2 CHAPTER

Human Reproduction

Level - 1 CORE SUBJECTIVE QUESTIONS

MULTIPLE CHOICE QUESTIONS (MCQs) (1 Mark)

1. Option (B) is correct
Explanation: Parturition is an induced complex neuroendocrine mechanism. These signals come from a placenta and fully grown fetus. This results in fetal ejection reflex and mild uterine contractions. The mother's pituitary then releases oxytocin, which affects the uterine muscles and causes powerful contractions. This results in contractions that get stronger and stronger. Consequently, the baby and placenta are expelled out through the birth canal from the uterus.
2. Option (B) is correct
Explanation: Human Chorionic Gonadotropin is secreted by the placenta during pregnancy. It helps maintain the corpus luteum, which produces progesterone. Progesterone is crucial for sustaining the uterine lining and supporting early pregnancy.
3. Option (B) is correct
Explanation: The correct sequence of events in the human female reproductive cycle is:
(i) Secretion of FSH → (iv) Growth of follicle and oogenesis → (v) Sudden increase in LH → (ii) Ovulation → (iii) Growth of corpus luteum.
4. Option (C) is correct
Explanation: In humans, the secondary oocyte completes meiotic division when it is penetrated by the sperm cell. This triggers the completion of the second meiotic division in the oocyte, forming a mature ovum and a second polar body.
5. Option (B) is correct
Explanation: Estrogen is primarily secreted by the granulosa cells of the Graafian follicle during the follicular phase of the menstrual cycle. These cells surround the developing oocyte and produce estrogen as they mature under the influence of Follicle Stimulating Hormone (FSH).
6. Option (C) is correct
Explanation: A is ovum. The ovum represents the mature egg cell that is released from the ovary during ovulation. E is morula. The morula is a solid ball of cells that forms after several divisions of the fertilised egg (zygote). It typically forms around day 3-4 post-fertilisation. G represents blastocyst. The blastocyst is a later stage of embryonic development that contains a fluid-filled cavity and the cells that will develop into the embryo.
7. Option (C) is correct
Explanation: Leydig cells, found in the testes, secrete androgens, primarily testosterone. Testosterone is essential for initiating and maintaining spermatogenesis, the process by which sperm are produced. It stimulates the development of sperm within the seminiferous tubules and supports overall reproductive health.
8. Option (D) is correct
Explanation: The human placenta secretes hormones such as progesterone, estrogen, and human chorionic gonadotropin (HCG) to support pregnancy. Relaxin, however, is primarily produced by the ovaries.
9. Option (C) is correct
Explanation: A human ovum completes its second meiosis when the sperm gains entry into the cytoplasm of the ovum. The ovum remains arrested in metaphase II of meiosis II until fertilisation occurs. Upon sperm entry, the ovum completes meiosis II, resulting in the formation of a mature ovum and a second polar body.
10. Option (A) and (B) are correct.
(Also as per CBSE Marking Scheme)
Explanation: Fertility peaks around ovulation, which generally happens around day 14 of a 28-day cycle. The most fertile period includes the days leading up to and immediately following ovulation.
Conversely, the days just after menstruation and before the next ovulation, usually from days 1 to 7 or 21-28 are less fertile since the body is just beginning a new cycle and ovulation has not yet occurred. As the cycle progresses past ovulation and approaches menstruation, fertility decreases.
11. Option (C) is correct
Explanation: The human mammary gland consists of several key structures involved in milk production and delivery. The glandular tissue made up of 15-20 lobes and each lobe is made up of numerous alveoli, where milk is produced and stored in the lumen of these alveoli. The mammary ampulla, an expansion of the duct system, acts as a reservoir for milk and is connected to the lactiferous ducts. These ducts transport the milk from the ampulla to the nipple for breastfeeding.

ASSERTION-REASON QUESTIONS (1 Mark)

1. Option (C) is correct

   Explanation: Breastfeeding is highly beneficial for newborns as it provides essential nutrients, helps in building the immune system, and promotes healthy growth and development.

   While colostrum is indeed rich in antibodies, the primary antibody it contains is IgA, not IgE or IgG. Secretory IgA plays a crucial role in protecting the newborn's mucous membranes (e.g., in the gut and respiratory tract) from infections. IgG is also present but in smaller amounts, and IgE is not significantly present in colostrum.

2. Option (A) is correct

   Explanation: During fertilisation, only one sperm successfully penetrates the ovum, ensuring monospermy. Mechanisms like the cortical reaction prevent multiple sperm from fertilising the ovum, thus avoiding polyspermy.

   The sperm binds to specific receptors on the zona pellucida (a glycoprotein layer surrounding the ovum), triggering acrosomal reactions that allow the sperm to penetrate this layer and fuse with the ovum. The interaction with the zona pellucida layer is a critical step in fertilisation, leading to the prevention of polyspermy and ensuring that only one sperm fertilises the ovum. Thus, the reason explains the assertion.

VERY SHORT ANSWER TYPE QUESTIONS (2 Marks)

1. **(i)** Negative hCG implies no pregnancy.
   Placenta.
   (ii) Human placental lactogen (hPL), estrogen, progestogens, relaxin. (any two)
2. **(i)** A sperm induces changes in the zona pellucida membrane on contact, blocking entry of other sperms.
   (ii) Ovum and sperms should be transported simultaneously to the ampullary region for fertilisation.
3. **Myometrium:**
   - Smooth muscular layer of uterus.
   - It exhibits strong contraction of the uterus during delivery of the baby (parturition).

   Endometrium:
   - Glandular.
   - Undergoes cyclic changes during menstruation /implantation of the developing embryo or blastocyst / other events of pregnancy.
4. **(i)**
   - Outside seminiferous tubule / interstitial spaces.
   - Synthesise and secrete testicular hormones or androgens.

   (ii)
   - In seminiferous tubule (along inner lining).
   - Provide nutrition to germ cells.
5. X- In woman X, thickness of uterine wall increases after mid of menstrual cycle.

   Reason: Due to fertilisation of egg/pregnancy/ conceived.

   Y- In woman Y, thickness of uterine wall decreases after mid of menstrual cycle

   Reason: Egg has not been fertilised/ leading to the breakdown of lining of the uterus/menstrual flow/ bleeding.
6. **(i)** Blastocyst
   (ii) Uterine wall/endometrium/innermost layer of uterine wall.
   (iii) (Outer layer/trophoblast) 'X'- helps in implantation in uterus/attachment to endometrium.
   (Inner cell mass) 'Y'- gets differentiated into embryo.
7. **(i)** 47 years.
   (ii) 6-8 years of age.
8.

	Follicular phase	Luteal Phase
(i) Days of their occurrence in the cycle	6th – 13th / 6th – 14th day	15th – 28th/15th – 29th day
(ii) Stage of the follicle	Development of primary follicle into Graafian follicle	Transformation of Graafian follicle into Corpus Luteum
(iii) Hormones influencing the phases	LH/FSH/Estrogen	Progesterone
(iv) State of endometrium	Regeneration of endometrium through proliferation.	Endometrium further proliferate and thickens.

SHORT ANSWER TYPE QUESTIONS (3 Marks)

1.
   - The first meiotic division is completed in the primary oocyte during oogenesis.
   - Then primary oocyte undergoes first meiotic division to form a large haploid secondary oocyte and a tiny first polar body.
   - The primary oocyte comprises of 46 chromosomes, whereas secondary oocyte and first polar body have 23 chromosomes each.
2. Oogonia (2n) in embryonic/foetal ovary
   ↓ Mitosis and Differentiation

Primary oocyte (2n)
↓ Ist meiotic division begins in foetal stage and gets arrested till puberty
Secondary oocyte (n) and 1st polar body
↓ 2nd meiotic division completes upon entry of sperm ovum (n) and 2nd Polar body

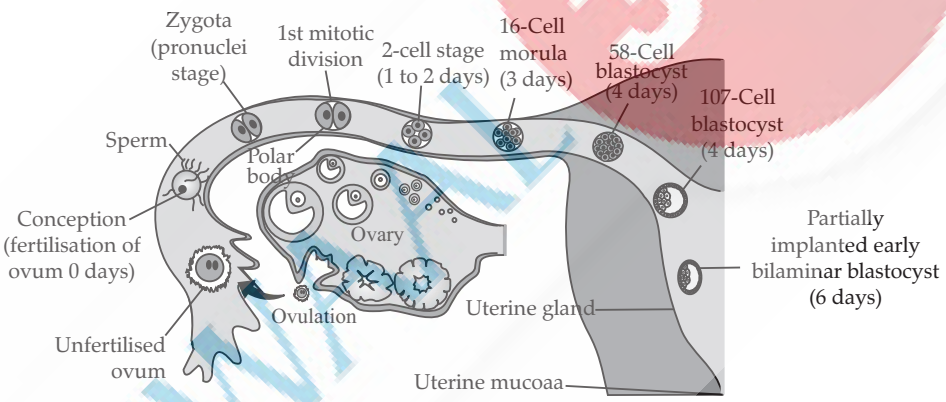
3. **(i)** 'Y'- Fimbriae. It helps in collection of the ovum after ovulation.
(ii) 'Z'- Isthmus. Zygote undergoes cleavage to form morula.
(iii) • Prophase I of meiotic division.
• Primary oocyte.

4. Implantation is the process in which the fertilised egg attaches it self to the endometrium. The blastocyst reaches the uterus and gets embedded in the endometrium of the uterus. This usually occurs 6-7 days after fertilisation.
Immediate changes after the process:
Finger like projections appears on the trophoblast called Chorionic villi which are surrounded by uterine tissue and maternal blood.
These tissues interdigitate with each other to form placenta.

5. **(i)** **(1)** 'b' (secondary spermatocytes) formed after first meiotic division/ Meiosis -I in 'a' (primary spermatocytes)
(2) 'e' (sperms) formed via a process called spermiogenesis/ differentiation from 'd' (spermatids)
(3) 'd' (Spermatids) formed after second meiotic division/ Meiosis- II from 'b' (secondary spermatocyte).
(ii) a – Primary spermatocyte
b – Secondary spermatocyte
c – Sertoli cell

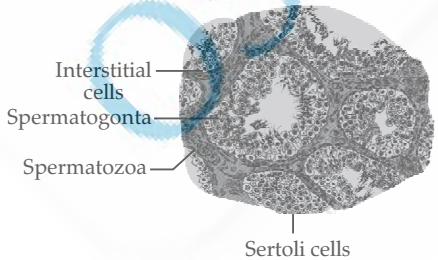
6. **(i)** • Primary follicle
• During fetal stage
(ii) • Secondary Oocyte
• It is formed at follicular phase/ between 6-13 day of menstrual cycle.
• Tertiary follicle grows in size and completes its first meiotic division and this unequal division results in a large haploid secondary Oocyte and a tiny first polar body.
(iii) Progesterone

7. Mitotic division of the zygote (in isthmus) is called cleavage. The zygote moves towards the uterus, cleavage results in formation of (2,4,8,16) daughter cells called blastomeres. Embryo with 8 to 16 blastomeres is called morula which continues to divide and transforms into blastocyst as it moves further into the uterus. Blastomeres in the blastocyst are arranged into an outer layer called trophoblast. Trophoblast layer gets embedded to the endometrium and this is called implantation.

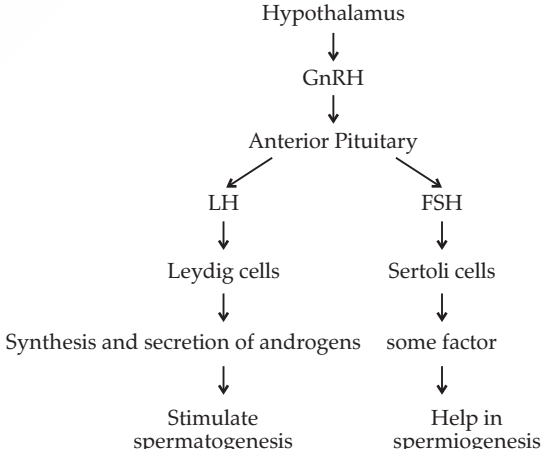


LONG ANSWER TYPE QUESTIONS (5 Marks)

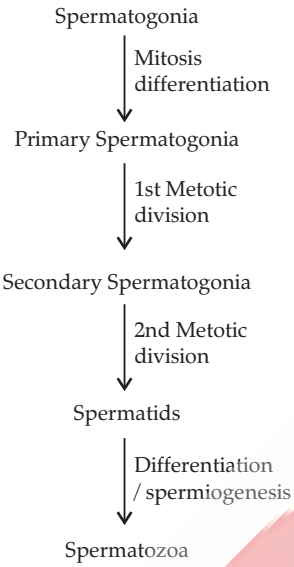
1. **(i)**



(ii)



2. (i) The process depicted in the diagram is Spermatogenesis.



(ii) Sertoli cells. It provides nourishment to the developing sperm.

3. Menstrual cycle in a normal human female

	Uterine event	Ovarian event
(i) Proliferative phase/ Follicular phase	Endometrium of the uterus regenerates through proliferation under the influence of estrogen.	Primary follicles in the ovary grow to become Graafian follicles under FSH. (Secretion of estrogens by the growing follicles).
(ii) Luteal phase/Secretory phase	Maintenance of the endometrium (thickness) in the presence of progesterone.	Ruptured Graafian follicle transforms into corpus luteum. (secretes large amounts of progesterone).
(iii) Menstrual phase	Breakdown of the endometrium lining of the uterus in the absences of progesterone from Corpus luteum.	Primary follicles start maturing and developing in the ovary under the effect of FSH.

4. (i) In a human female, the fertilisation of the ovum occurs in the ampulla region of fallopian tube.

A sperm comes in contact with zona pellucida (layer of ovum), the secretion of the acrosome of the sperm helps the sperm to enter into the cytoplasm of the ovum, this induces completion of meiosis II to form haploid ovum (ootid), haploid nucleus of the sperm and of the ovum fuse together to form the diploid zygote.

On contact of sperm with zona pellucida induces changes in the membrane of the ovum that blocks the entry of the additional sperms thereby preventing polyspermy.

(ii) Blastocyst.

Trophoblast layer of the blastocyst gets attached to the endometrium, inner cell mass gets differentiated into an embryo, the uterine cells divide rapidly and blastocyst gets embedded in the endometrium of the uterus.

5. (i) (A) Menstrual period
(B) Follicular phase/proliferative phase
(C) Luteal phase/secretory phase
(D) Ovulatory phase

(ii)

	Days	Ovarian hormones	Pituitary hormones
(A)	8-12	Follicular growth / proliferation of endometrial cells.	Simulates follicular Development/ secretion of estrogen by growing follicles.
(2)	13-15	Maturation of ovarian follicles/ Formation of graafian follicles / thickening of endometrium.	Rupture of Graafian follicle to release ovum.
(3)	16-18	Maintenance of endometrium.	Secretion of progesterone from corpus luteum.

6. (i) The fetal ejection reflex is a neuroendocrine reflex that begins when the fully developed fetus

exerts pressure on the cervix in the final weeks of pregnancy. As the fetus grows and moves lower in the uterus, it applies pressure to the cervix. Stretch receptors in the cervix send signals to the hypothalamus in the brain. The posterior pituitary gland release oxytocin, which stimulates strong uterine contractions. These contractions cause more cervical stretching, leading to more oxytocin release, further intensifying contractions units birth occurs.

(ii) The posterior pituitary gland releases oxytocin. Oxytocin stimulates strong uterine contractions. It works through a positive feedback mechanism, meaning that stronger contractions lead to more oxytocin release, further intensifying lobar.

(iii) 1- Mammary lobes, has clusters of cells called alveoli.
2- Mammary alveolus, secrete milk.
3-Lactiferous duct, through this milk is sucked out.

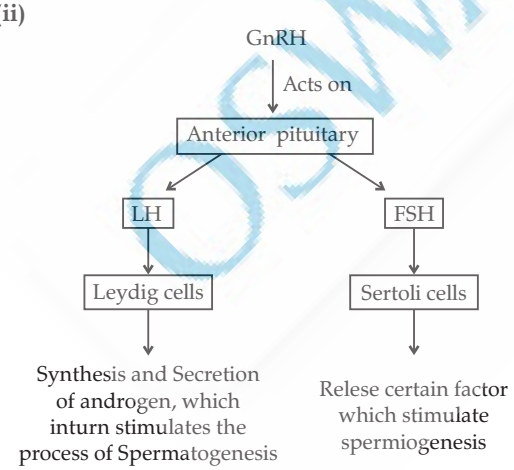
7. (i) a- Cells of corona radiata
b- Zona pellucida /Perivitelline space
c- Haploid nucleus

(ii)
- The meiotic division is completed once the sperm enters the cytoplasm of the ovum.
- The whole process is completed within the fallopian tube.
- Entry of sperm in the cytoplasm of the ovum induces the completion of the 2nd meiotic division of the secondary oocyte; it is unequal division and results in formation of a second polar body and a haploid ovum(ootid).

(iii) During fertilisation, as the sperm comes in contact with the zona pellucida layer of the ovum, it induces changes in the membrane, that block the entry of any additional sperms.

8. (i) **(1)** Within seminiferous tubule
(2) In interstitial spaces / between the seminiferous tubules

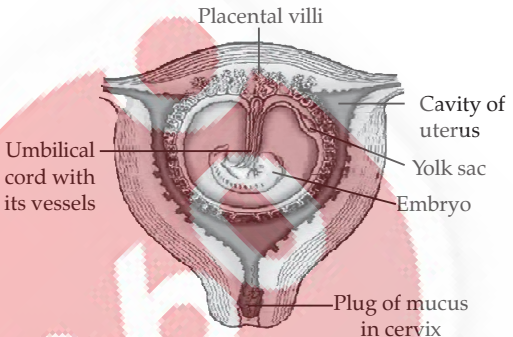
(ii)



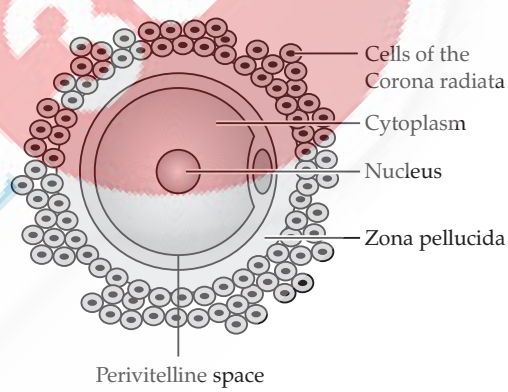
The increased levels of GnRH, then acts at the anterior pituitary gland, and stimulates secretion of two gonadotropins – luteinising hormone (LH), and follicle stimulating hormone (FSH), LH acts at the Leydig cells, and stimulates synthesis and secretion of androgens which in turn stimulate the process of spermatogenesis, FSH acts on the Sertoli cells, and stimulates secretion of some factors which help in the process of spermiogenesis.

9. (i) After implantation finger like projections appear on the trophoblast called chorionic villi which are surrounded by the uterine tissue and maternal blood, these tissues become interdigitated with each other, and jointly form a structural and functional unit between developing embryo and maternal body called placenta.

(ii)



10. (i)



During fertilisation a sperm comes in contact with the zona pellucida layer of the ovum and induces changes in the membrane that block the entry of additional sperms. The secretions of the acrosome help the sperm enter into the cytoplasm of the ovum through the zona pellucida and the plasma membrane. This induces the completion of the meiotic division of the secondary oocyte, and results in the formation of second polar body and a haploid ovum (ootid).
The haploid nucleus of the sperms and that of the ovum fuse together to form a diploid zygote.

(ii) If sperm carrying X chromosomes fertilise egg, child born will be a female baby. If the sperm carrying Y chromosomes fertilise the egg, the child born will be a male baby.

Level - 2 ADVANCED COMPETENCY FOCUSED QUESTIONS

MULTIPLE CHOICE QUESTIONS (MCQs) (1 Mark)

1. Option (A) is correct
   Explanation: Spermatids are the cells produced after meiosis during spermatogenesis and contain half the number of chromosomes as the diploid cells (like spermatogonia). Sertoli cells and Leydig cells are diploid, and spermatogonia are also diploid.
2. Option (A) is correct
   Explanation: High levels of follicle stimulating hormone (FSH), luteinising hormone (LH), and estrogen, with a low level of progesterone, suggest the stage when the follicle is maturing and preparing for ovulation.
   High FSH and LH are typical of the ovulatory phase, which occurs towards the end of the follicular phase.
   Low progesterone indicates that the luteal phase has not yet started, as progesterone rises after ovulation.
3. Option (B) is correct
   Explanation: In *In Vitro* Fertilisation (IVF), the zygote formed in the laboratory is typically transferred to the uterus after it undergoes a few mitotic divisions, usually reaching the 8-cell or morula stage (about 2–3 days after fertilisation). This stage is more viable for implantation in the uterine lining. Implantation is more successful when the embryo is at least at the **8-cell stage**, resembling the natural stage at which a fertilised egg would reach the uterus in vivo.
4. Option (C) is correct
   Explanation: The testes are located in the scrotum (a pouch of skin outside the abdominal cavity) because spermatogenesis (formation of sperm) requires a temperature 2–2.5°C lower than the core body temperature. The scrotum helps regulate this lower temperature, essential for the proper development of sperm.
5. Option (A) is correct
   Explanation: If a woman has a blockage in her fallopian tubes, natural fertilisation or certain ART methods won't work because the egg and sperm cannot meet or the embryo cannot travel to the uterus. ZIFT (Zygote Intra-Fallopian Transfer) is used when fertilisation is done outside the body (in vitro), forming a zygote. The zygote is then transferred into the fallopian tube using a laparoscope. It is suitable when fallopian tubes are partially blocked but still accessible via surgical techniques.

ASSERTION-REASON QUESTIONS (1 Mark)

1. Option (A) is correct
   Explanation: Assertion is true. Spermatogenesis begins at puberty due to hormonal activation of the testes.
   Reason is also true. FSH (Follicle Stimulating Hormone) acts on Sertoli cells to help nourish developing sperm and support spermatogenesis. LH (Luteinizing Hormone) stimulates Leydig cells to produce testosterone, which is essential for spermatogenesis.
   Since testosterone production and Sertoli cell activity are both necessary for spermatogenesis and are triggered by FSH and LH at puberty, the reason correctly explains the assertion.
2. Option (A) is correct
   Explanation: Assertion is true. The zona pellucida is a glycoprotein-rich outer membrane surrounding the ovum. It plays a crucial role in species-specific sperm binding and prevents polyspermy (entry of multiple sperms).
   Reason is also true. The acrosome (a cap-like structure on the head of the sperm) contains digestive enzymes like hyaluronidase and acrosin, which help break down the zona pellucida, enabling the sperm to penetrate and fuse with the ovum.
   Since the acrosomal reaction targeting the zona pellucida is a key step in fertilisation, the Reason correctly explains the Assertion.
3. Option (A) is correct
   Explanation: Assertion is true. This is essential to maintain the correct diploid chromosome number in the resulting zygote. Fertilisation by more than one sperm (polyspermy) would result in an abnormal zygote.
   Reason is also true. Upon entry of the first sperm, the ovum initiates a cortical reaction—release of cortical granules that modify the zona pellucida, making it impermeable to other sperms, thereby blocking polyspermy.
4. Option (D) is correct
   Explanation: Assertion is false. Implantation does not occur in the cervix. It normally takes place in the endometrium (inner lining) of the uterus, specifically in the upper posterior wall of the uterine body, not the cervix.
   Reason is true. The blastocyst (early embryo) embeds itself into the endometrial lining of the uterus during implantation, typically around 6–7 days after fertilisation.

VERY SHORT ANSWER TYPE QUESTIONS (2 Marks)

1. **(i)** **(1)** Pituitary
   (2) Initiation of parturition
   (ii) • Positive
   • Because the secretion of oxytocin stimulates the release of further oxytocin.
2. **(i)** Haploid.
   (ii) To provide energy to the sperm to swim.

(iii) Contains enzymes that help in the process of fertilisation.

(iv) The first sperm induces changes in the ovum membrane to block the entry of other sperms.

3. • Tentative date would be between February 4 and February 6.

• **Reason:** Ovulation happens between 14th-16th day from the onset of latest or previous menstruation/period.

4. • No

• **Reason:** Unlike males, a human female contains of a pair of the same sex chromosome 'X', one from each parent.

5. • Cervix

• Vagina

6. • Progesterone prevents the shedding of endometrium.

• Progesterone prevents ovulation.

SHORT ANSWER TYPE QUESTIONS (3 Marks)

1. (i) • Oogenesis results in one gamete and some polar bodies, while meiosis results in the production of four haploid gametes.

(ii) • FSH or follicle-stimulating hormone

• LH or Luteinizing hormone

(iii) • In females, FSH stimulates the development of follicles in ovary.

• In males, LH stimulates the production of testosterone hormone by Leydig cells.

OR

In females, LH triggers ovulation.

• In males, FSH acts on the Sertoli cells and stimulates them to secrete some factors which help in spermiogenesis.

2. (i) False.

The Graafian follicle releases the ovum and transforms into the corpus luteum.

(ii) False.

The corpus luteum is detected in both pregnant and non-pregnant women. It is formed after ovulation.

(iii) False

The urethra is the passage for urination only.

The unfertilised egg and menstrual blood pass through the vagina.

3. (i) Steps involved in IVF (In Vitro Fertilisation) and Embryo Transfer:

(1) Hormonal Stimulation of the Ovaries: The woman is given hormonal injections (usually FSH) to stimulate the maturation of multiple ova in her ovaries.

(2) Egg Retrieval (Ovum Pick-Up): Mature eggs (ova) are collected from the woman's ovaries using a laparoscope or ultrasound-guided needle.

(3) Collection of Sperm: A sperm sample is collected from the male partner.

(4) Fertilisation in the Laboratory: The collected ova and sperms are combined in a culture medium in a petri dish under sterile conditions to allow fertilisation outside the body (in vitro).

(5) Zygote Culture and Embryo Formation: The zygote formed is cultured in the lab for about 2–3 days until it reaches the 8-cell (cleavage) stage.

(6) Embryo Transfer (ET): The healthy 8-cell stage embryo is then transferred into the uterus of the mother or a surrogate using a catheter.

(ii) The uterus naturally receives the embryo only after it has reached the 8-cell to 16-cell stage, which typically occurs 2–3 days after fertilisation. Immediate transfer of the zygote (just-fertilised egg) into the uterus would not result in successful implantation, as the uterine lining is not yet ready to support a fertilised egg at such an early stage. At the 8-cell stage, the embryo is developmentally ready and the endometrium is optimally prepared for implantation, increasing the chances of successful pregnancy.

4. (i) Placenta is a temporary, disc-shaped, highly vascular organ that forms a vital connection between the developing fetus and the uterine wall of the mother.

Formation: The placenta is formed after implantation, from the chorionic villi (finger-like projections from the trophoblast layer of the embryo) and the maternal uterine tissue (endometrium). These structures interdigitate to form the feto-maternal placental interface.

(ii) Three major functions of the placenta:

(1) Nutritional Function: It facilitates the transfer of nutrients (glucose, amino acids, fatty acids, vitamins, etc.) from the mother's blood to the fetus for growth and development.

(2) Respiratory Function: The placenta allows oxygen to diffuse from the maternal blood to the fetal blood and removes carbon dioxide from fetal blood to maternal blood.

(3) Excretory Function: It helps eliminate waste products like urea and creatinine from fetal blood into maternal blood for excretion by the mother's kidneys.

5. (i) Intrauterine Insemination (IUI) is a type of Assisted Reproductive Technology (ART) in which sperm is directly introduced into the woman's uterus during the time of ovulation to increase the chances of fertilisation.

IUI	IVF (In Vitro Fertilisation)
Inside the female body (natural site)	Outside the body in a lab dish
Minimally invasive	More invasive (requires egg retrieval and lab work)

Less expensive and simpler	More expensive and complex
Low sperm count or motility	Blocked fallopian tubes, failed IUI, etc.

(ii) In this case, the male partner has low sperm motility, meaning sperm may not reach the egg naturally. IUI bypasses the cervix and places sperm directly into the uterus, closer to the fallopian tubes where fertilisation occurs. It increases the chances of successful fertilisation without the need for external egg and sperm handling like in IVF. IUI is also less expensive, less invasive, and often the first line of treatment before moving to more complex ARTs like IVF or ICSI.

CASE BASED QUESTIONS (4 Mark)

1. (i) Option (C) is correct
Explanation: The placenta acts as the interface between the mother and the fetus, allowing for the transfer of nutrients, gases, and waste products between maternal and fetal blood.

(ii) Option (C) is correct
Explanation: The placenta is made up of both maternal and embryonic tissues. The maternal part comes from the uterine lining, while the embryonic part is derived from the trophoblast of the developing embryo.

(iii) Option (A) is correct
Explanation: The placenta acts as an endocrine organ and secretes hormones such as hCG, progesterone, and estrogen, while the umbilical cord primarily functions as a conduit for blood flow between the mother and fetus and does not have a hormonal role.

(iv) Option (D) is correct
Explanation: The shedding of the placenta occurs after the baby is delivered. This process, known as the "third stage of labor," involves the detachment and expulsion of the placenta from the uterine wall.

2. (i) (a) FSH acts on sertoli cells in seminiferous tubule, induces release of some factors which induce spermiogenesis.

OR

(b) LH acts on Leydig cells, and stimulates the synthesis and secretion of androgens for spermatogenesis.

(ii) (a) Spermatogonia $\xrightarrow{\text{mitosis/differentiation}}$ Primary Spermatocyte

(b) Primary Spermatocyte $\xrightarrow{\text{meiosis I}}$ Secondary Spermatocyte $\xrightarrow{\text{meiosis II}}$ Spermatid.

(iii) Rete testis, vasa efferentia

3. (i) week 10

(ii)
- hCG or human chorionic gonadotropin
- placenta

(iii) (a)
- oxytocin
- It stimulates contractions of the uterus and leads to childbirth

OR

(b) (i) hCG
(ii) relaxin

LONG ANSWER TYPE QUESTIONS (5 Marks)

1. (i) Gametogenesis is the biological process by which male and female gametes are formed.
In males, the process is called Spermatogenesis. It takes place in the seminiferous tubules of the testes and begins at puberty.
Involves the formation of spermatogonia → primary spermatocytes → secondary spermatocytes → spermatids → spermatozoa (sperms).
Regulated by hormones: FSH, LH, and testosterone.
In females, the process is called Oogenesis. It begins before birth but completes after puberty. Oogonia multiply and form primary oocytes arrested in prophase I (prenatal stage). At puberty, one primary oocyte resumes meiosis each cycle and forms a secondary oocyte and polar body. Fertilisation completes meiosis II, forming a mature ovum.

(ii) Two Assisted Reproductive Technologies (ARTs):

(1) In Vitro Fertilisation (IVF): It involves fertilisation of an ovum by a sperm outside the body in a lab dish. The zygote is allowed to divide up to the 8-cell stage and then transferred into the uterus. It is used when fallopian tubes are blocked. Ovulation issues or unexplained infertility.

(2) Intracytoplasmic Sperm Injection (ICSI): A single sperm is injected directly into the ovum using a micro-needle. The fertilised egg is implanted into the uterus. It is used when male has extremely low sperm count or poor sperm motility and previous IVF attempts have failed.

2. (i) Fertilisation is the fusion of a haploid sperm with a haploid ovum to form a diploid zygote.
It occurs in the ampullary-isthmic junction of the fallopian tube. Out of millions of sperms ejaculated, only a few reach the ovum. The sperm binds to the zona pellucida of the ovum. The acrosome of the sperm releases enzymes (e.g., hyaluronidase) to digest the zona pellucida. Once a sperm enters, a cortical reaction occurs preventing entry of other sperms (polyspermy is blocked). The

male and female pronuclei fuse, completing fertilisation and forming a zygote.

(ii) Post-Fertilisation Events and Implantation: The zygote undergoes cleavage (mitotic divisions) to form a morula and then a blastocyst. This journey takes about 5–7 days as it travels from the fallopian tube to the uterus. The blastocyst consists of:

(1) **Trophoblast (outer layer):** forms part of the placenta.

(2) **Inner cell mass:** develops into the embryo.

Implantation: Occurs around the 7th day after fertilisation. The blastocyst gets embedded in the endometrial lining of the uterus. The endometrium thickens and becomes highly vascular under the influence of progesterone to support implantation. After implantation, placenta formation begins and embryonic development continues.

3. (i) The menstrual cycle (about 28 days) is tightly regulated by hormones from the hypothalamus, anterior pituitary, and ovaries, involving four key phases:

(1) **Menstrual Phase (Day 1–5):** Shedding of the endometrial lining due to low levels of estrogen and progesterone.

(2) **Follicular Phase (Day 1–13):** The hypothalamus secretes GnRH (Gonadotropin-releasing hormone). GnRH stimulates the anterior pituitary to release. FSH (Follicle-Stimulating Hormone) stimulates growth of ovarian follicles. LH (Luteinizing Hormone) helps in follicular maturation and ovulation. The developing follicles secrete estrogen, which thickens the endometrium and provides negative feedback to reduce FSH/LH (initially), then a positive feedback loop triggers the LH surge.

(3) **Ovulation (Around Day 14):** LH surge causes rupture of the mature follicle and release of the ovum (ovulation).

(4) **Luteal Phase (Day 15–28):** The ruptured follicle forms the corpus luteum which secretes progesterone and some estrogen.

Progesterone: Maintains the endometrium for implantation. Provides negative feedback to inhibit further FSH/LH secretion. If fertilisation does not occur, the corpus luteum degenerates, leading to a drop in progesterone, triggering menstruation.

(ii) Role of Hormonal Contraceptives in Preventing Pregnancy:

(1) Hormonal contraceptives (e.g., pills, patches, injections) contain synthetic estrogen and progesterone which:

(2) Inhibit Ovulation: Continuous levels of estrogen and progesterone suppress GnRH, which in turn inhibits FSH and LH. This prevents follicular development and LH surge, thereby preventing ovulation.

(3) Alter Cervical Mucus: Becomes thicker, making it difficult for sperm to enter the uterus.

(4) Modify Endometrium: Makes the uterine lining unsuitable for implantation of the embryo.

Thus, hormonal contraceptives mimic pregnancy-like hormone levels to prevent actual conception.

4. (i) Spermatogenesis is the process of formation of spermatozoa (sperms) from spermatogonial stem cells in the seminiferous tubules of the testes. It occurs in the following stages:

(1) **Multiplication phase:** Diploid spermatogonia (2n) undergo mitosis to increase in number.

(2) **Growth phase:** Some spermatogonia grow into primary spermatocytes (2n).

(3) **Maturation phase:** Primary spermatocytes undergo meiosis I → form two secondary spermatocytes (n). Secondary spermatocytes undergo meiosis II → form four spermatids (n).

(4) **Spermiogenesis:** Spermatids differentiate into spermatozoa (mature sperms).

(5) **Spermiation:** Mature sperms are released into the lumen of seminiferous tubules.

Role of Hormones:

(1) Hypothalamus secretes GnRH (Gonadotropin-Releasing Hormone).

(2) GnRH stimulates anterior pituitary to release: FSH and LH.

(3) FSH (Follicle Stimulating Hormone) → stimulates sertoli cells to nourish and support spermatogenesis.

(4) LH (Luteinizing Hormone) → stimulates Leydig cells to secrete testosterone. Testosterone is essential for maintaining spermatogenesis, development of male reproductive organs, and secondary sexual characteristics.

(ii) Structural Adaptations for Production, Maturation & Transport of Sperms:

(1) **Testes (within Scrotum):** Located outside the abdominal cavity in the scrotum to maintain 2–2.5°C lower temperature, optimal for spermatogenesis. Contain seminiferous tubules where sperms are produced.

(2) **Epididymis:** Coiled tube attached to the testis. Site of sperm maturation, acquiring motility and functionality.

(3) **Vas Deferens:** Transports sperms from epididymis to ejaculatory duct.

(4) **Seminal Vesicles, Prostate Gland & Bulbourethral Glands:** Secrete seminal fluid that nourishes sperms and facilitates transport by forming semen.

(5) **Penis & Urethra:** Help in copulation and ejaculation of semen.