a rate of about 200 million sperms per day. Spermatogenesis starts at the age of puberty and is initiated due to the increase in the release of Gonadotropin-Releasing Hormone (GnRH) by the hypothalamus. GnRH acts on the anterior pituitary gland and stimulates the secretion of two gonadotropins namely Follicle Stimulating Hormone (FSH) and Luteinizing Hormone (LH). FSH stimulates testicular growth and enhances the production of Androgen Binding Protein (ABP) by the Sertoli cells and helps in the process of spermiogenesis. LH acts on the Leydig cells and stimulates the synthesis of testosterone which in turn stimulates the process of spermatogenesis.



## HOTS QUESTIONS:-

**1. A proper understanding of menstrual cycle can help immensely in family planning. Do you agree with the statement? Provide reasons for your answer.**

**Ans.** 1. Yes, a proper understanding of menstrual cycle can help in family planning as this knowledge can be used to avoid the meeting of sperms and ovum.
2. This is known as periodic abstinence or rhythm method of birth control, i.e. temporary avoidance of sex.
3. In this method, a couple can avoid (or) abstain from coitus from day 10-17 of the menstrual cycle because ovulation occurs during this period.
4. The chances of fertilisation are very high during this period. Thus, we can say that it helps in family planing.

**2. In our society, the women are often blamed for giving birth to daughters. Can you explain why this is not correct?**

**Ans.** 1. Women are blamed for giving birth daughters.
2. This is wrong because sex of the baby is determined by the sperm that can have either X (or)Y - chromosome.
3. Women have only one type of chromosome (X) in all the ova.
4. If the sperm having X-chromosome fertilizes the ovum (X), the resulting zygote (XX) will become a female.
5. If the sperm having Y-chromosome fertilizes the ovum (X), the resulting zygote (XY) will become a male.

# CHAPTER 3 – REPRODUCTIVE HEALTH

## EVALUATION:-

**1. Which of the following is correct regarding HIV, hepatitis B, gonorrhoea and trichomoniasis?**

a) Gonorrhoea is a STD whereas others are not.

b) Trichomoniasis is a viral disease whereas others are bacterial.

c) HIV is a pathogen whereas others are diseases.

d) Hepatitis B is eradicated completely whereas others are not.

**Ans: c) HIV is a pathogen whereas others are diseases.**

**2. Which one of the following groups includes sexually transmitted diseases caused by bacteria only?**

a) Syphilis, gonorrhoea and candidiasis b) Syphilis, chlamydiasis and gonorrhoea

c) Syphilis, gonorrhoea and trichomoniasis d) Syphilis, trichomoniasis and pediculosis

**Ans: b) Syphilis, chlamydiasis and gonorrhoea**

**3. Identify the correct statements from the following**

a) Chlamydiasis is a viral disease

b) Gonorrhoea is caused by a spirochaete bacterium, Treponema palladium

c) The incubation period for syphilis is 2 to 14 days in males and 7 to 21 days females.

d) Both syphilis and gonorrhoea are easily cured with antibiotics.

**Ans: d) Both syphilis and gonorrhoea are easily cured with antibiotics.**

**4. A contraceptive pill prevents ovulation by**

a) blocking fallopian tube b) inhibiting release of FSH and LH

c) stimulating release of FSH and LH d) causing immediate degeneration of released ovum.

**Ans : b) inhibiting release of FSH and LH**

**5. The approach which does not give the defined action of contraceptive is**

| | | |
|---|---|---|
| a) | Hormonal contraceptive | Prevents entry of sperms, prevent ovulation and fertilization |
| b) | Vasectomy | Prevents spermatogenesis |
| c) | Barrier method | Prevents fertilisation |
| d) | Intra uterine device | Increases phagocytosis of sperms, suppresses sperm motility and fertilizing capacity of sperms |

**Ans: b) Vasectomy - Prevents spermatogenesis**

**6. Read the given statements and select the correct option.**

**Statement I :** Diaphragms, cervical caps and vaults are made of rubber and are inserted into the female reproductive tract to cover the cervix before coitus.

**Statement 2 :** They are chemical barriers of conception and are reusable.

a) Both statements 1 and 2 are correct and statement 2 is the correct explanation of statement 1.

b) Both statements 1 and 2 are correct but statement 2 is not the correct explanation of statement 1.
c) Statement 1 is correct but statement 2 is incorrect.
d) Both statements 1 and 2 are incorrect.
**Ans: c) Statement 1 is correct but statement 2 is incorrect.**

**7. Match column I with column II and select the correct option from the codes given below.**

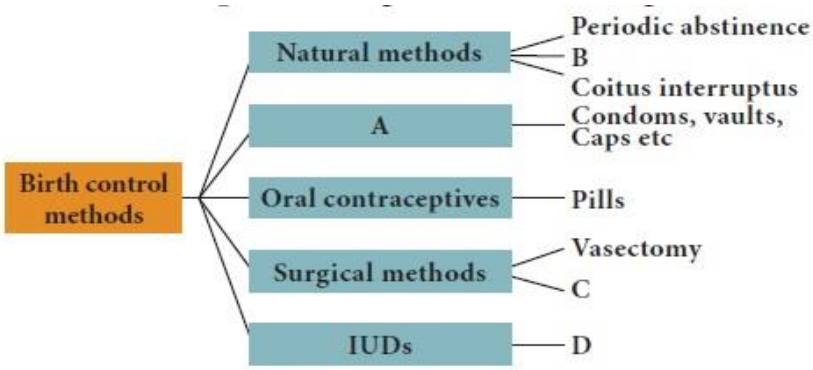
| Column I | Column II |
|---|---|
| A. Copper releasing IUD | (i) LNG - 20 |
| B. Hormone releasing | (ii) Lippes loop IUD |
| C. Non medicated IUD | (iii) Saheli |
| D. Mini pills | (iv) Multiload - 375 |

a) A - (iv), B - (ii), C - (i), D - (iii) b) A - (iv), B - (i), C - (iii), D - (ii)
c) A - (i), B - (iv), C - (ii), D - (iii) d) A - (iv), B - (i), C- (ii), D - (iii)
**Ans: d) A - (iv), B - (i), C- (ii), D - (iii)**

**8. Select the incorrect action of hormonal contraceptive pills from the following**
a) Inhibition of spermatogenesis b) Inhibition of ovulation
c) Changes in cervical mucus impairing its ability to allow passage and transport of sperms.
d) Alteration in uterine endometrium to make it unsuitable for implantation.
**Ans: a) Inhibition of spermatogenesis**

**9. What is amniocentesis? Why a statutory ban is imposed on this technique?**
**Answer:** Amniocentesis is a prenatal technique used to detect any chromosomal abnormalities in the foetus and it is being often misused to A determine the sex of the foetus. Once the sex of the foetus is known, there may be a chance' of female foeticide. Hence, a statutory ban on amniocentesis is imposed.

**10. Select the correct term from the bracket and complete the given branching tree**




(Barriers, Lactational amenorrhoea, CuT, Tubectomy)

**Answer:** A - Barrier methods B - Lactational amenorrhoea C – Tubectomy D-CuT

**11. Correct the following statements**

**a) Transfer of an ovum collected from donor into the fallopian tube is called ZIFT.**
**b) Transfering of an embryo with more than 8 blastomeres into uterus is called GIFT.**
**c) Multiload 375 is a hormone releasing IUD.**
**Answer:** (a) Transfer of an ovum collected from donor into the fallopian tube is called GIFT (Gamete Intra-fallopian transfer
(b) Transferring of an embryo with more than 8 blastomeres into uterus is called IUT (Intra uterine transfer)
(c) Multi load 375 is a copper releasing IUD

**12. Which method do you suggest the couple to have a baby, if the male partner fails to inseminate the female or due to very low sperm count in the ejaculate?**
**Answer:** Intra Uterine Insemination (IUI)

**13. Expand the following a) ZIFT b) ICSI**
**Answer:** (a) ZIFT - Zygote intra-fallopian transfer
(b) ICSI - Intra-cytoplasmic sperm injection

**14. What are the strategies to be implemented in India to attain total reproductive health?**
**Answer:** These programmes are popularly named as 'Reproductive and Child Health Care (RCH).
Major tasks carried out under these programmes are:
(i) Creating awareness and providing medical assistance to build a healthy society.
(ii) Introducing sex education in schools to provide information about adolescence and adolescence related changes.
(iii) Educating couples and those in the marriageable age' groups about the available birth control methods and family planning norms.
(iv) Creating awareness about care fo pregnant women, post-natal care of mother and child and the importance of breast feeding.
(v) Encouraging and supporting governmental arid non-governmental agencies to identify new methods and/or to improve upon the existing methods of birth control.
Health care programmes such as massive child immunization, supply of nutritional food to the pregnant women, Ianani Suraksha Yojana, Ianani Shishu Suraksha Karyakaram, RMNCH+A approach etc., are taken up at the national level by the Government of India.

**15. Differentiate foeticide and infanticide**
**Answer:** Foeticide: It refers to 'aborting the foetus in the mother's womb' intentionally.
Infanticide: It is 'killing the child after the birth

**16. Describe the major STDs and their symptoms.**

**Answer:**

| Name of the Disease | Causative agent | Symptom |
|---|---|---|
| | **Bacterial STI** | |
| **Gonorrhoea** | Neisseria gonorrhoeae | Affects the urethra, rectum and throat and in females the cervix also get affected.<br>Pain and pus discharge in the genital tract and burning sensation during urination |
| **Syphilis** | Treponema palladium | Primary stage: Formation of painless ulcer on the external genitalia.<br>Secondary stage: Skin lesions, rashes, swollen joints and fever and hair loss.<br>Tertiary stage: Appearance of chronic ulcers on nose, lower legs and palate. Loss of movement, mental disorder, visual impairment, heart problems, gummas (soft non-cancerous growths) etc |
| **Chlamydiasis** | Chlamydia trachomatis | Trachoma, affects the cells of the columnar epithelium in the urinogenital tract, respiratory tract and conjunctiva. |
| | Viral STI | |
| **Genital herpes** | Herpes simplex virus' | Sores in and around the vulva, vagina, urethra in female<br>or sores on or around the penis in male. Pain.during urination, bleeding between periods.<br>Swelling in the groin nodes. |
| **Genital warts** | Human papilloma virus (HPV) | Hard outgrowths (Tumour) on the external genitalia, cervix and perianal region |
| **Hepatitis- B** | Hepatitis B virus (HBV) | Fatigue, jaundice, fever, rash and stomach pain.<br>Liver cirrhosis and liver failure occur in the later stage |
| **AIDS** | Human immunodeficiency virus (HIV) | Enlarged lymph nodes, prolonged fever, prolonged diarrhoea, weight reduction, night sweating. |
| **Fungal STI** | | |
| **Candidiasis** | Candida albicans | Attacks mouth, throat, intestinal tract and vagina.<br>Vaginal itching or soreness, abnormal vaginal discharge and pain during urination |
| | **Protozoan STI** | |
| **Trichomoniasis** | Trichomonas vaginalis | Vaginitis, greenish yellow vaginal discharge, itching and burning sensation, urethritis, epididymitis and prosatitis. |

**17. How are STDs transmitted?**

**Answer:** (i) Normally Sexually transmitted infections (STI) are. Transmitted from person to person during intimate sexual contact with an infected partner.

(ii) Infections like Hepatitis-B and HIV are transmitted sexually as well as by sharing of infusion needles, surgical instruments, etc with infected people, blood transfusion or from infected mother to baby.

**18. Write the preventive measures of STDs.**

**Answer:** Prevention of STDs (Sexually Transmitted diseases)

(i) Avoid sex with unknown partner/ multiple partners

(ii) use condoms

(iii) In case of doubt, consult a doctor for diagnosis and get complete treatment.

**19. The procedure of GIFT involves the transfer of female gametes into the fallopain tube, can gametes be transferred to the uterus to achieve the same result? Explain.**

**Answer:** (i) Fertilization of sperm and egg takes place in the fallopian tube.

The fertilized egg (Zygote) slowly move down and reaches the uterus as a ball of cells for implantation.

(ii) Therefore in most cases related to the Assisted Reproductive Technology, the zygote is transferred to the uterus.

(iii) In a method called as Intra-uterine insemination male gametes are introduced in the uterus. This is a procedure to treat infertile men with low sperm count. The semen is collected either from the husband or from a healthy donor and is introduced into the uterus through the vagina by a catheter after stimulating the ovaries to produce more ova. The sperms swim towards the fallopian tubes to fertilize the egg, resulting in normal pregnancy.

**20. Amniocentesis, the foetal sex determination test, is banned in our country, Is it necessary? comment**

**Answer:** (i) Amniocentesis is a prenatal technique used to detect any chromosomal abnormalities in the foetus.

(ii) This can be done to check if the baby is normal or has any kind of genetic defect.

(iii) If the baby shows genetic abnormalities, abortion of the foetus may be required, Therefore amniocentesis can help to' confirm the healthy status of the foetus. But using the technique for sex determination must be banned, because it can lead to female foeticide.

(Iv) Nowadays other tests are also available to test the chromosomal abnormalites of the foetus.

**21. Open Book Assessment**

**'Healthy reproduction, legally checked birth control measures and proper family planning programmes are essential for the survival of mankind' Justify**

**Answer:** Open book Assessment

The teacher may request students to make use of the text and find answers for the same in the class.

## INTERIOR QUESTIONS:-

**1. Mention any 3 causes for infertility.**
**Answer:** (i) Low body fat or anorexia in women. i.e. a psychiatric eating disorder characterised by the fear of gaining weight.
(ii) Under developed ovaries or testes.
(iii) Female may develop antibodies against her partner's sperm.

**2. What is ZIFT?**
**Answer:** ZIFT - Zygote Intra-Fallopian Transfer. As in IVF, the zygote upto 8 blastomere stage is transferred to the fallopian tube by laparoscopy. The zygote continues its natural divisions and migrates towards the uterus where it gets implanted.

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

**4. What is GIFT?**
**Answer:** GIFT - Gamete Intra-Fallopian Transfer
(i) Transfer of an ovum collected from a donor into the fallopian tube. In this the eggs are collected from the ovaries and placed with the sperms in one of the fallopian tubes.
(ii) The zygote travels toward the uterus and gets implanted in the inner lining of the uterus.

**5. What is embryo transfer technique?**
**Answer:** The transfer of an embryo with more than 8 blastomeres stage into uterus is called embryo transfer technique.

**6. MTP is legalized in our country. Yes or No? why?**
**Answer:** Yes. Government of India legalized MTP in 1971 for medical necessity and social consequences with certain restrictions like sex discrimination and illegal female foeticides to avoid its misuse. MTP performed illegally by unqualified quacks is unsafe and could be fatal. MTP of the first conception may have serious psychological consequences.

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

**8. What is lactational amenorrhoea?**
**Answer:** Menstrual cycles resume as early as 6 to 8 weeks from parturition. However, the reappearance of normal ovarian cycles may be delayed for six months during breastfeeding. This delay in ovarian cycles is called Lactational amenorrhoea. It serves as a natural but an unreliable form of birth control.

**9. What is Mayer- Rokitansky syndrome?**
**Answer:** All women are born with ovaries, but some .do not have functional uterus. This condition is called Mayer- Rokitansky syndrome.

**10. Define Surrogacy.**
**Answer:** Surrogacy is a method of assisted reproduction or agreement whereby a woman agrees to carry a pregnancy for another person, who will become the newborn child's parent after birth.

**11. Why is Ultrasonography performed during pregnancy?**
**Answer:** Ultrasonography is usually performed in the first trimester for dating, determination of the number of foetuses, and for assessment of early pregnancy complications.

**12. What is CVS?**
**Answer:** CVS - Chorionic Villus Sampling. CVS is a prenatal test that involves taking a sample of the placental tissue to test for chromosomal abnormalities.

**13. What is cervical dysplasia?**
**Answer:** Cervical cancer is caused by a sexually transmitted virus called Human Papilloma virus (HPV). HPV may cause abnormal growth of cervical cells or cervical dysplasia.

**14. What is PCPNDT Act?**
**Answer:** Government of India has taken various steps like PCPNDT Act (Preconception and Prenatal diagnostic technique act-1994) enacted to ban the identification of sex and to prevent the use of prenatal diagnostic techniques for selective abortion.

**15. Define birth control.**
**Answer:** The voluntary use of contraceptive procedures to prevent fertilization or prevent implantation of a fertilized egg in the uterus is termed as birth control.

**16. What are the characteristics of an ideal contraceptive?**
**Answer:** An ideal contraceptive should be user friendly > easily available, with least side effects and should not interfere with sexual drive.

**17. What is the purpose of barrier method of contraception?**

**Answer:** In these methods, the ovum and sperm are prevented from meeting so that fertilization does not occur.

**18. What is Saheli?**
**Answer:** Saheli, is a contraceptive pill devised by Central Drug Research Institute (CDRI) in Lucknow, India. It contains a non-steroidal preparation called centchroman.

## FIVE MARKS:-

**1. Write notes on any two techniques in Assisted Reproductive Technology (ART).**
**Answer:**

A collection of procedures, which includes the handling of gametes and/or embryos outside the body to achieve a pregnancy, is known as **Assisted Reproductive Technology**. It increases the chance of pregnancy in infertile couples. ART includes intra-uterine insemination (IUI), *in vitro* fertilization, (IVF) Embryo transfer (ET), Zygote intra-fallopian transfer (ZIFT), Gamete intra fallopian transfer (GIFT), Intra-cytoplasmic sperm injection (ICSI), Pre implantation genetic diagnosis, oocyte and sperm donation and surrogacy.

**Intra-uterine insemination (IUI)**

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

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

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

Egg retrieval is done by minor surgery under general anesthesia, using ultrasound guide after 34 to 37 hours of hCG (human chorionic gonadotropin) injection. The eggs are prepared and stripped from the surrounding cells. At the same time, sperm preparation is done using a special media. After preparing the sperms, the eggs are brought together. 10,000-1,00,000 motile sperms are needed for each egg. Then the zygote is allowed to divide to form 8 celled blastomere and then transferred into the uterus for a successful pregnancy. The transfer of an embryo with more than 8 blastomeres stage into uterus is called **Embryo transfer technique**.

**Zygote intra-fallopian transfer (ZIFT)**

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

**Intra uterine transfer (IUT)**

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

**Gamete intra-fallopian transfer (GIFT)**

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

**Intra-cytoplasmic sperm injection (ICSI)**

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

**Surrogacy**

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

2. Write a note on cervial cancer.

**Answer:** cervial cancer: Cervical cancer is caused by a sexually transmitted virus called Human Papilloma virus (HPV). HPV may cause abnormal growth of cervical cells or cervical dysplasia. The most common symptoms and signs of cervical cancer are pelvic pain, increased vaginal discharge and abnormal vaginal bleeding. The risk factors for cervical cancer include

(i) Having multiple sexual partners

(ii) Prolonged use of contraceptive pills

Cervical cancer can be diagnosed by a Papanicolaou smear (PAP smear) combined With an HPV test. X-Ray, CT scan, MRI and a PET scan may also be used to determine the stage of cancer. The treatment options for cervical. Cancer include radiation therapy, surgery and chemotherapy. Modern screening techniques can detect precancerous changes in the cervix. Therefore screening is recommended for women above 30 years once in a year. Cervical cancer can be prevented with vaccination. Primary prevention begins with HPV vaccination of girls aged 9 - 13 years, before they become sexually active. Modification in lifestyle can also help in preventing cervical cancer. Healthy diet, avoiding tobacco usage, preventing early marriages, practicing monogamy and regular exercise minimize the risk of cervical cancer.

**3. What is infertility and write its causes.**

**Answer:** Inability to conceive or produce children even after unprotected sexual cohabitation is called infertility. That is, the inability of a man to produce sufficierrt numbers or quality of sperm to impregnate a woman or inability of a woman to become pregnant or maintain a pregnancy. The causes for infertility are tumours formed in the pituitary or reproductive organs, inherited mutations of genes responsible for the biosynthesis of sex hormones, malformation of the < Cervix or fallopian tubes and

inadequate nutrition before adulthood. Long-term stress damages many aspects of health especially the menstrual cycle. Ingestion of toxins (heavy metal cadmium), heavy use of alcohol, tobacco and marijuana, injuries to the gonads and aging also cause infertility.

Other causes of infertility:

(i) Pelvic inflammatory disease (PID), uterine fibroids and endometriosis are the most common causes of infertility in women.

(ii) .Low body fat or anorexia in women. i.e. a psychiatric eating disorder characterised by the fear of gaining weight.

(iii) Undescended testes and swollen veins (varicocoele) in scrotum. Tight clothing in men may raise the temperature in the scrotum and affect sperm production.

(iv) Under developed ovaries or testes.

(v) Female may develop antibodies against her partner's sperm.

(vi) Males may develop an autoimmune response to their own sperm.

**4. Give a detailed account on various natural methods of contraception.**

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

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

b. Continuous abstinence is the simplest and most reliable way to avoid pregnancy is not to have coitus for a defined period that facilitates conception.

c. Coitus interruptus is the oldest family planning method. The male partner withdraws his penis before ejaculation, thereby preventing deposition of semen into the vagina.

d. Lactational amenorr~oea : Menstrual cycles resume as early as 6 to 8 weeks from parturition. However, the reappearance of normal ovarian cycles may be delayed for six months during breast-feeding. This delay in ovarian cycles is called lactational amenorrhoea. It serves as a natural, but an unreliable form of birth control. Suckling by the baby during breast-feeding stimulates the pituitary to secrete increased prolactin hormone in order to increase milk production. This high prolactin concentration in the mother's blood may prevent menstrual cycle by suppressing the release of GnRH (Gonadotropin Releasing Hormone) from hypothalamus and gonadotropin secretion from the pituitary.

1. Assertion: STD can be prevented by Monogamy
Reason: TNHSP, a unit of Health and family welfare development of Government of Tamil Nadu does free screening for cervical and breast cancer
(a) A and R correct, R is the correct explanation of A
(b) A and R right but R is not the correct explanation of A
(c) A is correct R is false
(d) Both A & R are false
**Answer: A and R right but R is not the correct explanation of A**

2. Assertion: MTP during the second trimester is risky for the parent & foetus.
Reason: It must be performed by trained medical personnel.
(a) A and R correct, R is the correct explanation of A
(b) A and R right but R is not the correct explanation of A
(c) A is correct R is false
(d) Both A & R are false
**Answer: A and R correct, R is the correct explanation of A**

3. Assertion: Oral contraceptives are not recommended for birth control.
Reason: Surgical sterilisation is the best birth control method for all age groups.
(a) A and R correct, R is the correct explanation of A
(b) A and R right but R is not the correct explanation of A
(c) A is correct R is false
(d) Both A & R are false
**Answer: Both A & R are false**

4. Assertion: Vitamin E helps in the normal functioning of reproductive structures in man.
Reason: Vitamin E is known as anti sterility vitamin.
(a) A and R correct, R is the correct explanation of A
(b) A and R right but R is not the correct explanation of A
(c) A is correct R is false
(d) Both A & R are false
**Answer: A and R correct. R is the correct explanation of A**

5. Assertion: Condoms safeguards the user from AIDS and STDs
Reason: Condoms are made of polyurethane, latex and lambskin.
(a) A and R correct, R is the correct explanation of A
(b) A and R right but R is not the correct explanation of A
(c) A is correct R is false
(d) Both A & R are false
**Answer: A and R correct, R is the correct explanation of A**

# CHAPTER 4 – PRINCIPLES OF INHERITANCE AND VARIATION

## TEXTBOOK EVALUATION:-

**1. Haemophilia is more common in males because it is a**

a) Recessive character carried by Y-chromosome

b) Dominant character carried by Y-chromosome

c) Dominant trait carried by X-chromosome

**d) Recessive trait carried by X-chromosome**

**2. ABO blood group in man is controlled by**

**a) Multiple alleles** b) Lethal genes c) Sex linked genes d) Y-linked genes

**3. Three children of a family have blood groups A, AB and B. What could be the genotypes of their parents?**

a) IA IB and ii **b) IA IO and IB IO** c) IBIB and IAIA d) IA IA and ii

**4. Which of the following is not correct?**

a) Three or more alleles of a trait in the population are called multiple alleles.

b) A normal gene undergoes mutations to form many alleles

**c) Multiple alleles map at different loci of a chromosome**

d) A diploid organism has only two alleles out of many in the population

**5. Which of the following phenotypes in the progeny are possible from the parental combination AxB?**

a) A and B only b) A,B and AB only c) AB only **d) A,B,AB and O**

**6. Which of the following phenotypes is not possible in the progeny of the parental genotypic combination IAIO X IAIB?**

a) AB **b) O** c) A d) B

**7. Which of the following is true about Rh factor in the offspring of a parental combination Dd X Dd (both Rh positive)?**

a) All will be Rh-positive b) Half will be Rh positive

c) About ¾ will be Rh negative **d) About one fourth will be Rh negative**

**8. 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

**9. If the child's blood group is 'O' and fathers blood group is 'A' and mother's blood group is 'B' the genotype of the parents will be**

a) IA IA and IB Io **b) IA IO and IB IO** c) IA I**o** and IOIO d) IOIO and IB IB

**10. XO type of sex determination and XY type of sex determination are examples of**

**a) Male heterogamety** b) Female heterogamety

c) Male homogamety d) Both b) and c)

**11. In an accident there is great loss of blood and there is no time to analyse the blood group which blood can be safely transferred?**

**a) 'O' and Rh negative** b) 'O' and Rh positive

c) 'B' and Rh negative d) 'AB' and Rh positive

**12. Father of a child is colourblind and mother is carrier for colourblindness, the probability of the child being colourblind is**

a) 25% **b) 50%** c) 100% d) 75%

**13. A marriage between a colourblind man and a normal woman produces**

**a) All carrier daughters and normal sons**

b) 50% carrier daughters, 50% normal daughters

c) 50% colourblind sons, 50% normal sons

d) All carrier offsprings

**14. Mangolism is a genetic disorder which is caused by the presence of an extra chromosome number**

a) 20 **b) 21** c) 4 d) 23

**15. Klinefelters' syndrome is characterized by a karyotype of**

a) XYY b) XO c) XXX **d) XXY**

**16. Females with Turners' syndrome have**

a) Small uterus b) Rudimentary ovaries c) Underdeveloped breasts **d) All of these**

**17. Pataus' syndrome is also referred to as**

**a) 13 -Trisomy** b) 18-Trisormy c) 21-Trisormy d) None of these

**18. Who is the founder of Modern Eugenics movement?**

a) Mendel b) Darwin **c) Fransis Galton** d) Karl pearson

**19. Improvement of human race by encouraging the healthy persons to marry early and produce large number of children is called**

**a) Positive eugenics** b) Negative eugenics c) Positive euthenics d) Positive euphenics

**20. The _____deals with the control of several inherited human diseases especially inborn errors of metabolism**

**a) Euphenics** b) Eugenics c) Euthenics d) All of these

**21. "Universal Donor" and "Universal Recipients" blood group are _____ and_____ respectively**

a) AB, O **b) O, AB** c) A, B d) B, A

**22. ZW-ZZ system of sex determination occurs in**

a) Fishes b) Reptiles c) Birds **d) All of these**

**23. Co-dominant blood group is**

a) A **b) AB** c) B d) O

**24. Which of the following is incorrect regarding ZW-ZZ type of sex determination?**

a)It occurs in birds and some reptiles

**b) Females are homogametic and males are heterogametic**

c) Male produces two types of gametes

d) It occurs in gypsy moth

**25. What is haplodiploidy?**

**Answer:** (i) It is a system of sex determination in which "C sex of the offspring is determined by the number of sets of chromosomes it receives.

(ii) Eg. Honey bees in which fertilized eggs develop into females (Queen or worker bees) and unfertilized eggs develop into males (drones) by parthenogenesis.

(iii) This means males have half the number of chromosomes (haploid - n) and females have double the number of chromosomes (diploid - 2n). Hence the method is called haplodiploidy.

**26. Distinguish between heterogametic and homogametic sex determination systems.**

| S. No. | Heterogametic sex determination | Homogametic sex determination |
|---|---|---|
| 1 | In this type **two types of gametes are** produced | In this type **only one types of gamete is** produced |
| 2 | Sex chromosomes are **dissimilar** | Sex chromosomes are **similar** |
| 3 | These organisms are called as **Heteromorphic individuals** | These organisms are called as **Homomorphic individuals** |

**27. What is Lyonisation?**

**Answer:** (i) In the XY chromosomal system of sex determination, males have only one X chromosome, whereas females have two. In mammals, the necessary dosage compensation is accomplished by the inactivation of one of the X chromosomes in females so that both males and females have only one functional X chromosome per cell.

(ii) Mary Lyon suggested that Barr bodies represented an inactive chromosome, which in females becomes tightly coiled into a heterochromatin, a condensed and visible form of chromatin' (Lyon's hypothesis). The number of Barr bodies observed in cell was one less than the number of X-Chromosome. XO females have no Barr body, whereas XXY males have one Barr body.

(iii) The discovery of X inactivator is attributed by British Genetician Mary Lyon and is called as Lynoisation.

**28. What is criss-cross inheritance?**

**Answer:** It is the transmission of a gene from mother to son or father to daughter. The character is inherited to the second generation through the carrier of first generation. **E.g.** Inheritance of gene causing haemophilia (x linked inheritance).

**29. Why are sex linked recessive characters more common in the male human beings?**

**Answer:** (i) Male human beings are hemizygous. Their sex chromosomes consist of one X and one Y chromosomes.

(ii) Sex linked character are inherited through genes in sex chromosomes since males inherit one allele only for sex linked character (one X and Y chromosomes) they express the trait commonly.

(iii) In female there are two x chromosome representing the sex chromosomes for each sex linked character. Therefore expression of the character depends on both the alleles. Sex linked inherited traits are more common in males than females because, males are hemizygous and therefore express the trait when they inherit one mutant allele.

**30. What are holandric genes?**

**Answer:** The genes present in the differential region of Y chromosome are called Y-linked or holandric genes. The Y- linked genes have no corresponding allele in X chromosome. **Eg:** Hypertrichosis

**31. Mention the symptoms of Phenylketonuria.**

**Answer:** It is characterized by severe mental retardation, light pigmentation of skin and hair. Phenylpyruvic acid is excreted in the urine.

**32. Mention the symptoms of Down's syndrome.**

**Answer:**

- ✓ Severe mental retardation,
- ✓ Defective development of the central nervous system,
- ✓ Increased separation between the eyes,
- ✓ Flattened nose,
- ✓ Ears are malformed,
- ✓ Mouth is constantly open and the tongue protrudes

**33. Differentiate Intersexes from Supersexes**

**Answer:**

- ➢ The presence of both **male and female reproductive characteristics** in one individual is common both, but **Supersex** is a natural condition while **intersex is a disorder.**
- ➢ **Supersex individuals** are **able to reproduce** while **intersex individuals are usually not.**
- ➢ **Supersexes** are **found among animals and plants**, but intersex individuals are **found among humans.**

**34. Explain the genetic basis of ABO blood grouping man.**

**Answer:**

- ➢ Blood group is determined by -**three autosomal alleles located on chromosome 9**.
- ➢ The **gene controlling** blood type are **'L'** (L-Landsteiner) or **I** (I - isoagglutination).
- ➢ I gene occurs in three allelic forms, **IA, IB and IO**.
- ✓ **IA denotes A antigen. IB denotes B antigen. IO denotes no antigen.**

- **IA and IB are dominant** to I**O**, but **co-dominant to each other** (I**A**=I**B**).
- Dominance hierarchy is - (**IA=IB> IO**).
- A child receives one of **three alleles from each parent**, and result in **six possible genotypes** and **four possible blood groups** (phenotypes).
- The genotypes : **IA IA, IA IO - A group**

✓ **IBIB, IB IO** - B group

✓ **IA IB - AB Group**

✓ **IOIO - O Group**

**35. How is sex determined in human beings?**

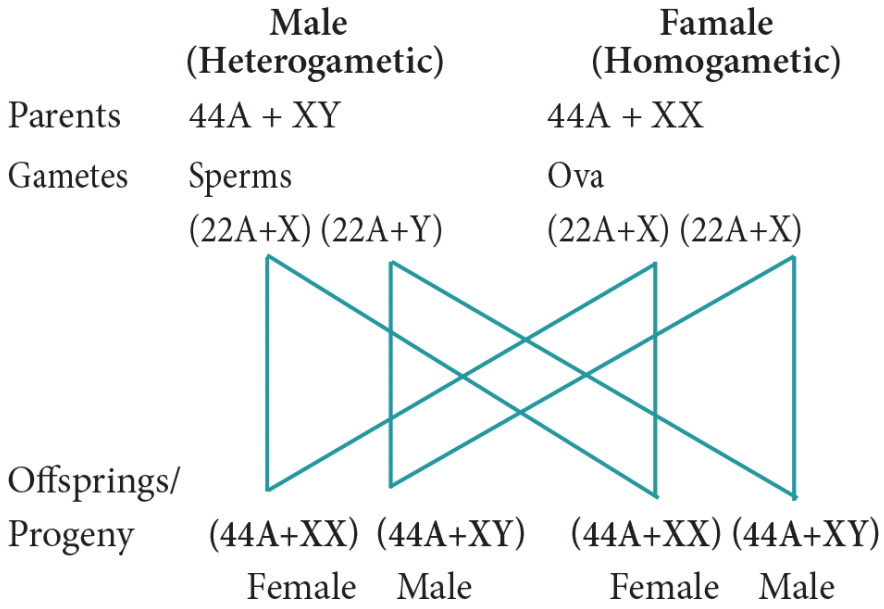
**Answer:**

✓ **Sex chromosomes determine the sex** of the individual.

✓ Autosomes - **chromosomes other than the sex chromosomes**

✓ Sex chromosomes may be **similar** (homomorphic) and **dissimilar** (heteromorphic).

✓ **Homomorphic individuals** - produce **only one type of gametes** (homogametic)



- ✓ **Heteromorphic individuals** - produce **two types of gametes** (heterogametic).
- ✓ **Females are homogametic** with XX chromosome,
- ✓ **Males are heterogametic** with X and Y chromosome.
- ✓ **Females produce only one kind of egg**, each with one X chromosome,
- ✓ **Males produce two kinds of sperms** (1.with X chromosome and 2. with Y chromosome.
- ✓ Gender - **depends on the type of fertilizing sperm**.

**36. Explain male heterogamety**

**Answer: Heterogametic Males:** In this method of sex determination the males are heterogametic producing dissimilar gametes while females are homogametic producing similar gametes. It is of kinds XX-XO type and XX-XY type.

(i) **XX-XO Type: Eg.** Cockroaches and grasshoppers.

(a) The female with two X chromosomes are homogametic (XX) while the males with only one X chromosome are heterogametic (XO).

(b) The presence of an unpaired X chromosomes determines the male sex. The males with unpaired 'X' chromosome produce two types of sperms, one half with X chromosome and other half without X chromosome.

(c) The sex of the offspring depends upon the sperm that fertilizes the egg.

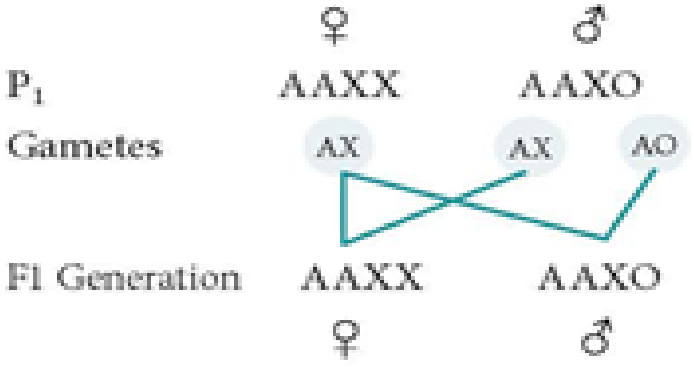



**Fig. 4.2 XX-XO Type of sex determination**

(ii) **XX-XV type (Lygaeu Type):** This method of sex determination is seen in human beings and in Drosophila.

(a) The females are homogametic with XX chromosome, while the males are heterogametic with X and Y chromosome.

(b) Homogametic females produce only one kind of egg, each with one X chromosome, while the heterogametic males produce two kinds of sperms some with X chromosome and some with Y chromosome.

(c) The sex of the embryo depends on the fertilizing sperm. An egg fertilized by an 'X' bearing sperm produces a female, if fertilized by a 'Y' bearing sperm, a male is produced.

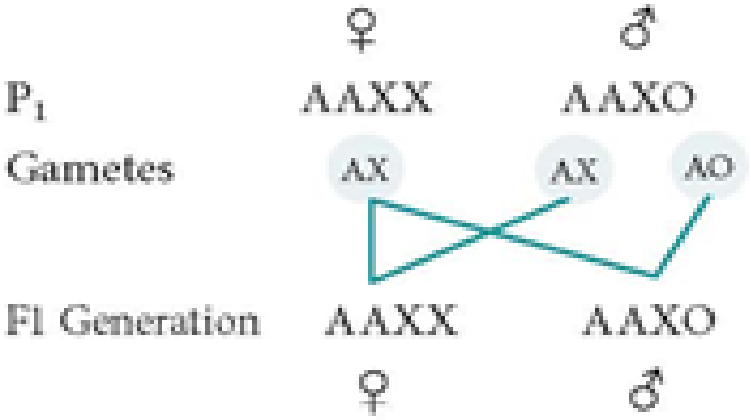



**Fig. 4.2 XX-XO Type of sex determination**

37. Brief about female heterogamety

**Answer: Heterogametic Females:** In this method of sex determination, the homogametic male possesses two 'X' chromosomes as in certain insects and certain vertebrates like fishes, reptiles and birds producing a single type of gamete; while females produce dissimilar gametes.

The female sex consists of a single 'X' chromosome or one 'X' and one 'Y' chromosome. Thus the females are heterogametic and produce two types of eggs. Heterogametic females are of two types, ZO-ZZ type and ZW-ZZ type.

(i) **ZO-ZZ Type: Eg**. Certain moths, butterflies and domestic chickens. In this type, the female possesses single 'Z' chromosome in its body cells and is heterogametic (ZO)

producing two kinds of eggs some with 'Z' chromosome and some without 'Z' chromosome, while the male possesses two 'Z' chromosomes and is homogametic (ZZ).

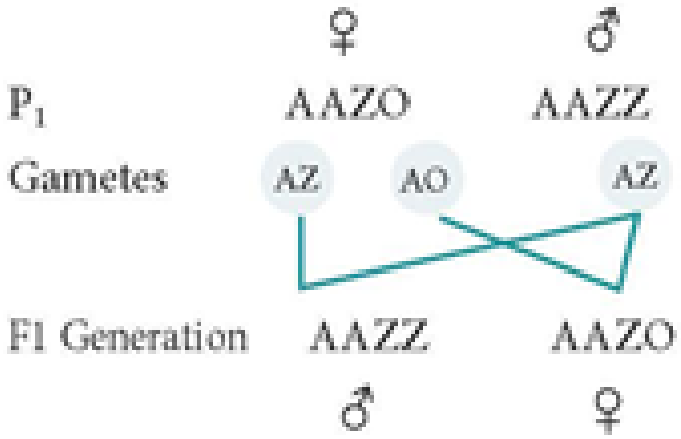



**Fig. 4.4 ZO-ZZ type of sex determination**

(ii) **ZW-ZZ type: Eg.** Insects (gypsy moth) and invertebrates such as fishes. In this method the female has one 'z' and one 'w' chromosome (ZW) producing two types of eggs, some carrying the Z chromosomes and some carry the W chromosome. The male sex has two 'Z' chromosomes and is homogametic (ZZ) producing a single type of sperm.

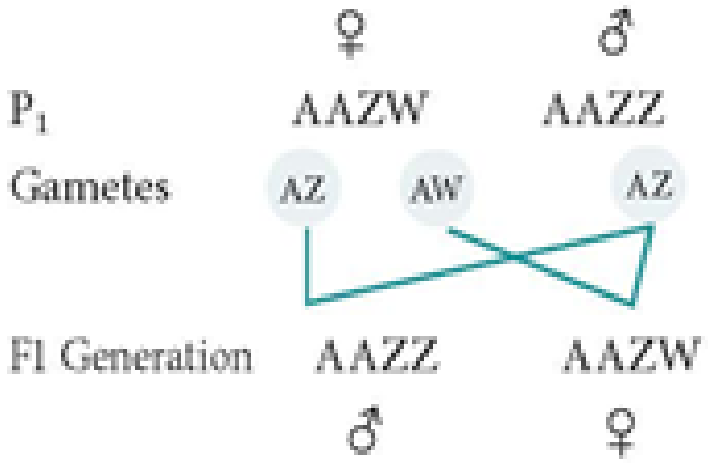



**Fig. 4.5 ZW-ZZ type of sex determination**

**38. Give an account of genetic control of Rh factor.**

**Answer :** The term Rh factor refers to the immunogenic D antigen of Rh blood group system.

**Genetic control of Rh factor**

(i) **Fisher and Race hypothesis:** Rh factor involves three different pairs of alleles located on three different closely linked loci on the chromosome pair. This system is more commonly ill use today, and uses the 'Cde' nomenclature.

(ii) Three pairs of Rh alleles (Cc, Dd and Ee) occur at 3 different loci on homologous chromosome pair-1. The possible genotypes will be one C or c, one D or d, one E or e from each chromosome. For **E.g.** CDE/cde; CdE/cDe; cde/cde; CDe/CdE etc., All genotypes carrying a dominant 'D' allele will produce Rh ositive phenotype and double recessive genotype 'dd' will give rise to Rh-negative phenotype.

(iii) **Wiener Hypothesis** Wiener proposed the existence of eight alleles (R, R , R , R , r, r , r , r ) at a single Rh locus. All genotypes carrying a dominant 'R allele' (R , R, R , R) will produce Rh positive' phenotype and double recessive genotypes (rr, rr , rr , rr) will give rise to Rh-negative phenotype.

**39. Explain the mode of sex determination in honeybees.**

**Answer:** (i) In hymenopteran insects such as honeybees, ants and wasps a mechanism of sex determination called **haplodiploidy** mechanism of sex determination is common.

(ii) In this system, the sex of the offspring is determined by the number of sets of chromosomes it receives. Fertilized eggs develop into females (Queen or Worker) and unfertilized eggs develop into males (drones) by parthenogenesis. It means that the males have half the number of chromosomes (haploid) and the females have double the number (diploid), hence the name haplodiplody for this system of sex determination.

(iii) This mode of sex determination facilitates the evolution of sociality in which only one diploid female becomes a queen and lays the eggs for the colony.

(iv) All other females which are diploid having developed from fertilized eggs help to raise the queen's eggs and so contribute to the queen's reproductive success and indirectly to their own, a phenomenon known as Kin Selection.

(v) The queen constructs their social environment by releasing a hormone that suppresses fertility of the workers.

**40. Discuss the genic balance mechanism of sex determination with reference to Drosophila.**

**Answer:**

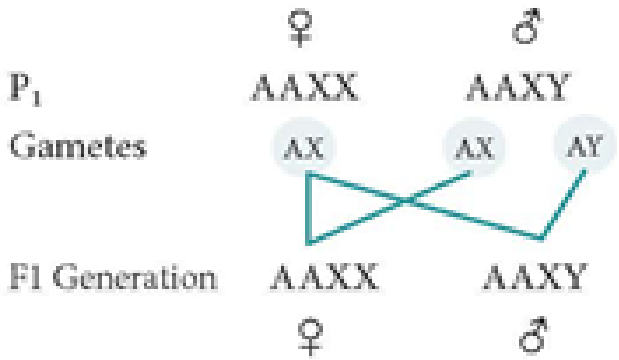



**Fig. 4.3 XX-XY Type of sex determination**

This type seen in **human beings and in Drosophila**.

- ✓ **Females are homogametic** with XX chromosome,
- ✓ **Males are heterogametic** with X and Y chromosome.
- ✓ **Females produce only one kind of egg**, each with one X chromosome,
- ✓ **Males produce two kinds of sperms** (1. with X chromosome and 2. with Y chromosome.)
- ✓ Gender - **depends on the type of fertilizing sperm**.

**41. What are the applications of Karyotyping?**

**Answer:**

- ➢ It helps in **gender identification.**
- ➢ It is **used to detect the chromosomal aberrations** like deletion, duplication, translocation, nondisjunction of chromosomes.
- ➢ It helps to **identify chromosomal abnormalities** like aneuploidy.
- ➢ It is also used to **predict the evolutionary relationships** between species.
- ➢ It is used to **Genetic diseases** can be detected.

**42. Explain the inheritance of sex linked characters in human being.**

**Answer:**

- The inheritance of X or Y linked genes is called **sex-linked inheritance.**
- **Genes present on region of X or Y** chromosomes are called **sex linked genes**.
- **X linked genes** - The genes present in the l region of "X" chromosome.
- The X–linked genes have **no corresponding alleles in the Y chromosome**.
- **Y- linked or holandric genes –** The genes present in the region of Y chromosome
- The Y linked genes have **no corresponding allele in X chromosome.**
- Y linked genes inherit along with Y chromosome and **phenotypically express only in the male.**
- Sex linked inherited traits are **more common in males** than females
- This is because, males are hemizygous (has **only one X gene**)
- **X - linked and Y - linked genes** (non homologus region) **do not undergo pairing or crossing over** during meiosis.

**43. What is extra chromosomal inheritance? Explain with an example.**

**Answer:** (i) Certain characters are controlled by nonnuclear genomes found in chloroplast, mitochondria, infective agents and plasmids. These characters do not reveal Mendelian pattern of inheritance.

(ii) The inheritance of the extra chromosomal genes are found to exhibit maternal influence.

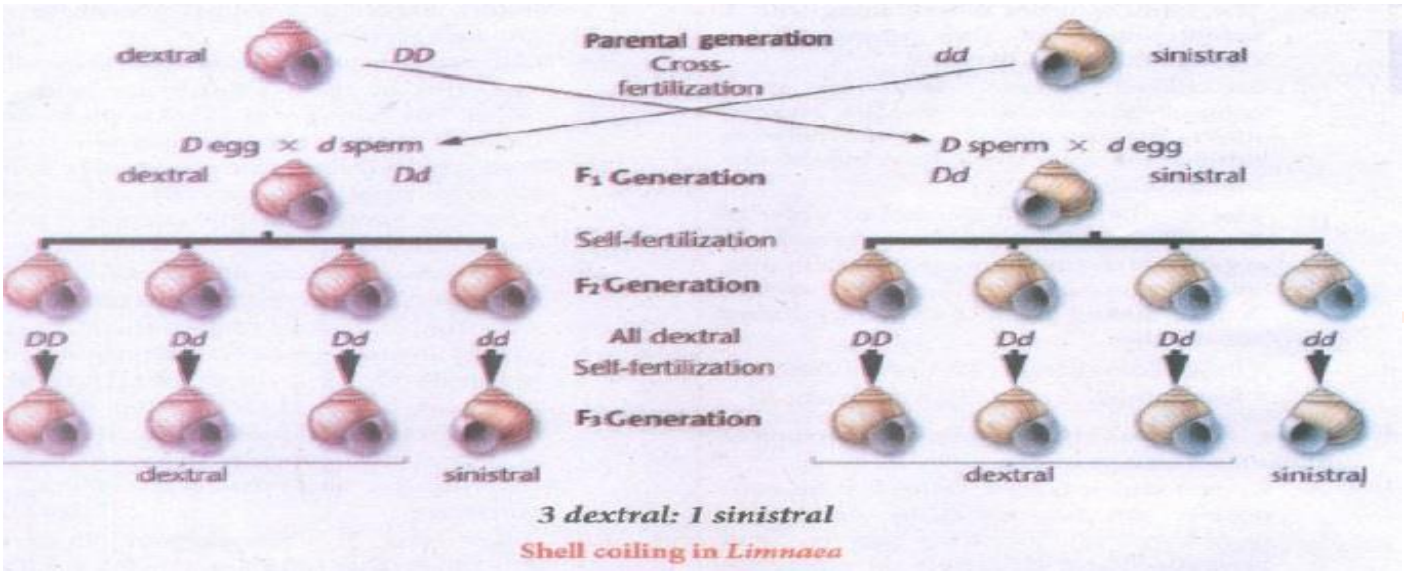
(iii) Although both male and female parents contribute equally to the zygote in terms of chromosomal genes, the female parent usually contributes the zygote's initial cytoplasm and organelles, since the sperms contain very little cytoplasm. If there are hereditary units in the

cytoplasm, these will be transmitted to the offsprings through the egg, so the offsprings exhibit maternal effect.

(iv)The cytoplasmic extranuclear genes have a characteristic pattern of inheritance which do not resemble the genes of nuclear chromosomes and is known as extra chromosomal or extra nuclear or cytoplasmic inheritance and exhibit maternal influence.

(v) In extra nuclear inheritance, male and female parents contribute equally their nuclear genes to the progeny but do not make equal contribution of' extra chromosomal genes hence, the crosses can yield different (or) non Mendelian results. Extra chromosomal inheritance in Limnaea peregra.

(vi) Limnaea peregra is a freshwater snail. The shell of these animals are spirally coiled. The coiling of the shell is clockwise (dextral) or anticlockwise (sinistral).




(vii) Both type of coilings are produced by two. different types of genetically controlled cleavages namely, dextral cleavage and sinistral cleavage.

(viii) In Limnaea, dextral coiling is normal and Sinistral coiling is a mutant character.

(ix) Direction of coiling is determined by a pair of nuclear genes, D( dextral) and d (sinistral). The gene for dextral (D) being dominant over sinistral coiling (d). In Fig. a dextral snail provides the eggs and a sinistral snail provides the sperm. The offsprings are all dextral (Dd), in the F1 generation.

(x) When the F1 heterozygous dextral individual (Dd) were self crossed the F2 generation showed dextral coiling with genotype of IDD, 2Dd and l dd.

(xi) When a reciprocal cross is made the F1 individuals have Dd genotype but are coiled sinistrally, as in the female parent. In both the crosses the Flare phenotypically similar to the female parent, though the offsprings in both crosses have the same genotype Dd. This is because the genotype of the maternal parent determines the phenotype of the offspring.

(xii) When the F1 sinistral individuals were self crossed, the shell coiling in the F2 generation, were all dextral. This is because the genes do not segregate in the F2 generation. Only in the F3 generation segregation occurs in the ratio of 3 dextral: 1 sinistral.

(xiii) **Reasons:** The type of cleavage depends on the organization of the egg which is established before the maturation division of the oocyte nucleus and by the influence of the maternal genotype.

(xiv) The direction of coiling of the shell depends upon the orientation of the mitotic spindle during the first cleavage.

(xv) Obviously, maternal control affects only one generation. In each generation the coiling is dependent on the maternal genotype.



**44. Comment on the methods of Eugenics**

**Classical eugenics**

- Advocacy for sexual abstinence
- **Sex education** in schools.
- Promoting the **use of contraception.**
- Research for **better contraceptives.**
- **Voluntary sterilization.**
- **Abortion.**

**Negative eugenics**

- **Incentives** for sterilization.
- **Incentives for women** on welfare to use contraceptions.
- **Compulsory sterilization** of the "mentally retarded" and criminals.

**Positive eugenics.**

- **Financial incentives** to have children.
- **Taxation of the childless**.
- Eugenic immigration

**New eugenics**

- **Artificial insemination** by donor.
- **Egg donation.**
- Pre implantation and prenatal diagnosis of genetic disorders and pregnancy terminations of defective fetuses.
- **Embryo selection.**
- **Genetic engineering.**
- **Gene therapy**
- **Cloning**

## ADDITIONAL ONE MARK:-

1. The blood group _____ is called universal donor.

(a) A(b) AB(c) B**(d) O**

2. The blood group _____ is called universal recipient.

(a) O**(b) AB**(c) B(d) A

3. The ABO blood group was discovered by _____.

(a) Sturli(b) Decastelle**(c) Landsteiner**(d) Alexander wiener

4. The inheritance of blood group is determined by multiple alleles as discovered by _____.

(a) Landsteiner**(b) Bernstein**(c) Alexander castelle(d) lyon

5. The_____ is called null allele.

(a) IA(b) IOIB**(c) IO**(d) IBIB

6. The secretors have the I allele in _____.

(a) tears(b) Gastric juice(c) Saliva**(d) All of these**

7. _____ proposed the existence of 8 alleles at a single Rh locus.

(a) Fischer(b) Landsteiner(c) Bernstein**(d) Wiener**

8. XX - XO type of sex determination is in _____.

**(a) Cockroaches**(b) Drosophila(c) Humans(d) Moths

9. The lygaeus type (XX - XY) type of sex determination is seen in _____

(a) Fishes(b) Chickens**(c) Human beings**(d) Gypsy moth

10. The ZO - ZZ type of sex determination is seen is _____.

**(a) moths**(b) Reptiles(c) Human beings(d) Bugs

11. The ZW - ZZ type of sex determination is seen _____.

(a) Butterflies(b) Drosophila**(c) Gypsy moth**(d) Human being

12. X chromosomes was discovered by _____.

(a) Landsteiner**(b) Henking**(c) Stevens(d) Bridges

13. Y chromosomes was discovered by _____.

**(a) Stevens**(b) Landsteiner(c) Henking(d) Wiener

14. Scientists who contributed to karyotyping _____.

**(a) Tjio and Levan**(b) John Cotto(c) Bridges(d) Wiener

15. Depending on position of centromere and relative length of two arms human chromosomes can be classified into _____ type. (a) 2 (b) 3 **(c) 4** (d) 5

16. _____ are examples of mendelian disorders.

a) Thalassemia(b) Albinism(c) Phenylketonuria**(d) Haemophilia**

17. _____ is a disease where abnormal haemoglobin is produced in patients.

(a) Phenylketonuria(b) Huntington's chorea**(c) Thalassemia**(d) Albinism

18. Phenylketonuria is linked to chromosome_____.

(a) 9(b) 10**(c) 12**(d) 8

19. Cooley's anaemia refers to _____.

(a) Phenylketonuria(b) Haemophilia**(c) Thalassemia**(d) Turner's sundrome

20. The gene responsible for _____ is inherited as an autosomal recessive lethal gene in man

(a) Huntington's chorea**(b) Albinism**(c) Colourblindness(d) Phenylketonuria

21. _____ is an inborn error of metabolism caused due to autosomal recessive gene.

(a) Thalassemia**(b) Albinism**(c) Phenylketonuria(d) Huntington's chorea

22. Incompatibility of blood groups leading to, dumping of erythrocytes is called_____.

**(a) agglutination**(b) non -agglutination(c) Inhibition(d) repolarization

23. One gene 'L' controlling blood groups is named after_____.

(a) C. B. Bridges(b) Henking**(c) Landsteiner**(d) Stevens

24. The allele I o is called _____

(a) Dominant allele **(b) null allele** (c) null allele (d) epistatic allele

25. The alleles IA and IB are _____

(a) Hypostatic **(b) Co-dominant** (c) Recessive (d) Epistatic

26. Individuals who possess the I antigens related to gene I in body fluids are called_____.

**(a) secretors** (b) enzymes (c) Lymph fluids (d) hormones

27. The XX - XY type of sex determination is also known as _____ type.

(a) Haploid - diploid**(b) Lygaeus**(c) Gynandromorphs(d) Genic balance

28. In gypsy moth we find _____ type of sex determination.

**(a) ZW - ZZ**(b) XX - XY(c) XX - XO(d) ZO - ZZ

29. Genic balance mechanism was first studied by _____.

(a) John Cotto**(b) C. B. Bridges**(c) Bernstein(d) Wiener

30. Sex switch genes have been reported in _____.

(a) Grasshopper(b) Cockroach(c) Wasp**(d) Drosophila**

31. In _____ the tissues of male and female genotype type form a mosaic

(a) lIaplo-diploidy**(b) Gynandromorphy**(c) Genic balance(d) Lygaeus type

32. Sex chromatin is also called as _____.

(a) polar body(b) nucleus(c) nucleolus**(d) Barr body**

33. The number of Barr bodies follows _____.

(a) N-0 Rule(b) N-3 rule**(c) N-1 rule**(d) N-2 rule

34. Kin selection is seen in _____

**(a) Honey bees**(b) Drosophila(c) Grasshopper(d) Cockroach



## ASSERTION AND REASON:-

1. Assertion: ABO Blood grouping is based on multiple alleles.

   Reason: There are 6 possible genotypes and 4 possible blood types

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

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

   C. A is true, R is false.

   D. Both A and R are false.

**Answer: A. A and R are true, R is the correct explanation of A.**

2. Assertion: The Kappa in paramecium appears to be a bacterium.

Reason: Kappa particles ate not dependent on the chromosomal genes

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

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

C. A is true, R is false.

D. Both A and R are false.

**Answer: C. A is true, R is false**

3. Assertion: Phenylketonuria occurs due to the mutation in gene PAH on chromosome 11.

Reason: DOPA is not converted to melanin

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

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

C. A is true, R is false.

D. Both A and R are false.

**Answer: D. Both A and R are false.**

4. Assertion: Inheritance is the basis of heredity

Reason: Inheritance is the process by which characters are passed on from parent to progeny.

a) If both Assertion & Reason are True & the Reason is a correct explanation of the Assertion

b) If both Assertion & Reason are True but Reason is not a correct explanation of the Assertion.

c) If Assertion is True but the Reason is False.

d) If both Assertion & Reason are false.

**Answer: a) If both Assertion & Reason are True & the Reason is a correct explanation of the Assertion**

5. Assertion : Multiple alleles can be found only when population studies are made.

Reason : Occasionally, a single gene product may produce more than one effect

a) If both Assertion & Reason are True & the Reason is a correct explanation of the Assertion

b) If both Assertion & Reason are True but Reason is not a correct explanation of the Assertion.

c) If Assertion is True but the Reason is False.

d) If both Assertion & Reason are false.

**Answer: b) If both Assertion & Reason are True but Reason is not a correct explanation of the Assertion.**

6. Assertion : XO type, XY type & ZW type are the example of male heterogamety.

Reason : Male produces two types of sperms

a) If both Assertion & Reason are True & the Reason is a correct explanation of the Assertion

b) If both Assertion & Reason are True but Reason is not a correct explanation of the Assertion.

c) If Assertion is True but the Reason is False.

d) If both Assertion & Reason are false.

**Answer: d) If both Assertion & Reason are false.**

7. Assertion : Sickle-cell anaemia is caused by the substitution of glumatic acid by valine at the sixth position of the beta globin chain of the haemoglobin molecule.

Reason : It is due to the single base substitution at the sixth codon of the beta globin gene from GUG to GAG

a) If both Assertion & Reason are True & the Reason is a correct explanation of the Assertion

b) If both Assertion & Reason are True but Reason is not a correct explanation of the Assertion.

c) If Assertion is True but the Reason is False.

d) If both Assertion & Reason are false.

**Answer: c) If Assertion is True but the Reason is False.**

8. Assertion : Male is haploid and female is diploid in honey bee.

Reason : Sex depends on paired and unpaired chromosomes in every organism

a) If both Assertion & Reason are True & the Reason is a correct explanation of the Assertion

b) If both Assertion & Reason are True but Reason is not a correct explanation of the Assertion.

c) If Assertion is True but the Reason is False.

d) If both Assertion & Reason are false.

**Answer: c) If Assertion is True but the Reason is False.**

9. Assertion : Most of the X – linked disorders can not be eliminated easily from nature and Our gene pool

Reason : X –linked disorders are due to recessive

a) If both Assertion & Reason are True & the Reason is a correct explanation of the Assertion

b) If both Assertion & Reason are True but Reason is not a correct explanation of the Assertion.

c) If Assertion is True but the Reason is False.

d) If both Assertion & Reason are false.

**Answer: a) If both Assertion & Reason are True & the Reason is a correct explanation of the Assertion**

**ADDITIONAL QUESTIONS:-**

1. Mention two measures under negative eugenics

**Answer:** (I) Sexual separation of the defectives.

(ii) Sterilization of the defectives

(iii) Control of immigration and

(iv) Regulation of marriages

2. Mention the symptoms seen in trisomy 13/ Pataus's syndrome.

**Answer:** It is characterized by multiple and severe body malformations as well as profound mental deficiency. Small head with small eyes, cleft palate, malformation of the brain and internal organs are some of the symptoms of this syndrome.

3. What is a syndrome?

**Answer:** Group of signs and symptoms that occur together and characterize a particular abnormality is called a syndrome. In humans, Down's syndrome, Turner's syndrome, Klinefelter's syndrome, Patau's syndrome are some of the examples of chromosomal disorders.

4. What is Lyon's hypothesis?

**Answer:** Mary Lyon suggested that Barr bodies represented an inactive chromosome, which in females becomes tightly coiled into a heterochromatin, a condensed and visible form of

chromatin. The number of Barr bodies observed in cell was one less than the number of X-Chromosome. XO females have no Barr body, whereas XXY males have one Barr body.

5. What are Gynandromorphy?

**Answer:** These individuals have parts of their body expressing male characters and other parts of the body expressing female characters. The organism is made up of tissues of male and female genotype and represents a mosaic pattern.

6. How does hemophilia affect an individual?

**Answer:** A person with a recessive gene for haemophilia lacks a normal clotting substance (thromboplastin) in blood, hence minor injuries cause continuous bleeding, leading to death

7. What is Rh factor or Rh antigen?

**Answer:** (i) Rh factor is a immunogenic D antigen of the Rh blood group system found on the surface of the erythrocytes of Rhesus monkey and human beings. In the blood it is inherited as a dominant trait.

(ii) An individual having D antigen are Rh D (Rh") and those without D antigen are Rh D negative (Rh).

8. Define multiple allelism.

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

9. Name the discoverers of antigen A, B, and AB.

**Answer:** Antigens A and Antigen B was discovered by Karl Landsteiner. Antigen AB was discovered by Von De Castelle and Sturli.

10. What happens if type A blood is injected to a person having B blood group? Explain the reason.

**Answer:** When two different incompatible blood types are mixed, agglutination (clumping together) of erythrocytes (RBC) occurs. The basis of these chemical differences is due to the presence of antigens (surface antigens) on the membrane of RBC and epithelial cells.

11. State the allelic forms of I gene and mention its chromosomal location.

**Answer:** The I gene exists in three forms: IA , IB and IO . The alleles are located on chromosome 9.

12. Write the possible genotypes for a person having B-blood group

**Answer:** The possible genotypes of a B-blood group person are IBIBor IBlO.

13. Write a note on Huntington's chorea.

**Answer:** Huntington's chorea is inherited as an autosomal dominant lethal gene in man. It is characterized by involuntary jerking of the body and progressive degeneration of the nervous system, accompanied by gradual mental and physical deterioration. The patients with this disease usually die between the age of 35 and 40.

14. Comment on Trisomy-21.

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

15. Mention the genetic makeup of Turner's syndrome person and Klinefelter's syndrome person.

**Answer:** Klinefelter's syndrome - 44AA+XXY

Turner's syndrome - 44AA+XO

16. List out any four clinical symptoms of Klinefelter's syndrome.

**Answer:** Gynaecomastia, high pitched voice, under developed genetalia and tall with long limbs.

17. Write a note on thalassemia.

**Answer:** (i) Thalassemia is an autosomal recessive disorder. It is caused by gene mutation resulting in excessive destruction of RBC's due to the formation of abnormal haemoglobin molecules. Normally haemoglobin is composed of four polypeptide chains, two ph and two bet globin chains. Thalassemia patients have defects in either the alpha or beta globin chain causing the production of abnormal haemoglobin molecules resulting in anaemia.

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

18. Write a note on allosomal chromosomal abnormalities.

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

i) Klinefelter's Syndrome (XXY Males)

This genetic disorder is due to the presence of an additional copy of the X chromosome resulting in a karyotype of 47,XXY. Persons with this syndrome have 47 chromosomes

(44AA+XXY). They are usually sterile males, tall, obese, with long limbs, high pitched voice, under developed genitalia and have feeble breast (gynecomastia) development.

(ii) Turner's Syndrome (XO Females)

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

# CHAPTER 5 – MOLECULAR GENETICS

## TEXTUAL BOOK BACK EVALUATION

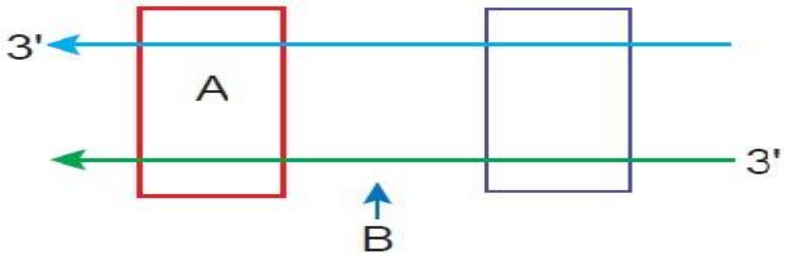
1. Hershey and Chase experiment with bacteriophage showed that
   a) Protein gets into the bacterial cells **b) DNA is the genetic material**
   c) DNA contains radioactive sulphur d) Viruses undergo transformation
2. DNA and RNA are similar with respect to
   a) Thymine as a nitrogen base b) A single-stranded helix shape
   **c) Nucleotide containing sugars, nitrogen bases and phosphates**
   d) The same sequence of nucleotides for the amino acid phenyl alanine
3. A mRNA molecule is produced by
   a) Replication **b) Transcription** c) Duplication d) Translation
4. The total number of nitrogenous bases in human genome is estimated to be about
   a) 3.5 million b) 35000 c) 35 million **d) 3.1 billion**
5. *E. coli* cell grown on 15N medium are transferred to 14N medium and allowed to grow for two generations. DNA extracted from these cells is ultracentrifuged in a cesium chloride density gradient. What density distribution of DNA would you expect in this experiment?
   a) One high and one low density band. b) One intermediate density band.
   c) One high and one intermediate density band.
   **d) One low and one intermediate density band.**
6. What is the basis for the difference in the synthesis of the leading and lagging strand of DNA molecules?
   a) Origin of replication occurs only at the 5' end of the molecules.
   b) DNA ligase works only in the 3' → 5' direction.
   **c) DNA polymerase can join new nucleotides only to the 3' end of the growing stand.**
   d) Helicases and single-strand binding proteins that work at the 5' end.
7. Which of the following is the correct sequence of event with reference to the central dogma?
   a) Transcription, Translation, Replication b) Transcription, Replication, Translation
   c) Duplication, Translation, Transcription **d) Replication, Transcription, Translation**
8. Which of the following statements about DNA replication is not correct?
   a) Unwinding of DNA molecule occurs as hydrogen bonds break.
   **b) Replication occurs as each base is paired with another exactly like it.**
   c) Process is known as semi conservative replication because one old strand is conserved in the new molecule.
   d) Complementary base pairs are held together with hydrogen bonds.

9. Which of the following statements is not true about DNA replication in eukaryotes?
   a) Replication begins at a single origin of replication.
   b) Replication is bidirectional from the origins.
   c) Replication occurs at about 1 million base pairs per minute.
   **d) There are numerous different bacterial chromosomes, with replication ocurring in each at the same time.**
10. The first codon to be deciphered was _____ which codes for _____.
   a) AAA, proline b) GGG, alanine **c) UUU, Phenylalanine** d)TTT, arginine
11. Meselson and Stahl's experiment proved
   a)Transduction b) Transformation
   c) DNA is the genetic material **d) Semi-conservative nature of DNA replication**
12. Ribosomes are composed of two subunits; the smaller subunit of a ribosome has a binding site for _____ and the larger subunit has two binding sites for two _____.**Ans (mRNA, tRNA)**
13. An operon is a:
   a) Protein that suppresses gene expression
   b) Protein that accelerates gene expression
   **c) Cluster of structural genes with related function**
   d) Gene that switched other genes on or off
14. When lactose is present in the culture medium:
   a) Transcription of *lac y*, *lac z*, *lac a* genes occurs.
   b) Repressor is unable to bind to the operator.
   c) Repressor is able to bind to the operator.
   **d) Both (a) and (b) are correct.**

15. Give reasons: Genetic code is 'universal'.

**Answer :** The genetic code is universal. It means that all known living systems use nucleic acids and the same three base codons (triplet codon) direct the synthesis of protein from amino acids. For example, the mRNA (UUU) codon codes for phenylalanine in all cells of all organisms. Some exceptions are reported in prokaryotic, mitochondrial and chloroplast genomes. However similarities are more common than differences. Most part of the genetic code is universal in prokaryotes and eukaryotes.

16. Name the parts marked 'A' and 'B' in the given transcription unit:




**Answer:** A – Promotor ; B – Coding Strand

17. Differentiate - Leading stand and lagging strand.

**Answer :** During DNA replication, One acts as the leading strand and the other is the lagging strand.

| Leading stand | Lagging strand |
|---|---|
| During DNA replication the two strands of DNA one s acts as the strand in w the replicate continuous called leading strand | During DNA replication among the two strands of DNA one strand acts as the coding strand and replication, is discontinuous in this strand known as lagging strand. |
| The polarity of this strand is 3'- > 5' | The polarity of this strand is 5'- > 3' |
| No Okazaki fragments are formed | Discontinuous fragments called Okazaki fragments are formed which are joined by the enzyme DNA ligase. |

18. Differentiate Template Strand and Coding Strand.

| Template stand | Coding strand |
|---|---|
| In transcriptional unit in DNA, one strand has with DNA - dependent RNA polymerase catalyzing the polymerization in only one direction, This strand acts as a template, known as template strand. | In transcriptional unit in DNA, one strand with a sequence same as RNA (except thymine at the place of uracil) and is displaced during transcription, is known as coding strand. |
| The polarity of this strand is 3'- > 5' | The polarity of this strand is 5'- > 3' |

19. Mention any two ways in which single nucleotide polymorphism (SNPs) identified in human genome can bring revolutionary change in biological and medical science

**Answer:** Scientists have identified about 1.4 million locations where single base DNA differences **($SNP_s$ = Single nucleotide polymorphism** - pronounced as **'snips')** occur in humans. Identification of **'SNIPS'** is helpful in finding chromosomal locations for disease associated sequences and tracing human history.

✓ Mapping of human chromosome is possible to examine a person's DNA and to identify genetic abnormalities. This extremely useful in diagnosing disease and to provide genetic counselling to those planning to have a children. This kind of information would create possibilities for new gene therapies.

✓ DNA sequences can lead to an understanding of their natural capabilities that can be applied towards solving challenges in healthcare, agriculture, energy production and environmental remediation.

✓ A new era of molecular medicine characterised by looking into the most fundamental causes of disease than treating the symptoms will be an important advantage.

20. State any three goals of the human genome project.

**Answer:**

- ✓ Identify all the genes (approximately 30000) in human DNA.
- ✓ Determine the sequence of the three billion chemical base pairs that make up the human DNA.
- ✓ To store this information in databases.
- ✓ Transfer related technologies to other sectors, such as industries.
- ✓ Improve tools for analysis.

21.In E.coli, three enzymes β- galactosidase, permease and transacetylase are produced in the presence of lactose. Explain why the enzymes are not synthesized in the absence of lactose.

**Answer:**

(i) **Escherichia coli** bacterium uses glucose as energy source in normal circumstances.

(ii) Glucose is the preferred carbon source of energy. In the absence of glucose, if lactose is available as energy source, it enters the bacterial cell with the help of enzyme permease enters the bacterial cell. It acts as an inducer and interacts with the repressor protein to inactivate it.

(iii) RNA Polymerase binds to the promote site and transcribes the opeum to produce lac mRNA. This enables formation of all required enzymes needed for lactose metabolism namely the enzymes β-galactosidase permease and transacetylase. Thus the three enzymes

are synthesized only in the presence of lactose.
The regulation of lac operon by the repressor is an example of negative control of transcription initiation.

22. Distinguish between structural gene, regulatory gene and operator gene
**Answer:** The clusters of gene with related functions are called **Operons**. Each Operon is a unit of gene expression and regulation and consists of:

(i) The structural gene codes for proteins, rRNA and tRNA required by the cell.

(ii) Promoters are the signal sequences in DNA that initiate RNA synthesis. RNA polymerase binds to the promoter prior to the initiation of transcription.
The operators are present between the promoters and structural genes. The repressor protein binds to the operator regions of the operon.

23. A low level of expression of lac operon occurs at all the windows for treatment of various genetic disorders. Justify the statement
**Answer:** (i) A low level of lac operon occurs due to the absence of formation of permeases. Permeases are necessary for the transport of lactose from medium into cells. Due to the failure of transport of lactose into the cell, it will not act as inducer.
(ii) Although lactose can induce the expression of lac operon, the level of expression is very low. The reason for this is that the lac operon is subject to catabolite repression or the reduced expression of genes brought on by growth in the presence of glucose.

24. Why the human genome project is called a mega project?
**Answer :**

- ✓ The international human genome project was launched in the year 1990. It was a mega project and took 13years to complete.
- ✓ If The human genome is about 25 times larger than the genome of any organism sequenced to date and is the first vertebrate genome to be completed. Human genome is said'to have approximately 3 X 109 bp).
- ✓ HGP was closely associated with the rapid development of a new area in biology called bioinformatics.
- ✓ The methodologies of the Human Genome Project involved two major approaches. One approach was focused on identifying all the genes that are expressed as RNA (ETSS - Expressed Sequence Tags). The other approach was sequence annotation. Here, sequencing the whole set of genome was taken, that contains all the coding and non-coding sequences and later assigning different regions in the sequences with functions. These sequences were

subsequently annotated and are assigned to each chromosome.

- ✓ The genetic and physical maps on the genome are assigned using information on polymorphism of restriction endonuclease recognition sites and **some repetitive DNA sequences, called microsatellites.**
- ✓ The latest method of sequencing even longer fragments is by a method called Shotgun sequencing using supercomputers, which has replaced the traditional sequencing methods.
- ✓ Scientists have identified about 1.4 million locations where single base DNA differences (SNPs - Single nucleotide polymorphism - pronounced as 'snips') occur in humans. Identification of 'SNIPS' is helpful in finding chromosomal locations for disease associated sequences and tracing human history.

25. From their examination of the structure of DNA, What did Watson and Crick infer about the probable mechanism of DNA replication, coding capability and mutation?

**Answer: DNA replication**

- ✓ Watson and Crick proposed the double stranded helical structure of DNA. According to them the most probable mechanism of DNA replication is semi conservative method.
- ✓ During semi conservative method of replication both the strands unwind and separate. one strand acts as the template strand with polarity 3' → 5' where the replication is continuous, called template strand. In the other strand and the replication is discontinuous, synthesized in fragments (Okazaki fragments) with polarity 5' → 3'. This is called lagging strand.
- ✓ Newly synthesized complementary nucleotides are paired with the existing nucleotides on the parent strand and covalently bonded together by DNA polymerase. This is possible because of base pair rule.
- ✓ According to Watson and Crick, the sequence of bases in DNA could be copied by using each of the separate partner strands. The DNA could contain genetic information in coded form in the sequence of bases similar to letters printed in a strip of paper. Changes in genetic information (mutations) could result from errors in copying in which the base sequences of DNA become altered.

26. Why tRNA is called an adapter molecule?

**Answer:** (i) The transfer RNA, (tRNA) molecule of a cell acts as a vehicle that picks up the amino acids scattered through the cytoplasm and also reads specific codes of mRNA molecules. Hence it is called an **adapter molecule.**

(ii) This is achieved by the interaction of tRNA with mRNA. The tRNA molecule has a region that contains complementary bases (anticodon) to the codon on the mRNA. This term was

postulated by Francis Crick.

27. What are the three structural differences between RNA and DNA?

**Answer:**

| RNA | DNA |
|---|---|
| It contains Ribose sugar | It contains Deoxyribose sugar |
| RNA has a single strand | DNA structure is a double helix. |
| The nitrogenous bases consist of Adenine, Guanine, Uracil, and Cytosine | The nitrogenous bases consist of Adenine, Guanine, Thymine, Cytosine |
| RNA differentiated into mRNA, tRNA, rRNA | DNA has no differentiation. |
| Uracil is unique for RNA | Thymine is unique for DNA |

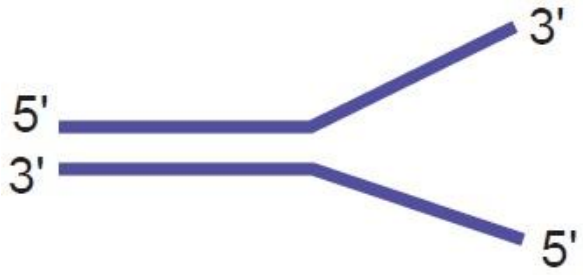
28. Name the anticodon required to recognize the following codons: AAU, CGA, UAU, and GCA.

**Answer:**

| **CODON** | - | **ANTICODON** |
|---|---|---|
| AAU | - | UUA |
| CGA | - | GCU |
| UAU | - | AUA |
| GCA | - | CGU |

29. a) Identify the figure given below

b) Redraw the structure as a replicating fork and label the parts



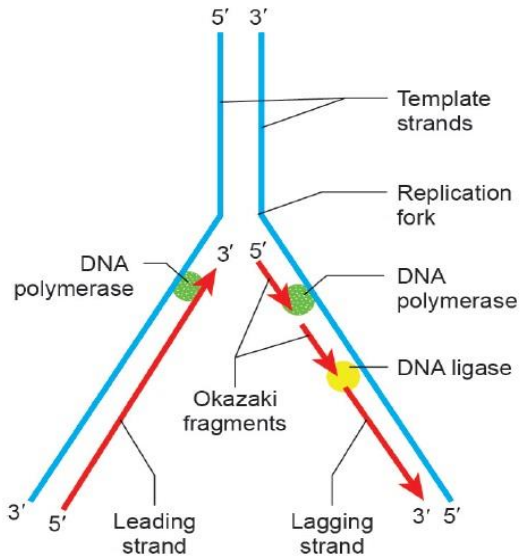

c) Write the source of energy for this replication and name the enzyme involved in this process.

d) Mention the differences in the synthesis of protein, based on the polarity of the two template strands.

**Answer:**

a) The figure shows the semiconcervative mode of DNA Replication - A Replication fork.

b)




(c) Source of energy for the replication is Deoxy nucleotide triphosphate provides energy for the process. The enzymes required for replication are different types of DNA polymerase. DNA helicase helps in unwinding of DNA. DNA ligase helps to join broken DNA fragments.

(d) During transcription process, the DNA dependent RNA polymerase enzyme catalyses the polymerisation in only one direction (3' ⟶ 5') which acts as template and is called template strand. The other strand with polarity 5' ⟶ 3' is displaced during transcription. Therefore the mRNA base sequence is complementary to the template strand only. mRNA brings the information for the formation of proteins. Thus the synthesis of protein is based on the sequence of the template strand of DNA with polarity 3'- > 5'.

30. If the coding sequence in a transcription unit is written as follows:
5' TGCATGCATGCATGCATGCATGCATGC 3' Write down the sequence of mRNA.

**Answer:** Sequence of mRNA for the given coding unit
3' ACGUACGUACGUACGUACGUACGUACG 5'

31. How is the two stage process of protein synthesis advantageous?

**Answer:** (i) Protein synthesis comprises two major parts - transcription and translation. The process involves ribonucleic acid (RNA), deoxyribonucleic acid (DNA), and a set of enzymes. All types of ribonucleic acids, namely messenger ribonucleic acid (mRNA), ribosomal ribonucleic acid (rRNA), and transfer ribonucleic acid (tRNA) are required for protein synthesis.

(ii) Accordingly, protein synthesis of a'.specific amino acid sequence takes place. Overall, the process of protein synthesis involves transcription of DNA to mRNA, 'which is then translated into proteins. This process requires proper coordination of RNA, DNA, enzymes, and ribosomes.

32. Why did Hershey and Chase use radioactively labelled phosphorous and sulphur only? Would they have got the same result if they use radiolabelled carbon and nitrogen?

**Answer:**

(i) **Alfred Hershey** and **Martha Chase** (1952) conducted experiments on bacteriophages that infect bacteria.Hershey and Chase wanted to ob-serve whether it was DNA or protein that entered the bacteria.

(ii) All nucleic acids contain phosphorus and contain sulphur (in the amino acid cysteine and methionine).

(iii) Hershey and Chase used radioactive isotopes of Sulphur ($^{35}S$)and phosphorus $^{(32}P$) to keep separate track of the viral protein and nucleic acids during the infection process.

(iv) The phages were allowed to infect bacteria in culture medium which contained trie radioactive isotopes $^{35}S$ or $^{32}p$.

(v) The bacteriophage that grew in the presence of 35Shad labelled proteins and bacteriophages grown in the presence of' 32phad labelled DNA.

(vi) The differential labelling thus enabled them to identify DNA and proteins of the phage.

(vii) Hershey and Chase mixed -the labelled phages with unlabelled E. coli and allowed bacteriophages to attack and inject their' genetic material.

(viii) It was observed that only $^{32}P$ was found associated with bacterial cells and $^{35}S$was in the surrounding medium and not in the bacterial cells.

(ix) When phage progeny was studied for radioactivity, it was found that it carried only $^{32}P$ and not $^{35}S$.

(x) Hershey and Chase thus conclusively proved that it was DNA, not protein, which carries the hereditary information from virus to bacteria.

(xi) If they had used radioactive labelled carbon and nitrogen they would have not got the same result because carbon and nitrogen are found in DNA and protein.

(xii) If they had used radioactive labelled carbon and nitrogen these labelled molecules would have been found in DNA and proteins and they would never be able to prove whether DNA or protein of a virus causes the heredity information.

33. Explain the formation of a nucleosome.
**Answer:** (i) In eukaryotes, chromatin is formed by a series of repeating units called **nucleosomes.**

(ii) Korenbergproposed a model for the nucleosome, in which 2 molecules of the four histone proteins H2A, H2B, H3 AND H4 are organized to form a unit of eight molecules called **histone octamere.**

(iii) The negatively charged DNA is wrapped around the positively charged histone octamer to form a structure called **nucleosome**. A typical nucleosome contains 200 bp of DNA helix.

(iv) The histone octameres are in close contact and DNA is coiled on the outside of nucleosome.

(v) Neighbouring nucleosomes are connected by linker DNA (Hl) that is exposed to enzymes. The DNA makes two complete turns around the histone octameres and the two turns are sealed off by an HI molecule

(vi)Chromatin lacking HI has **beads on a string** appearance in which DNA enters and leaves the nucleosomes at random places.

(vii)HI of one nucleosome can interact with HI of the neighbouring nucleosomes resulting in the further folding of the fibre.

(viii)The chromatin fiber in interphase nuclei and mitotic chromosomes have a diameter that vary between 200-300 nm and represents inactive chromatin. 30 nm fibre arises from the folding of nucleosome, chains into a **solenoid** structure having six nucleosomes per turn. This structure is stabilized by interaction between different HI molecules.

(ix)DNA is a solenoid and packed about 40 folds.

(x)In a typical nucleus, the chromatin that is tightly packed (stained darkly) is called heterochromatin. Euchromatin is transcriptionally active and heterochromatin is transcriptionally inactive.

34. It is established that RNA is the first genetic material. Justify giving reasons.
**Answer:**
(i) Three molecular biologists in the early 1980's (Leslie Orgel, Francis Brick and Carl Woese) independently proposed the **'RNA WORLD'** as the first stage in the evolutionary of life, a stage when RNA catalysed all molecules necessary for survival and replication.

(ii)The term 'RNA world' first used by **Walter Gilbert** in 1986, hypothesizes RNA as the first genetic material on earth.
(iii)There is now enough evidence to suggest that essential life processes (such as metabolism, translation, splicing etc.,) evolved around RNA. RNA has the ability to act as both genetic material and catalyst.
(iv)There are several biochemical reactions in living systems that are catalysed by RNA. This catalytic RNA is known as **ribozyme.** But, RNA being a catalyst was reactive and hence unstable.
(v)This led to evolution of a more stable form of DNA, with certain chemical modifications. Since DNA is a double stranded molecule having complementary strand, it has resisted changes by evolving a process of repair.
(vi)Some RNA molecules function as gene regulators by binding to DNA and affect gene expression.
(vii)Some viruses use RNA as the genetic material.
(viii)Andrew Fire and Craig Mellow (recipients of Nobel Prize in 2006) were of the opinion that RNA is an active ingredient in the chemistry of life.

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