Ch 2 · Human Reproduction

अध्याय 2 · मानव जनन

Class 12 Biology · NCERT based · English + हिंदी · ✍️ revision notes

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Reproductive events in humans · मानव में जनन घटनाएँ

Gameto-genesis	Insemination	Fertilisation	Cleavage → Blastocyst	Implantation	Gestation	Parturition
युग्मकजनन	तीर्यसेचन	निषेचन	विदलन	अंतर्रोपण	सगर्भता	प्रसव

Humans are sexually reproducing & viviparous · मनुष्य लैंगिक जनन करने वाले व सजीवप्रजक हैं

Infographic: chapter flow

1. Male Reproductive System / पुरुष जनन तंत्र

Located in **pelvis region**. Parts: pair of **testes** + accessory ducts + glands + external genitalia.

(a) Testes वृषण

- Situated outside abdominal cavity in a pouch called **scrotum** (वृषणकोश).
- Scrotum keeps testes temperature 2–2.5 °C lower than body temperature → necessary for **spermatogenesis**.
- Adult testis: oval, **4–5 cm long, 2–3 cm wide**.
- Each testis has about 250 testicular lobules; each lobule has **1–3 highly coiled seminiferous tubules** (शुक्रजनक नलिकाएँ).

Cell	Location	Function
Spermatogonia शुक्राणुजनन	Lining of seminiferous tubule	Male germ cells → form sperms
Sertoli cells सर्टोली कोशिकाएँ	Inside seminiferous tubule	Nourish germ cells
Leydig / Interstitial cells अंतराली कोशिकाएँ	Interstitial spaces (outside tubules)	Secrete androgens (testosterone)

Interstitial spaces also have blood vessels and **immunocompetent cells**.

(b) Accessory Ducts — Path of Sperm शुक्राणु का मार्ग

Seminiferous tubules → Rete testis → Vasa efferentia → Epididymis → Vas deferens → Ejaculatory duct → Urethra → Urethral meatus

📌 **Trick to remember:** "**S**ome **R**ats **V**isit **E**very **V**illage **E**ach **U**nder-**U**mbrella" → S-R-V-E-V-E-U-U.

Epididymis lies along posterior surface of testis. **Vas deferens** ascends to abdomen, loops over urinary bladder, joins duct of **seminal vesicle** → ejaculatory duct.

(c) Accessory Glands सहायक ग्रंथियाँ

- Paired **seminal vesicles** (शुक्राशय), single **prostate** (पुरस्थ), paired **bulbourethral glands** (बल्बोयूरेथ्रल).
- Their secretions = seminal plasma, rich in **fructose, calcium & certain enzymes**.
- Bulbourethral gland secretion → **lubrication of penis**.
- **Semen** (वीर्य) = seminal plasma + sperms.

(d) External Genitalia

Penis (शिश्न) – special erectile tissue helps erection for insemination. Enlarged tip = **glans penis**, covered by loose fold of skin = **foreskin**.

2. Female Reproductive System / स्त्री जनन तंत्र

Pair of **ovaries** + pair of **oviducts** + **uterus** + **cervix** + **vagina** + external genitalia + **mammary glands**. Located in pelvic region.

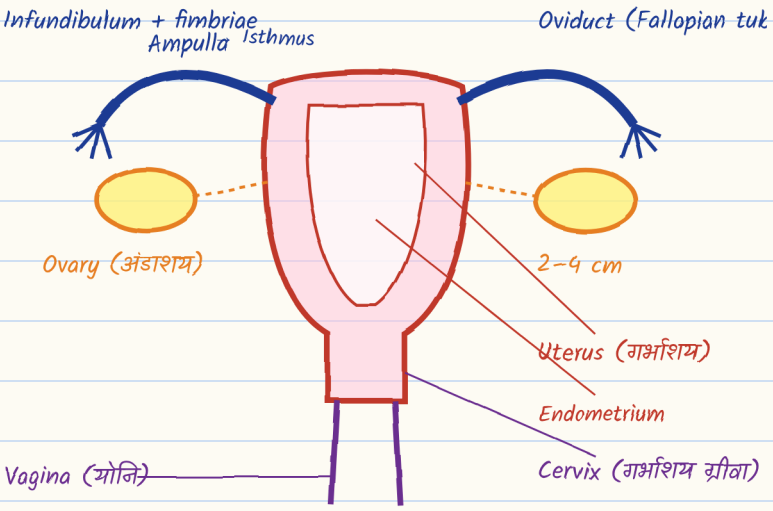


Fig: Female reproductive system (front view, schematic) · स्त्री जनन तंत्र

(a) Ovaries अंडाशय

- **Primary female sex organs** → produce **ovum** + ovarian hormones (estrogen, progesterone).
- Each ovary **2–4 cm** long; connected to pelvic wall & uterus by **ligaments**.
- Covered by thin epithelium enclosing **ovarian stroma** → outer **cortex** & inner **medulla**.

(b) Oviduct / Fallopian tube अंडवाहिनी (10–12 cm)

Part	Feature
Infundibulum (कीपक)	Funnel-shaped, near ovary; edges have finger-like **fimbriae** → collect ovum after ovulation
Ampulla (तुंबिका)	Wider part → site of fertilisation
Isthmus (संकीर्ण पथ)	Narrow lumen, joins uterus

(c) Uterus (Womb) गर्भाशय

- Single, shaped like an inverted pear; supported by ligaments.
- Opens into vagina through narrow **cervix**. Cervical canal + vagina = birth canal (जन्म नाल).
- Wall has 3 layers:
  1. **Perimetrium** – outer thin membrane
  2. **Myometrium** – middle thick **smooth muscle**; strong contractions during **delivery**
  3. **Endometrium** – inner glandular layer; cyclic changes during menstrual cycle

(d) External genitalia बाह्य जननांग

Mons pubis (fatty cushion with pubic hair) · **Labia majora** (fleshy folds) · **Labia minora** (paired folds under labia majora) · **Hymen** (membrane partially covering vaginal opening) · **Clitoris** (tiny finger-like structure above urethral opening).

📌 **Exam Tip:** Hymen may be torn by a fall, jolt, cycling, horseback riding, insertion of tampon, sports etc. → **presence or absence of hymen is NOT a reliable indicator of virginity**. (NCERT point)

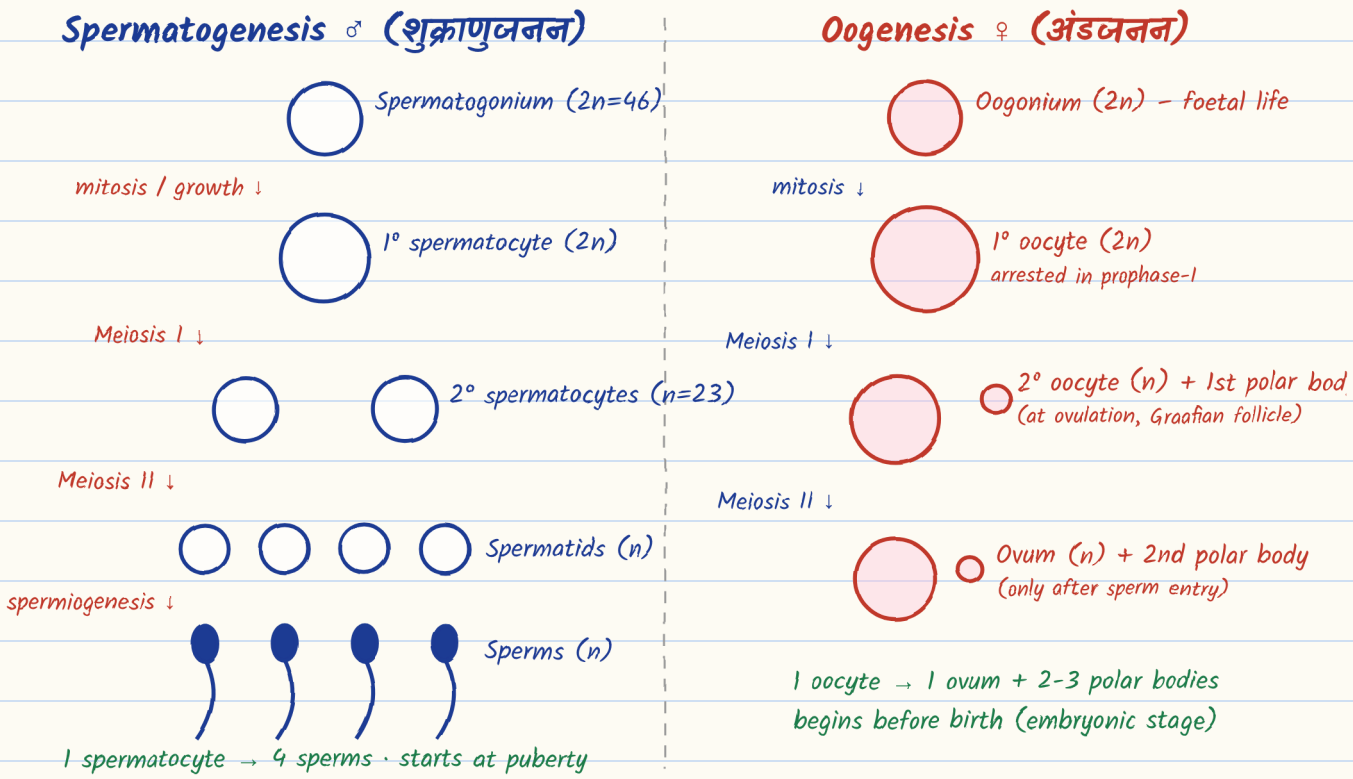
(e) Mammary Glands स्तन ग्रंथियाँ

Paired; contain glandular tissue + fat. Glandular tissue of each breast has 15–20 mammary lobes with clusters of cells called **alveoli** → secrete milk.

Alveoli → Mammary tubules → Mammary duct → Mammary ampulla → Lactiferous duct → Milk out

3. Gametogenesis / युग्मकजनन

Formation of gametes: **sperms** in testes (**spermatogenesis**) and **ovum** in ovary (**oogenesis**).



Infographic: Spermatogenesis vs Oogenesis · शुक्राणुजनन बनाम अंडजनन

(a) Spermatogenesis शुक्राणुजनन

- Begins at **puberty**, in seminiferous tubules.
- Spermatogonia (2n = 46) → mitosis → **primary spermatocytes** (2n) → **meiosis I** → 2 **secondary spermatocytes** (n = 23) → **meiosis II** → 4 **spermatids** (n).
- **Spermiogenesis** (शुक्राणुकायांतरण): spermatids transform into sperms.
- **Spermiation** (शुक्राणु मुक्तन): sperm heads embedded in Sertoli cells are finally released from seminiferous tubules.

Hormonal control हॉर्मोन नियंत्रण

Hypothalamus → **GnRH** ↑ (at puberty) → Anterior pituitary → **LH + FSH**

LH	FSH
Acts on **Leydig cells** → synthesis & secretion of **androgens** → stimulate spermatogenesis	Acts on **Sertoli cells** → secretion of factors that help in **spermiogenesis**

(b) Structure of Sperm शुक्राणु की संरचना

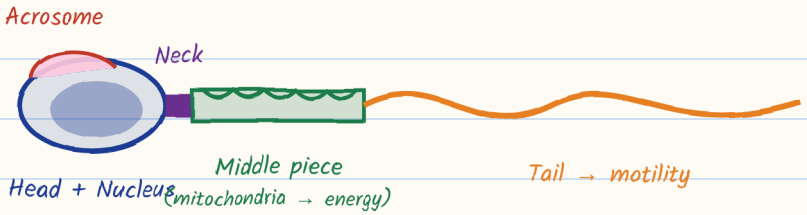
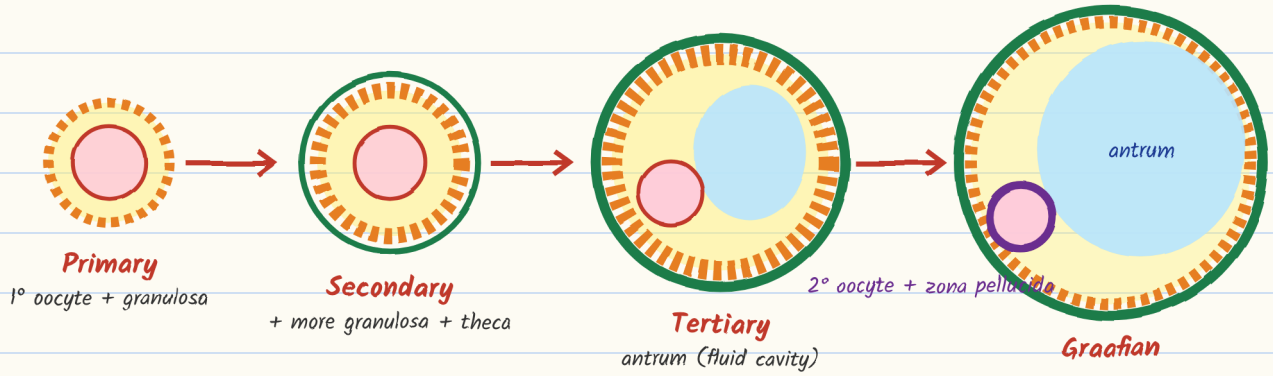


Fig: Structure of a human sperm · मानव शुक्राणु

- Microscopic; head, neck, middle piece, tail; covered by **plasma membrane**.
- **Acrosome** (अग्रपिंडक) – cap-like; filled with enzymes that help fertilisation.
- Middle piece – numerous **mitochondria** → energy for tail movement.
- Ejaculate: 200–300 million sperms; for normal fertility ≥ **60%** normal shape & size and ≥ **40%** vigorous motility.

(c) Oogenesis अंडजनन

- Initiated during embryonic development stage – millions of **oogonia** formed in each foetal ovary; **no more formed or added after birth**.
- Oogonia enter prophase-I of meiosis & get **temporarily arrested** → **primary oocytes**.
- Primary oocyte + layer of **granulosa cells** = **primary follicle**.
- Many follicles degenerate from birth till puberty → only 60,000–80,000 primary follicles left in each ovary at puberty.



Infographic: Stages of ovarian follicle · पुटक की अवस्थाएँ

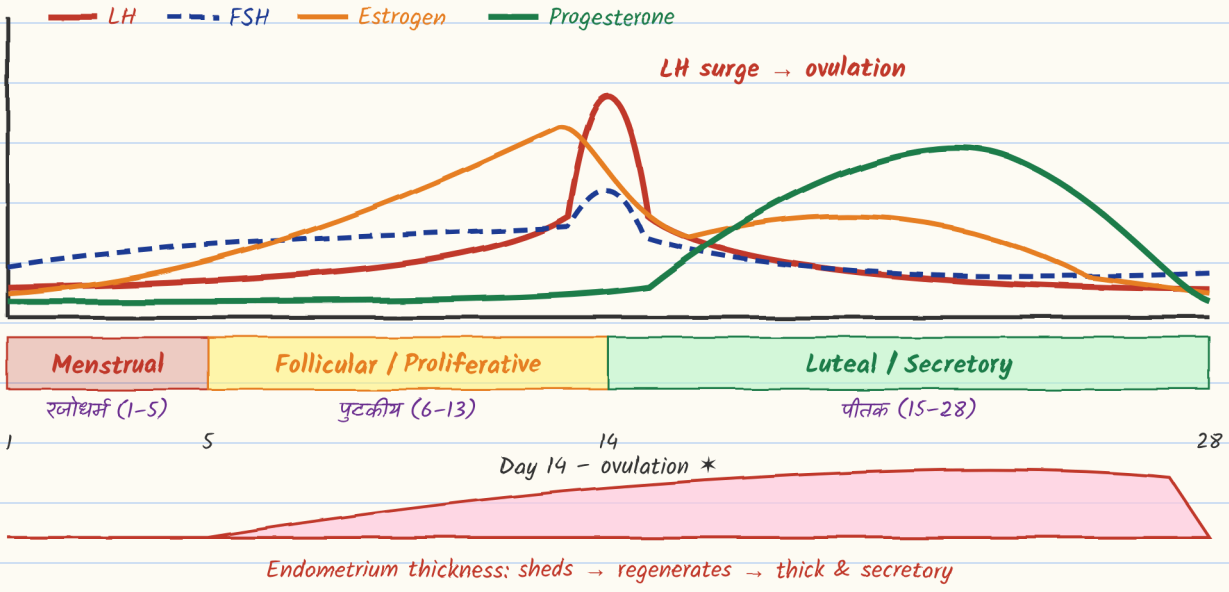
- **Secondary follicle**: more granulosa layers + new **theca** layer.
- **Tertiary follicle**: fluid-filled cavity **antrum**; theca → theca interna & theca externa.

- Within tertiary follicle the primary oocyte completes **meiosis I** → large haploid **secondary oocyte** + tiny **first polar body** (unequal division).
- Tertiary → **mature (Graafian) follicle**. Secondary oocyte forms new membrane = **zona pellucida** (अंडावरण).
- **Ovulation** (अंडोत्सर्ग): Graafian follicle ruptures → releases secondary oocyte (not ovum!).

Spermatogenesis	Oogenesis
In testes	In ovary
Starts at puberty, continues life-long	Starts in foetus; stops at menopause
1 primary spermatocyte → 4 sperms	1 primary oocyte → 1 ovum + polar bodies
Equal divisions	Unequal cytoplasmic divisions
Meiosis completes in testis, no arrest	Arrested at prophase-I; meiosis II completes only after sperm entry

4. Menstrual Cycle / आर्तव चक्र

- Reproductive cycle in female **primates** (monkeys, apes, humans).
- First menstruation at puberty = menarche (रजोदर्शन). Stops around **50 years** = menopause (रजोनिवृत्ति).
- Average cycle length: **28/29 days**. One ovum released in middle of each cycle.



Infographic: Phases of menstrual cycle & hormone levels (schematic) · आर्तव चक्र

Phase	Days	What happens
Menstrual (रजोधर्म प्रावस्था)	1–5 (lasts 3–5 days)	Breakdown of endometrium & its blood vessels → liquid flows out. Occurs only if released ovum is **not fertilised**.
Follicular / Proliferative (पुटकीय प्रावस्था)	6–13	Primary follicles → Graafian follicle; endometrium **regenerates**. LH & FSH rise gradually; growing follicles secrete **estrogen**.
Ovulatory (अंडोत्सर्ग प्रावस्था)	~14	LH & FSH peak in middle of cycle; LH surge → rupture of Graafian follicle → **ovulation**.
Luteal / Secretory (पीतक प्रावस्था)	15–28	Remaining follicle → corpus luteum (पीत पिंड) → secretes large amounts of **progesterone** → maintains endometrium for implantation.

- No fertilisation → corpus luteum degenerates → progesterone falls → endometrium disintegrates → **menstruation** → new cycle.
- During pregnancy all menstrual events stop; **no menstruation**.
- Lack of menstruation may indicate **pregnancy**, or also stress, poor health, etc.

📌 **Exam Tip:** Hormones of **pituitary** (LH, FSH) + **ovarian** hormones (estrogen, progesterone) control the cycle. Corpus luteum = "yellow body" → **progesterone**. Ovulation is caused by **LH surge** – a 1-mark favourite!

5. Fertilisation & Implantation / निषेचन व अंतर्रोपण

- **Insemination** (वीर्यसेचन): semen released into **vagina** during coitus.
- Motile sperms swim through cervix → uterus → reach ampullary region of fallopian tube.
- Ovum released by ovary also reaches ampullary region. Fertilisation occurs only if ovum & sperm are transported **simultaneously** to ampullary region → that's why **not all copulations lead to fertilisation**.
- **Fertilisation** = fusion of sperm with ovum → zygote.
- Sperm contacts **zona pellucida** → induces changes in membrane that block entry of additional sperms → only one sperm fertilises.
- **Acrosome secretions** help sperm enter cytoplasm of ovum through zona pellucida & plasma membrane.
- Sperm entry → secondary oocyte completes **meiosis II** → ovum (ootid) + second polar body. Haploid nuclei of sperm & ovum fuse → **diploid zygote**.

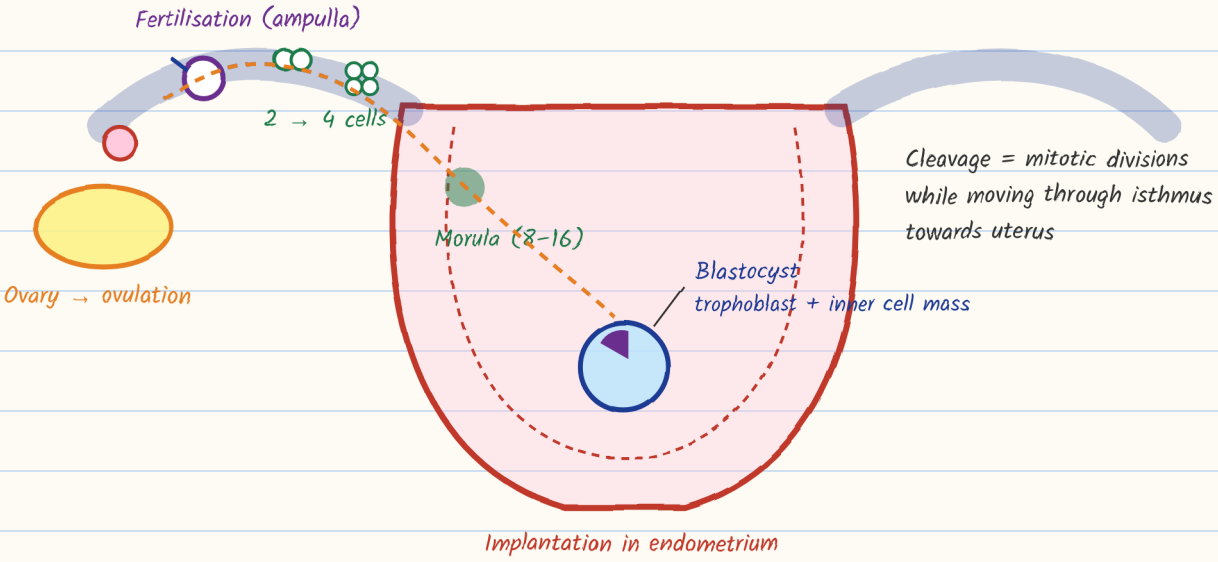
Sex determination लिंग निर्धारण

Female: **XX** → all ova carry **X**. Male: **XY** → 50% sperms X, 50% sperms Y.

Ovum (X) + Sperm (X) → **XX = Female** ♀ | Ovum (X) + Sperm (Y) → **XY = Male** ♂

∴ Sex of baby is decided by the father (sperm), not mother.

शिशु का लिंग पिता के शुक्राणु द्वारा निर्धारित होता है।



Infographic: Ovulation → Fertilisation → Cleavage → Implantation

Cleavage & Implantation विदलन व अंतर्रोपण

- Zygote moves through isthmus towards uterus, undergoing mitotic division = **cleavage** → 2, 4, 8, 16 daughter cells = **blastomeres** (कोरकखंड).
- Embryo with **8–16 blastomeres** = morula (तूतक).
- Morula → blastocyst (कोरकपुटी): outer layer **trophoblast** + inner group of cells = **inner cell mass**.
- Trophoblast attaches to endometrium; inner cell mass → differentiates into **embryo**.
- Uterine cells divide rapidly and cover the blastocyst → blastocyst embedded in endometrium = implantation → leads to pregnancy.

📌 **Exam Tip:** **Inner cell mass** contains **stem cells** – they can give rise to all tissues & organs. Trophoblast forms **chorionic villi** (part of placenta).

6. Pregnancy & Embryonic Development / सगर्भता व भ्रूणीय परिवर्धन

(a) Placenta अपरा

- After implantation, finger-like projections from trophoblast = **chorionic villi**, surrounded by uterine tissue & maternal blood.
- Chorionic villi + uterine tissue interdigitate → structural & functional unit between developing embryo (foetus) & mother = placenta.
- Connected to embryo through **umbilical cord** (नाभि रज्जु) → transport of substances to & from embryo.

Functions of placenta:

1. Supply of **oxygen & nutrients** to embryo.
2. Removal of **CO_2 & excretory/waste materials** from embryo.
3. Acts as an **endocrine tissue** – produces hormones:
   hCG (human chorionic gonadotropin), hPL (human placental lactogen), estrogens, progestogens, etc.

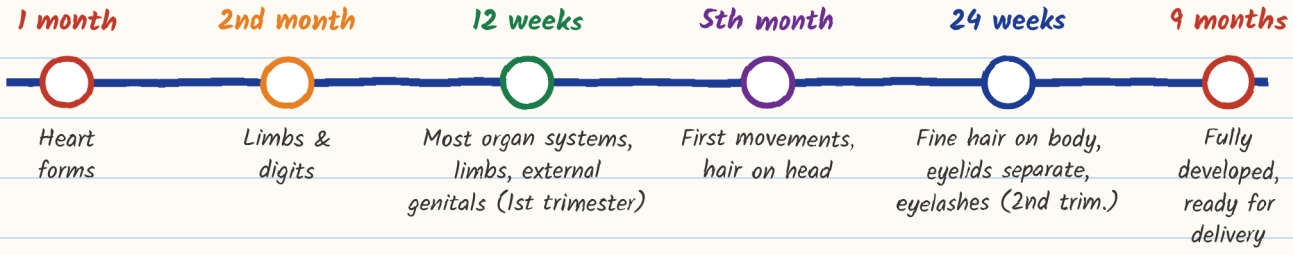
Late pregnancy: **relaxin** secreted by ovary.

hCG, hPL & relaxin are produced **only during pregnancy**. Levels of estrogens, progestogens, cortisol, prolactin, thyroxine also increase.

(b) Germ layers जनन स्तर

Immediately after implantation, inner cell mass differentiates into outer **ectoderm**, middle **mesoderm** and inner **endoderm** → give rise to all tissues (organs).

(c) Timeline of foetal development गर्भ विकास समय-रेखा



Infographic: Human foetal development timeline · गर्भावधि ~9 माह

📌 **Exam Tip:** First sign of growing foetus can be noticed by listening to the **heart sound** with a stethoscope. Gestation period in humans ≈ **9 months**.

7. Parturition & Lactation / प्रसव व दुग्धस्रवण

(a) Parturition प्रसव

Vigorous contraction of uterus at end of pregnancy → expulsion/delivery of foetus.

Fully developed foetus + placenta → signals → Mild uterine contractions = **foetal ejection reflex** → Release of **oxytocin** (maternal pituitary) → Stronger uterine contractions → More oxytocin... → **Baby delivered** through birth canal

This is a positive feedback loop. Parturition is induced by a complex **neuroendocrine mechanism**. Placenta is also expelled soon after the infant.

(b) Lactation दुग्धस्रवण

- Mammary glands of female undergo differentiation during pregnancy and start producing milk towards end of pregnancy = **lactation**.
- Milk produced during **initial few days** = colostrum (खीस) – contains several **antibodies** (e.g. IgA) → develops resistance in newborn.
- Breast-feeding during initial period of infant growth is recommended by doctors for bringing up a healthy baby.

⚡ Quick Revision / त्वरित पुनरावृत्ति

Structure / Hormone	Source	Role
Androgens (testosterone)	Leydig cells	Spermatogenesis, male characters
GnRH	Hypothalamus	Stimulates LH & FSH release
LH	Anterior pituitary	♂ Leydig cells; ♀ ovulation, corpus luteum
FSH	Anterior pituitary	♂ Sertoli cells; ♀ follicle growth
Estrogen	Growing follicles	Endometrium regeneration
Progesterone	Corpus luteum	Maintains endometrium
hCG, hPL	Placenta	Maintain pregnancy
Relaxin	Ovary (late pregnancy)	Helps in parturition
Oxytocin	Posterior pituitary	Uterine contractions (parturition)

Number to remember	Value
Testis temp lower than body	2–2.5 °C
Testicular lobules / testis	~250
Oviduct length	10–12 cm
Mammary lobes / breast	15–20
Primary follicles at puberty / ovary	60,000–80,000
Sperms per ejaculate	200–300 million
Menstrual cycle / menses	28–29 days / 3–5 days
Morula	8–16 blastomeres
Chromosomes: sperm / ovum / zygote	23 / 23 / 46

⭐ Exam Corner / परीक्षा उपयोगी प्रश्न

1-Mark Questions 1M

Q1. Where does fertilisation occur in humans? / मनुष्य में निषेचन कहाँ होता है?

→ Ampullary region of fallopian tube (oviduct) / अंडवाहिनी का तुंबिका भाग

Q2. Name the cells that secrete androgens.

→ Leydig (interstitial) cells.

Q3. What is spermiation?

→ Release of sperms from seminiferous tubules.

Q4. Which hormone surge causes ovulation?

→ LH surge (mid-cycle).

Q5. What is colostrum? Why is it important?

→ First milk after birth; rich in antibodies (IgA) → immunity to newborn.

Q6. At what stage is the human oocyte released from the ovary?

→ Secondary oocyte (arrested in metaphase II).

Q7. Name the hormones produced only during pregnancy.

→ hCG, hPL, relaxin.

2/3-Mark Questions 2–3M

Q8. Why are testes located outside the abdominal cavity?

→ Scrotum keeps testicular temperature 2–2.5 °C lower than body temp, which is necessary for spermatogenesis.

Q9. Give the role of Sertoli cells and Leydig cells.

→ Sertoli: nourish germ cells, support spermiogenesis (under FSH). Leydig: secrete androgens (under LH).

Q10. Differentiate between spermatogenesis and oogenesis (any 3 points).

→ See comparison table above.

Q11. What is the role of acrosome and zona pellucida in fertilisation?

→ Acrosome enzymes help sperm penetrate ovum; zona pellucida changes after first sperm contact and blocks polyspermy.

Q12. "Sex of the child is determined by the father." Justify.

→ Mother gives only X; father gives X or Y → XX girl, XY boy.

Q13. Describe the functions of placenta.

→ Nutrient & O_2 supply, waste/CO_2 removal, endocrine role (hCG, hPL, estrogens, progestogens).

Q14. Explain the role of oxytocin in parturition (foetal ejection reflex).

→ Signals from foetus & placenta → mild contractions → oxytocin release → stronger contractions (positive feedback) → delivery.

5-Mark Questions SM ★★★

Q15. Describe the events of the menstrual cycle with role of hormones. Draw a diagram.

→ Menstrual, follicular, ovulatory, luteal phases; LH/FSH/estrogen/progesterone; graph.

Q16. Explain oogenesis with a schematic diagram.

→ Oogonia (foetal) → 1° oocyte (arrested) → follicles → 2° oocyte + 1st polar body → ovulation → ovum + 2nd polar body after sperm entry.

Q17. Draw a labelled diagram of the human male reproductive system / sectional view of seminiferous tubule.

→ Label testis, epididymis, vas deferens, seminal vesicle, prostate, bulbourethral gland, urethra, penis; spermatogonia, Sertoli, Leydig cells.

Q18. Describe fertilisation, cleavage and implantation in humans.

→ Ampulla; zona pellucida; meiosis II; zygote → morula → blastocyst → implantation.

✏ Diagrams to practise / अभ्यास हेतु चित्र:

1. Male reproductive system (side view) ⭐
2. Female reproductive system (front view) ⭐
3. Sectional view of seminiferous tubule
4. Structure of sperm
5. Schematic of spermatogenesis & oogenesis ⭐
6. Section of ovary (follicle stages) & Graafian follicle
7. Menstrual cycle graph
8. Transport of ovum, fertilisation & passage of embryo to uterus
9. Human foetus within uterus
10. Mammary gland

🎯 **Last-minute tips:** Always mention **ploidy (n/2n)** in gametogenesis · Write "secondary oocyte" (not ovum) for ovulation · Remember the duct order (S-R-V-E-V-E-U-U) · Write hormone + its source together.

~ All the best! / शुभकामनाएँ! ~