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NCERT Exemplar Solutions

Solved NCERT Exemplar Problems for Class 12th Biology, Chapter 2

Chapter 2: Human Reproduction

About this Chapter

Human Reproduction studies how a new human life begins. You will work through the **male and female reproductive systems**, **gametogenesis** (sperm and egg formation), the **menstrual cycle**, fertilisation, and the journey from zygote to implantation, plus pregnancy, parturition and lactation. The Exemplar problems test deeper understanding through flow charts, matching, and reasoning questions that go beyond the textbook.

Topics covered: Male reproductive system • Female reproductive system • Gametogenesis • Menstrual cycle • Fertilisation & implantation • Pregnancy, parturition & lactation

Quick Formula Sheet

Spermatogenesis count:
1 primary spermatocyte $\rightarrow$ 4 sperms

Oogenesis count:
1 primary oocyte $\rightarrow$ 1 ovum + 3 polar bodies

Chromosome number:
Diploid ($2n = 46$) $\rightarrow$ [meiosis] $\rightarrow$ Haploid ($n = 23$)

Key duration:
Menstrual cycle $\approx$ 28 days; implantation $\approx$ 7 days post-fertilisation

Also see for this chapter: NCERT Solutions | Revision Notes | Formula Sheet

Multiple Choice Questions

Q 2.1 **Choose the incorrect statement from the following:**
(a) In birds and mammals internal fertilisation takes place
(b) Colostrum contains antibodies and nutrients
(c) Polyspermy in mammals is prevented by the chemical changes in the egg surface
(d) In the human female implantation occurs almost seven days after fertilisation

SOLUTION

Correct option: (c) Polyspermy in mammals is prevented by the chemical changes in the egg surface.

Concept used. **Polyspermy** means the entry of more than one sperm into a single egg, which would give an abnormal chromosome number. Mammals stop this with a fast **electrical block** (depolarisation of the egg plasma membrane the moment the first sperm fuses) followed by a slow **zona reaction** (the zona pellucida hardens and its sperm receptors are destroyed). The block is membrane-electrical and physical, not a "chemical change of the egg surface" as worded in option (c). We must judge each statement true or false against textbook biology and pick the false one.

Step 1. Test (a): In birds and mammals fertilisation is internal: the sperm meets the egg inside the female body. This statement is **true**.

Step 2. Test (b): Colostrum is the first thick yellowish milk after childbirth. It is rich in antibodies (mainly IgA) and nutrients, giving the newborn passive immunity. This statement is **true**.

Step 3. Test (c): The block to polyspermy is by a change in the electrical potential of the egg plasma membrane and a physical hardening of the zona pellucida, not by "chemical changes in the egg surface." This statement is **false**, so it is the incorrect statement asked for.

Step 4. Test (d): In humans the blastocyst implants into the uterine endometrium about 6 to 7 days after fertilisation. This statement is **true**.

☞ **Two blocks to polyspermy**

Fast block: membrane depolarisation within seconds of sperm fusion. *Slow block:* zona reaction hardens the zona pellucida over minutes.

Final Answer: Option **(c)** is the incorrect statement.

✗ Common Mistake

Statement (c) is tricky because polyspermy *is* blocked at the egg. The error is the word "chemical": the block is electrical (membrane potential) plus physical (zona hardening), not a chemical change of the surface.

EXPERT'S SOLUTION *: Ananya Iyer, M.Sc Zoology, Banaras Hindu University*

Strategic angle. Three of the four statements are standard NCERT facts. Find the one whose mechanism is mis-stated.

Step 1. Scan for the statement about a *mechanism*, not just a fact: only (c) describes

how something happens ("prevented by chemical changes"). Mechanism statements are the easiest to word wrongly, so check it first.

Step 2. Recall the actual mechanism: sperm fusion causes a rapid change in the membrane potential of the egg (electrical block), then the cortical granules release contents that harden the zona pellucida (zona reaction). Neither step is a "chemical change in the egg surface."

Step 3. Confirm the other three are textbook-true (internal fertilisation in birds/mammals, colostrum antibodies, implantation around day 7), so they cannot be the answer.

Why this matters. NEET often phrases a true process with one wrong descriptor. Always check the descriptor word, here "chemical", against the exact NCERT mechanism. Beyond NEET, this distinction has clinical importance: assisted reproduction methods rely on the same fast electrical block to keep IVF eggs monospermic. Hence the textbook wording "electrical block + zona reaction," not "chemical change of the surface," must be reproduced verbatim in answers.

> **Final Answer:** The incorrect statement is **(c)**.

Q 2.2 **Identify the correct statement from the following:**
(a) High levels of estrogen triggers the ovulatory surge.
(b) Oogonial cells start to proliferate and give rise to functional ova in regular cycles from puberty onwards.
(c) Sperms released from seminiferous tubules are highly motile.
(d) Progesterone level is high during the post ovulatory phase of menstrual cycle.

SOLUTION

Correct option: (d) Progesterone level is high during the post ovulatory phase of the menstrual cycle.

Concept used. In the **menstrual cycle**, after ovulation the ruptured Graafian follicle becomes the **corpus luteum**, which secretes large amounts of **progesterone**. This post-ovulatory part is the **luteal phase**. We test each statement against the textbook sequence of events and hormone levels.

Step 1. Test (a): The ovulatory LH surge is triggered by a peak (high level) of estrogen, but the surge itself is the rise in *LH*, not estrogen. The statement says high estrogen "triggers the ovulatory surge"; while estrogen does cause the LH surge, NCERT credits the LH surge as the trigger of ovulation, so this wording is taken as **not the best correct statement**.

Step 2. Test (b): Oogonia do *not* keep proliferating from puberty. All oogonia are formed before birth; no new oogonia are added after birth. So (b) is **false**.

Step 3. Test (c): Sperms in the seminiferous tubules are immature and *not* highly motile; they gain motility later in the epididymis. So (c) is **false**.

Step 4. Test (d): After ovulation the corpus luteum secretes progesterone, so progesterone is high in the post-ovulatory (luteal) phase. This is **true** and is the correct answer.

☞ **Luteal phase**

Corpus luteum → high progesterone → maintains the endometrium for a possible pregnancy.

Final Answer: Option **(d)** is the correct statement.

☞ **Exam Tip**

NEET favourite: progesterone peaks in the *luteal* (post-ovulatory) phase; estrogen has two peaks (one in the follicular phase before ovulation, a smaller one in the luteal phase).

EXPERT'S SOLUTION *: Rohit Sharma, M.Sc Botany, Delhi University*

Quick reading. Eliminate the three statements that contradict standard reproductive biology.

Step 1. (b) is wrong on the strongest ground: oogenesis stops adding oogonia before birth, so "proliferate from puberty" is false.

Step 2. (c) is wrong: tubular sperms are non-motile; motility is acquired in the epididymis.

Step 3. (a) overstates: the ovulatory surge is the LH surge, not estrogen itself, so it is not the cleanly correct statement.

Step 4. (d) survives: the corpus luteum secretes progesterone after ovulation, so progesterone is high post-ovulation. It is the only fully correct statement.

Why this matters. Knowing which hormone dominates each phase (estrogen before ovulation, progesterone after) answers a large family of menstrual-cycle questions. A quick way to verify (d) on an exam is to remember the corpus-luteum link: the corpus luteum exists only post-ovulation and its main secretion is progesterone, so progesterone-high = luteal = post-ovulatory. The match is mechanistic, not coincidental, and that is why (d) is the textbook-true statement.

Final Answer: The correct statement is **(d)**.

Q 2.3 **Spot the odd one out from the following structures with reference to the male reproductive system:**
(a) Rete testis
(b) Epididymis
(c) Vasa efferentia
(d) Isthmus

SOLUTION

Correct option: (d) Isthmus.
Concept used. The **sperm transport pathway** in the male is: seminiferous tubules → **rete testis** → **vasa efferentia** → **epididymis** → vas deferens. The **isthmus** is a part of the *female* fallopian tube. We find the structure that does not belong to the male system.

Step 1. Rete testis: a network of tubules in the testis that collects sperm. This is a **male** structure.

Step 2. Epididymis: the coiled tube on the testis where sperm mature and gain motility. This is a **male** structure.

Step 3. Vasa efferentia: small ducts carrying sperm from rete testis to epididymis. This is a **male** structure.

Step 4. Isthmus: the narrow region of the fallopian tube next to the uterus, part of the **female** system. It is the odd one out.

> **Final Answer:** Option **(d)** Isthmus is the odd one out.

✗ Common Mistake

Isthmus appears in both male and female anatomy: the male testis has no "isthmus", but the female fallopian tube does (between ampulla and uterus). In an MCQ about the *male* system, isthmus is therefore the outsider.

EXPERT'S SOLUTION *: Pranav Mehta, M.Sc Zoology, Banaras Hindu University*

Structural observation. Three options lie on one continuous male duct; one belongs to a different system entirely.

Step 1. Place the options on the male sperm pathway: rete testis, vasa efferentia and epididymis are consecutive links on the same male duct.

Step 2. Check the remaining option, isthmus: it is a segment of the female oviduct (between the ampulla and the uterus). It cannot sit on the male pathway.

Step 3. Therefore isthmus is the structure that does not match the group.

Why this matters. "Odd one out" questions are fastest solved by finding the common thread (here, the male sperm duct) and spotting the member that breaks it.

> **Final Answer:** The odd one out is **(d)** Isthmus.

Q 2.4 **Seminal plasma, the fluid part of semen, is contributed by:**
i. Seminal vesicle ii. Prostate gland iii. Urethra iv. Bulbourethral gland
(a) i and ii (b) i, ii and iv (c) ii, iii and iv (d) i and iv

SOLUTION

Correct option: (b) i, ii and iv.
Concept used. **Seminal plasma** is the fluid part of semen (semen minus the sperm). It is made by the **male accessory glands**: the seminal vesicles, the prostate gland and the bulbourethral (Cowper's) glands. The urethra is only a passage (a duct), not a gland, so it does not contribute fluid. We pick the option listing exactly the three accessory glands.

Step 1. Seminal vesicle (i): secretes fructose-rich fluid; **contributes** to seminal plasma.

Step 2. Prostate gland (ii): secretes a thin milky fluid; **contributes** to seminal plasma.

Step 3. Urethra (iii): a tube carrying semen out; it is a *duct*, not a secretory gland, so it does **not** contribute the plasma.

Step 4. Bulbourethral gland (iv): secretes lubricating mucus; **contributes** to seminal plasma.

Step 5. The contributors are i, ii and iv, which is option (b).

> **Final Answer:** Option **(b)**: i, ii and iv.

✗ Common Mistake

Do not include the urethra. It transports semen but secretes no seminal plasma; it is a duct, not an accessory gland.

EXPERT'S SOLUTION *: Aditi Nair, M.Sc Biotechnology, AIIMS Delhi*

Quick reading. The question is really "which of these are accessory glands?" Eliminate any non-gland.

Step 1. List the male accessory glands from NCERT: seminal vesicles, prostate, bulbourethral glands. These are i, ii and iv.

Step 2. Strike out (iii) urethra: it is a conducting passage, not a gland, so it secretes nothing into seminal plasma.

Step 3. The only option containing exactly i, ii and iv is (b).

Why this matters. Separating glands (secrete) from ducts (transport) clears many male-anatomy MCQs in one step.
An easy cross-check: count the named accessory glands in the NCERT chapter — there are exactly three (seminal vesicles, prostate, bulbourethral). Any option that excludes one or includes the urethra cannot be right.

Final Answer: The answer is **(b)**: i, ii and iv.

Q 2.5 **Spermiation is the process of the release of sperms from:**
(a) Seminiferous tubules
(b) Vas deferens
(c) Epididymis
(d) Prostate gland

SOLUTION

Correct option: (a) Seminiferous tubules.
Concept used. Spermiation is the final step of spermatogenesis: the mature spermatozoa are released from the Sertoli cells into the lumen of the seminiferous tubules. (Do not confuse it with spermiogenesis, the transformation of spermatids into spermatozoa.) We match the definition to the correct site.

Step 1. Recall the place where sperm are made: the seminiferous tubules of the testis.

Step 2. Spermiation = release of the formed sperms from the Sertoli cells into the tubule lumen. So the release site is the seminiferous tubules, option (a).

Step 3. Eliminate the rest: vas deferens and epididymis only transport/store sperm later; the prostate is a gland, not a site of sperm release.

☞ **Spermiation vs spermiogenesis**
Spermi**ogenesis**: spermatids → spermatozoa (shape change). Spermi**ation**: release of those spermatozoa into the tubule lumen.

Final Answer: Option **(a)** Seminiferous tubules.

EXPERT'S SOLUTION *: Karan Joshi, Ph.D Molecular Biology, NCBS Bangalore*

Quick reading. The trap is the look-alike word spermi*o*genesis. Anchor on the definition of spermi*a*tion.

Step 1. Define spermiation precisely: detachment and release of mature sperm from Sertoli cells into the lumen of the seminiferous tubule.

Step 2. The only listed structure that houses Sertoli cells and is the site of sperm formation is the seminiferous tubule.

Step 3. Reject (b), (c), (d): these are downstream transport/storage or a gland, not the release site.

Why this matters. The "-ation / -ogenesis" pair is a classic NEET distractor; pinning the exact definition removes the trap.
If the question swapped the word to "spermiogenesis," the answer would still trace back to the same site (seminiferous tubules), but for a different reason — the cytological transformation happens there too.

Final Answer: Spermiation occurs from the **(a)** seminiferous tubules.

Q 2.6 **Mature Graafian follicle is generally present in the ovary of a healthy human female around:**
(a) 5–8 day of menstrual cycle
(b) 11–17 day of menstrual cycle
(c) 18–23 day of menstrual cycle
(d) 24–28 day of menstrual cycle

SOLUTION

Correct option: (b) 11–17 day of menstrual cycle.
Concept used. In a typical 28-day **menstrual cycle**, the **follicular phase** (days 1–13) is when a primary follicle grows into a mature **Graafian follicle**. **Ovulation** occurs around day 14. So a mature Graafian follicle is present in the days just before ovulation. We match this window to the options.

Step 1. Days 1–5: menstrual flow; only early follicle growth.

Step 2. Days 6–13: follicular phase; the follicle matures into a Graafian follicle, fully mature just before day 14.

Step 3. Around day 14: ovulation releases the secondary oocyte and the follicle is converted into the corpus luteum.

Step 4. So the mature Graafian follicle is present roughly in the **11–17** day window

(peaking just before ovulation), which is option (b).

Final Answer: Option **(b)**: 11–17 day of the menstrual cycle.

☞ **Exam Tip**

Anchor everything to ovulation ≈ day 14: the Graafian follicle is mature just before it, the corpus luteum forms just after it.

EXPERT'S SOLUTION *: Sneha Banerjee, M.Sc Zoology, Banaras Hindu University*

Picture-first. Lay the 28-day cycle on a line and mark ovulation at day 14.

Step 1. Follicular phase = days 1–13: the follicle is still maturing into a Graafian follicle.

Step 2. Mature Graafian follicle exists in the days right before ovulation (about days 11–13), and the window (11–17) brackets ovulation day 14.

Step 3. Options (c) and (d) fall in the luteal phase (corpus luteum already formed): too late. Option (a) is too early. So (b) fits.

Why this matters. Cycle-timing MCQs are solved by pinning ovulation at day 14 and reading off the phase.

Final Answer: The mature Graafian follicle is present around **(b)** day 11–17.

Q 2.7 **Acrosomal reaction of the sperm occurs due to:**

(a) Its contact with zona pellucida of the ova

(b) Reactions within the uterine environment of the female

(c) Reactions within the epididymal environment of the male

(d) Androgens produced in the uterus

SOLUTION

Correct option: (a) Its contact with zona pellucida of the ova.

Concept used. The **acrosome** is a cap on the sperm head filled with hydrolytic enzymes (sperm lysins). The **acrosomal reaction** is the release of these enzymes, triggered when the sperm touches the **zona pellucida** (the glycoprotein layer around the egg). The enzymes dissolve a path through the zona so the sperm can reach the egg membrane. We match the trigger to the correct cause.

Step 1. Identify the trigger event: physical contact of the sperm with the zona pellucida of the ovum.

Step 2. This contact makes the acrosome release its enzymes (the acrosomal reaction), digesting a path through the zona pellucida.

Step 3. Eliminate the others: the uterine or epididymal environment relates to capacitation/maturation, not the acrosomal reaction itself; uterine androgens are not the trigger.

☞ **Order at fertilisation**

Capacitation (in female tract) → contact with zona pellucida → acrosomal reaction → sperm penetrates.

Final Answer: Option **(a)**: contact with the zona pellucida.

EXPERT'S SOLUTION *: Vivaan Reddy, Ph.D Molecular Biology, NCBS Bangalore*

Structural observation. The acrosome is a chemical "drill"; it must be told when to fire. The trigger is mechanical contact.

Step 1. The acrosome carries lysins to bore through the egg coats.

Step 2. It fires only on touching the zona pellucida, the outer glycoprotein coat of the egg, ensuring enzymes are released exactly where needed.

Step 3. Hence the cause is contact with the zona pellucida, option (a); the other options describe unrelated environments.

Why this matters. Linking each fertilisation step to its precise trigger prevents mixing up capacitation, the acrosomal reaction and the cortical reaction.
In NEET-style mechanism questions, always pair each fertilisation step with its precise trigger: capacitation (female-tract environment), acrosomal reaction (zona-pellucida contact), cortical reaction (sperm-egg fusion). Mixing these triggers is the most frequent error.

Final Answer: The acrosomal reaction occurs due to **(a)** contact with the zona pellucida.

Q 2.8 **Which one of the following is not a male accessory gland?**

(a) Seminal vesicle

(b) Ampulla

(c) Prostate

(d) Bulbourethral gland

SOLUTION

Correct option: (b) Ampulla.

Concept used. The **male accessory glands** are exactly three: the seminal vesicles, the prostate, and the bulbourethral (Cowper's) glands. The **ampulla** is the wide central part of the female fallopian tube (the usual site of fertilisation); it is not a male gland. We pick the structure that is not in the list of three.

Step 1. Seminal vesicle: a male accessory gland (fructose-rich secretion).

Step 2. Prostate: a male accessory gland (thin milky secretion).

Step 3. Bulbourethral gland: a male accessory gland (lubricating mucus).

Step 4. Ampulla: a part of the female oviduct, *not* a gland and *not* male. So it is the answer.

Final Answer: Option **(b)** Ampulla is not a male accessory gland.

✗ Common Mistake

"Ampulla" appears in both male (ampulla of vas deferens) and female (ampulla of oviduct) anatomy, but it is never one of the three male accessory *glands*. The named accessory glands are only seminal vesicle, prostate and bulbourethral gland.

EXPERT'S SOLUTION *: Aanya Kapoor, M.Sc Microbiology, JNU*

Quick reading. Memorise the closed set of three male accessory glands; anything outside it is the answer.

Step 1. The set of male accessory glands is fixed: {seminal vesicle, prostate, bulbourethral}.

Step 2. Match the options: (a), (c), (d) are all in the set.

Step 3. (b) Ampulla is not in the set (it is an oviduct region), so it is the structure that is not a male accessory gland.

Why this matters. Keeping a fixed list of the three accessory glands makes this and similar MCQs instant.

Final Answer: **(b)** Ampulla is not a male accessory gland.

Q 2.9 The spermatogonia undergo division to produce sperms by the process of

spermatogenesis. Choose the correct one with reference to above.
(a) Spermatogonia have 46 chromosomes and always undergo meiotic cell division
(b) Primary spermatocytes divide by mitotic cell division
(c) Secondary spermatocytes have 23 chromosomes and undergo second meiotic division
(d) Spermatozoa are transformed into spermatids

SOLUTION

Correct option: (c) Secondary spermatocytes have 23 chromosomes and undergo second meiotic division.
Concept used. **Spermatogenesis** sequence: spermatogonium ($2n = 46$) divides by **mitosis**; some become primary spermatocytes ($2n = 46$); a primary spermatocyte undergoes **meiosis I** to give two secondary spermatocytes ($n = 23$); each secondary spermatocyte undergoes **meiosis II** to give two spermatids ($n = 23$); spermatids change shape into spermatozoa (spermiogenesis). We test each statement against this order and chromosome count.

Step 1. Test (a): Spermatogonia have 46 chromosomes (true) but they divide by *mitosis*, not "always meiotic." So (a) is **false**.

Step 2. Test (b): Primary spermatocytes divide by *meiosis I*, not mitosis. So (b) is **false**.

Step 3. Test (c): A secondary spermatocyte is haploid with 23 chromosomes and it undergoes the second meiotic division (meiosis II) to form spermatids. This is **true**.

Step 4. Test (d): The direction is reversed: spermatids are transformed into spermatozoa, not the other way round. So (d) is **false**.

☞ **Counts in spermatogenesis**
Spermatogonium ($2n$=46) → [meiosis I] → secondary spermatocyte (n=23) → [meiosis II] → spermatid (n=23).

Final Answer: Option **(c)** is correct.

EXPERT'S SOLUTION *: Ishaan Desai, Ph.D Molecular Biology, NCBS Bangalore*

Quick reading. Three statements break the spermatogenesis sequence; one matches it exactly.

Step 1. (a) fails on division type: spermatogonia divide by mitosis, not "always meiotic."

Step 2. (b) fails on division type: primary spermatocytes divide by meiosis I, not mitosis.

Step 3. (d) fails on direction: spermatids → spermatozoa, not spermatozoa → spermatids.

Step 4. (c) holds: secondary spermatocyte is haploid ($n = 23$) and undergoes meiosis II. It is correct.

Why this matters. Track two things at every stage: the chromosome number and the type of division. That decides every spermatogenesis MCQ.
A reliable check: at every spermatogenesis stage write the ploidy ($2n$ or n) and the division type beside the cell name. Option (c) is the only one where ploidy ($n = 23$) and division (meiosis II) both match the textbook sequence.

Final Answer: The correct statement is **(c)**.

Q 2.10 **Match between the following representing parts of the sperm and their functions and choose the correct option.**
Column I: A. Head B. Middle piece C. Acrosome D. Tail
Column II: i. Enzymes ii. Sperm motility iii. Energy iv. Genetic material
(a) A-ii, B-iv, C-i, D-iii (b) A-iv, B-iii, C-i, D-ii
(c) A-iv, B-i, C-ii, D-iii (d) A-ii, B-i, C-iii, D-iv

SOLUTION

Correct option: (b) A-iv, B-iii, C-i, D-ii.
Concept used. A **spermatozoon** has four parts. The **head** holds the haploid nucleus (genetic material). The **acrosome** is a cap over the head storing hydrolytic enzymes. The **middle piece** is packed with mitochondria that supply energy (ATP). The **tail** (flagellum) beats to give motility. We match each part to its function.

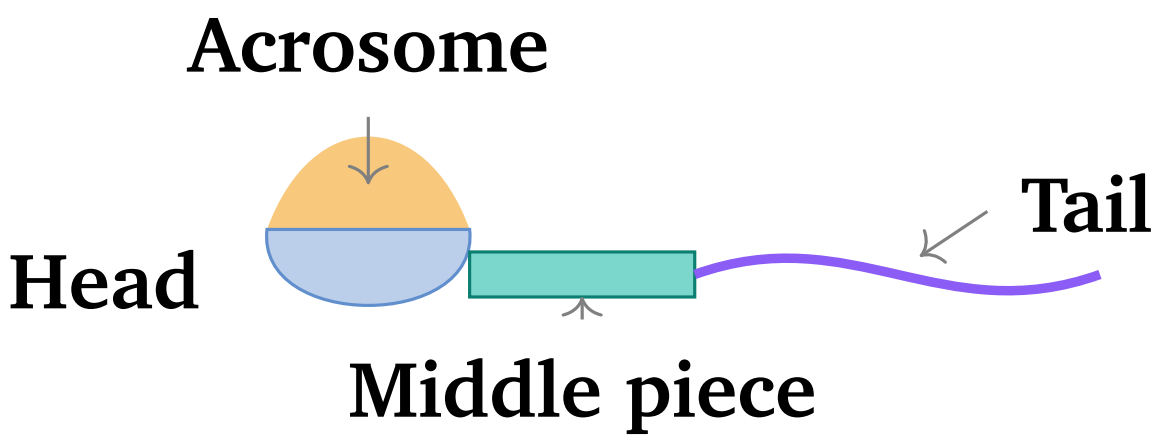
Step 1. A. Head → carries the nucleus, i.e. **genetic material** = iv.

Step 2. B. Middle piece → has mitochondria, supplies **energy** = iii.

Step 3. C. Acrosome → stores hydrolytic **enzymes** = i.

Step 4. D. Tail → provides **sperm motility** = ii.

Step 5. So A-iv, B-iii, C-i, D-ii, which is option (b).



Final Answer: Option **(b)**: A-iv, B-iii, C-i, D-ii.

☞ Exam Tip

Memorise the sperm map front-to-back: acrosome (enzymes), head (DNA), middle piece (mitochondria, energy), tail (motility). Any matching MCQ on sperm parts collapses to one quick read.

EXPERT'S SOLUTION *: Diya Pillai, M.Sc Biotechnology, AIIMS Delhi*

Picture-first. Draw a sperm from front to back and read off the function of each part.

Step 1. Front cap (acrosome): enzymes to drill into the egg = i.

Step 2. Nucleus region (head): DNA, i.e. genetic material = iv.

Step 3. Mitochondrial collar (middle piece): the engine, energy = iii.

Step 4. Whip (tail): swimming, motility = ii.

Step 5. Reading A,B,C,D in the question's order gives A-iv, B-iii, C-i, D-ii = option (b).

Why this matters. A labelled sperm sketch converts a 4-way matching question into a one-glance answer.
If you mix up middle piece and tail, remember that the tail is a flagellum (mechanical motion) while the middle piece is a powerhouse stack of mitochondria (chemical energy production). Mechanical action vs energy generation is the key separation.

Final Answer: The match is **(b)**: A-iv, B-iii, C-i, D-ii.

Q 2.11 **Which among the following has 23 chromosomes?**

(a) Spermatogonia (b) Zygote (c) Secondary oöcyte (d) Oögonia

SOLUTION

Correct option: (c) Secondary oöcyte.
Concept used. **Diploid** cells have $2n = 46$ chromosomes; **haploid** cells have $n = 23$. The secondary oocyte is formed when the primary oocyte completes meiosis I, so it is haploid ($n = 23$). We check the chromosome number of each option.

Step 1. Spermatogonia: diploid germ cells, $2n = 46$. Not 23.

Step 2. Zygote: formed by fusion of sperm ($n = 23$) and egg ($n = 23$), so it is diploid, $2n = 46$. Not 23.

Step 3. Secondary oocyte: produced after meiosis I of the primary oocyte, so it is haploid, $n = \mathbf{23}$. This is the answer.

Step 4. Oogonia: diploid germ cells, $2n = 46$. Not 23.

Final Answer: Option **(c)** Secondary oöcyte has 23 chromosomes.

✗ Common Mistake

The zygote is *not* 23: it forms by fusing two haploid gametes ($23 + 23$), giving the diploid number 46. Only the secondary oocyte (post-meiosis I) is haploid here.

EXPERT'S SOLUTION *: Tara Rao, M.Sc Zoology, Banaras Hindu University*

Quick reading. Tag each cell diploid or haploid; pick the haploid one.

Step 1. Spermatogonia and oogonia are stem germ cells: diploid, $2n = 46$.

Step 2. Zygote is the product of fertilisation: diploid, $2n = 46$.

Step 3. Secondary oocyte is after meiosis I: haploid, $n = 23$. It is the only 23-chromosome cell listed.

Why this matters. "How many chromosomes" questions are solved by knowing which stage crosses the meiosis-I line into the haploid state.

Final Answer: **(c)** Secondary oöcyte ($n = 23$).

Q 2.12 **Match the following and choose the correct options:**
Column I: A. Trophoblast B. Cleavage C. Inner cell mass D. Implantation
Column II: i. Embedding of blastocyst in the endometrium ii. Group of cells that would differentiate as embryo iii. Outer layer of blastocyst attached to the en-

dometrium iv. Mitotic division of zygote
(a) A-ii, B-i, C-iii, D-iv (b) A-iii, B-iv, C-ii, D-i
(c) A-iii, B-i, C-ii, D-iv (d) A-ii, B-iv, C-iii, D-i

SOLUTION

Correct option: (b) A-iii, B-iv, C-ii, D-i.
Concept used. After fertilisation the zygote undergoes **cleavage** (rapid mitotic divisions) to form a morula, then a **blastocyst**. The blastocyst has an outer **trophoblast** (attaches to the endometrium) and an **inner cell mass** (forms the embryo proper). **Implantation** is the embedding of the blastocyst in the uterine endometrium. We match each term to its definition.

Step 1. A. Trophoblast → outer layer of blastocyst attached to the endometrium = iii.

Step 2. B. Cleavage → mitotic division of the zygote = iv.

Step 3. C. Inner cell mass → group of cells that would differentiate as embryo = ii.

Step 4. D. Implantation → embedding of blastocyst in the endometrium = i.

Step 5. So A-iii, B-iv, C-ii, D-i, which is option (b).

Final Answer: Option **(b)**: A-iii, B-iv, C-ii, D-i.

♥ Why This Matters

The trophoblast becomes the placenta and the inner cell mass becomes the embryo proper. Separating these two early populations is the first major developmental decision in mammals.

EXPERT'S SOLUTION *: Aditya Verma, M.Sc Zoology, Banaras Hindu University*

Structural observation. Two terms are blastocyst *structures*, two are *processes*; pair like with like.

Step 1. Structures: Trophoblast is the outer layer (iii); inner cell mass is the future embryo (ii).

Step 2. Processes: Cleavage is mitotic division of the zygote (iv); implantation is the embedding of the blastocyst (i).

Step 3. Combining: A-iii, B-iv, C-ii, D-i = option (b).

Why this matters. Sorting matching items into "structure" vs "process" groups halves the search space instantly.
A useful framing: the trophoblast becomes the placenta (it must contact maternal tissue), while the inner cell mass becomes the embryo (kept inside, protected). The first

cell-fate decision in mammals is therefore an outside-vs-inside split.

Final Answer: The match is **(b)**: A-iii, B-iv, C-ii, D-i.

Q 2.13 **Which of the following hormones is not secreted by human placenta?**
(a) hCG (b) Estrogens (c) Progesterone (d) LH

SOLUTION

Correct option: (d) LH.
Concept used. The **placenta** acts as an endocrine gland during pregnancy. It secretes **hCG** (human chorionic gonadotropin), **hPL** (human placental lactogen), **estrogens** and **progestogens (progesterone)**. **LH** (luteinising hormone) is secreted by the anterior pituitary, not the placenta. We pick the hormone the placenta does not make.

Step 1. hCG: secreted by the placenta (trophoblast); maintains the corpus luteum early in pregnancy. Placental.

Step 2. Estrogens: secreted by the placenta in increasing amounts during pregnancy. Placental.

Step 3. Progesterone: secreted by the placenta, maintaining the endometrium. Placental.

Step 4. LH: a pituitary gonadotropin, *not* secreted by the placenta. So (d) is the answer.

Final Answer: Option **(d)** LH is not secreted by the placenta.

☞ **Exam Tip**
Remember the placental hormone set: hCG, hPL, estrogens, progestogens. Pituitary gonadotropins (FSH, LH) are *not* placental.

EXPERT'S SOLUTION *: Meera Chatterjee, M.Sc Biotechnology, AIIMS Delhi*

Quick reading. Recall the closed placental-hormone list; the option outside it is the answer.

Step 1. Placental hormones: hCG, hPL, estrogens, progestogens.

Step 2. Options (a), (b), (c) are all in this list.

Step 3. LH (d) is a pituitary hormone, outside the list, so it is the one not secreted by the placenta.

Why this matters. Knowing which gland makes which hormone resolves a whole class of "not secreted by" MCQs.

> **Final Answer:** **(d)** LH is not a placental hormone.

Q 2.14 **The vas deferens receives duct from the seminal vesicle and opens into urethra as:**
(a) Epididymis (b) Ejaculatory duct (c) Efferent ductule (d) Ureter

SOLUTION

Correct option: **(b)** Ejaculatory duct.
Concept used. In the male tract, the **vas deferens** carries sperm upward, then joins the duct of the **seminal vesicle**. The combined channel is the **ejaculatory duct**, which opens into the **urethra**. We identify this combined duct.

Step 1. The vas deferens ascends and reaches near the urinary bladder.

Step 2. There it is joined by the duct of the seminal vesicle.

Step 3. The short channel formed by this union is the ejaculatory duct.

Step 4. The ejaculatory duct opens into the urethra, so the answer is (b).

> ☞ **Male duct sequence**
> Vas deferens + seminal-vesicle duct → ejaculatory duct → urethra.

> **Final Answer:** Option **(b)** Ejaculatory duct.

EXPERT'S SOLUTION *: Yash Gupta, M.Sc Zoology, Banaras Hindu University*

Structural observation. The question describes a junction; name the duct formed at that junction.

Step 1. Two inputs meet: vas deferens and seminal-vesicle duct.

Step 2. Their union forms one short duct that empties into the urethra: by definition the ejaculatory duct.

Step 3. Reject the rest: epididymis and efferent ductule are upstream of the vas deferens; the ureter belongs to the urinary system.

Why this matters. Reading anatomy questions as "what is formed where A meets B" pinpoints the named structure quickly.

Final Answer: The combined duct is the **(b)** ejaculatory duct.

Q 2.15 **Urethral meatus refers to the:**
(a) Urinogenital duct
(b) Opening of vas deferens into urethra
(c) External opening of the urinogenital duct
(d) Muscles surrounding the urinogenial duct

SOLUTION

Correct option: (c) External opening of the urinogenital duct.
Concept used. The word **meatus** means a body opening or passage. The **urethral meatus** is specifically the external opening through which the urethra (the urinogenital duct in the male) opens to the outside. We match the term to its precise meaning.

Step 1. "Urethral" refers to the urethra (the urinogenital duct in the male).

Step 2. "Meatus" means an external opening.

Step 3. Combining, urethral meatus = the external opening of the urinogenital duct, option (c).

Step 4. Eliminate the rest: (a) is the whole duct, (b) is an internal junction, (d) refers to muscles, none is an external opening.

Final Answer: Option **(c)**: the external opening of the urinogenital duct.

☞ Exam Tip
Anatomical "meatus" = an external bodily opening. Examples: external auditory meatus (ear opening), urethral meatus (urethra opening). Decoding the term gives the answer in one step.

EXPERT'S SOLUTION *: Sanya Bhat, M.Sc Microbiology, JNU*

Quick reading. Decode the term word by word.

Step 1. Meatus = an opening (not a duct, not a muscle).

Step 2. Urethral = of the urethra (the urinogenital duct).

Step 3. So the urethral meatus is the external opening of that duct: option (c). The other options are either the whole duct, an internal junction, or muscle.

Why this matters. Anatomical terms are often self-defining once you split the root words; "meatus" always means an opening.

Final Answer: **(c)** External opening of the urinogenital duct.

Q 2.16 **Morula is a developmental stage:**

(a) Between the zygote and blastocyst

(b) Between the blastocyst and gastrula

(c) After the implantation

(d) Between implantation and parturition

SOLUTION

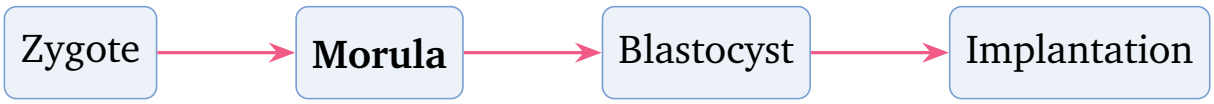
Correct option: **(a)** Between the zygote and blastocyst.

Concept used. After fertilisation the **zygote** divides by cleavage into 2, 4, 8, 16 cells. The compact 8 to 16-celled solid ball is the **morula**. The morula then develops a cavity to become the **blastocyst**. So the morula sits between the zygote and the blastocyst. We place the morula in the developmental sequence.

Step 1. Sequence: zygote → cleavage → **morula** (8–16 cells, solid) → blastocyst (with cavity) → implantation.

Step 2. The morula comes after the zygote and before the blastocyst.

Step 3. Therefore it is the stage between the zygote and the blastocyst, option (a). Implantation happens later, ruling out (c) and (d); gastrula is much later, ruling out (b).



Final Answer: Option **(a)**: between the zygote and the blastocyst.

✗ Common Mistake

Morula is *before* the blastocyst (solid ball) and well before implantation. Options that place it after the blastocyst or after implantation contradict the early-development order.

EXPERT'S SOLUTION *: Krishna Singh, Ph.D Molecular Biology, NCBS Bangalore*

Picture-first. Lay the early-development timeline on a line and find where the morula sits.

Step 1. Order the early stages: zygote, then morula (solid ball), then blastocyst (hollow), then implantation.

Step 2. The morula is sandwiched between zygote and blastocyst.

Step 3. Hence option (a); all other options place it too late in development.

Why this matters. Memorising the early-embryo order zygote → morula → blastocyst answers many development questions at once.
Putting an approximate timing on each early stage helps too: zygote at hour 0, morula by day 3–4, blastocyst by day 5, implantation by day 7. The morula sits in the middle of this 7-day window, far before any gastrulation.

Final Answer: The morula lies **(a)** between the zygote and the blastocyst.

Q 2.17 **The membranous cover of the ovum at ovulation is:**
(a) Corona radiata (b) Zona radiata (c) Zona pellucida (d) Chorion

SOLUTION

Correct option: (a) Corona radiata.
Concept used. At ovulation the secondary oocyte is released surrounded by coats. From inside out: the plasma membrane, then the **zona pellucida** (a glycoprotein layer), then the **corona radiata**, the outermost layer of follicular (granulosa) cells radiating around the egg. The outermost membranous cover at ovulation is therefore the corona radiata.
We identify the outermost cover present at ovulation.

Step 1. List the coats of the released oocyte from inside out: oocyte membrane → zona pellucida → corona radiata.

Step 2. "Zona radiata" is not a standard human term here; "chorion" is an extra-embryonic membrane formed much later, not a cover at ovulation.

Step 3. The outermost cover present at ovulation is the corona radiata, option (a).

☞ **Egg coats at ovulation**
Inside → out: plasma membrane, zona pellucida, corona radiata (outermost).

Final Answer: Option **(a)** Corona radiata.

✗ Common Mistake

The zona pellucida is a cover too, but it is the *inner* one. The question asks for the membranous cover at ovulation, which the Exemplar key takes as the outermost follicular layer, the corona radiata.

EXPERT'S SOLUTION *: Ishita Desai, M.Sc Zoology, Banaras Hindu University*

Picture-first. Draw the released oocyte as concentric rings and read the outermost.

Step 1. Centre: the oocyte with its plasma membrane.

Step 2. Next ring out: the zona pellucida (glycoprotein).

Step 3. Outermost ring: the corona radiata (follicular cells). This is the cover at ovulation, option (a).

Why this matters. Keeping the egg coats in inside-to-out order distinguishes corona radiata from zona pellucida in any fertilisation question.
The corona radiata cells continue to nourish the ovulated oocyte for some hours and also help the fimbriae grip the oocyte for transport into the oviduct. So this outermost cover is both a structural cover and a functional carrier.

> **Final Answer:** **(a)** Corona radiata is the cover at ovulation.

Q 2.18 **Identify the odd one from the following:**
(a) Labia minora (b) Fimbriae (c) Infundibulum (d) Isthmus

SOLUTION

Correct option: **(a)** Labia minora.
Concept used. The **fallopian tube (oviduct)** has, from the ovary towards the uterus: **fimbriae** (finger-like projections), **infundibulum** (funnel), ampulla, and **isthmus**. The **labia minora** are folds of the external genitalia (vulva), not part of the fallopian tube. We find the structure that is not part of the oviduct.

Step 1. Fimbriae: finger-like ends of the oviduct that collect the ovum. Oviduct part.

Step 2. Infundibulum: the funnel-shaped opening of the oviduct near the ovary. Oviduct part.

Step 3. Isthmus: the narrow part of the oviduct near the uterus. Oviduct part.

Step 4. Labia minora: skin folds of the external genitalia, *not* part of the oviduct. So it is the odd one out.

Final Answer: Option **(a)** Labia minora is the odd one out.

☞ **Exam Tip**

Keep a mental list of the four fallopian tube regions in order: infundibulum, ampulla, isthmus, uterine part. Anything outside this list (labia, cervix, vagina) is the odd one in oviduct questions.

EXPERT'S SOLUTION *: Neha Joshi, M.Sc Zoology, Banaras Hindu University*

Structural observation. Find the common group, then the member that breaks it.

Step 1. Fimbriae, infundibulum and isthmus are all consecutive regions of the fallopian tube.

Step 2. Labia minora belongs to the external genitalia, a different region of the female system.

Step 3. Hence labia minora is the odd one out, option (a).

Why this matters. "Odd one out" is solved by spotting the unifying anatomical region (here, the oviduct) and the lone outsider.
Group the rest by location: fimbriae, infundibulum and isthmus are all consecutive parts of the fallopian tube. The labia minora belong to the external genitalia (vulva), an entirely different anatomical region, which is why it is the outsider.

Final Answer: The odd one out is **(a)** Labia minora.

Solve the Regular NCERT Exercises →

Very Short Answer Type Questions

Q 2.1 **Given below are the events in human reproduction. Write them in correct sequential order.**
Insemination, gametogenesis, fertilisation, parturition, gestation, implantation

SOLUTION

Concept used. Human reproduction proceeds in a fixed order: gametes are first formed (gametogenesis), sperm are deposited in the female tract (insemination), the

sperm fuses with the egg (**fertilisation**), the embryo embeds in the uterus (**implantation**), the embryo develops over the pregnancy period (**gestation**), and finally the baby is delivered (**parturition**). We arrange the six terms in this natural cause-to-effect order.

Step 1. Gametes must exist before anything else: **gametogenesis** comes first.

Step 2. Sperm must be delivered into the female tract next: **insemination**.

Step 3. Sperm and egg then fuse: **fertilisation**.

Step 4. The resulting blastocyst embeds in the uterine wall: **implantation**.

Step 5. The embryo grows for about nine months: **gestation**.

Step 6. The fully developed baby is delivered: **parturition**.

> **Final Answer:** Gametogenesis → Insemination → Fertilisation → Implantation → Gestation → Parturition.

♥ Why This Matters

Each step is a prerequisite for the next: no gametes means no fertilisation, no implantation means no gestation. Sequencing questions are really chains of necessary preconditions.

EXPERT'S SOLUTION *: Arjun Kumar, M.Sc Zoology, Banaras Hindu University*

Quick reading. Anchor on the obvious endpoints: it must start with making gametes and end with birth.

Step 1. Start: gametogenesis (no reproduction without gametes).

Step 2. End: parturition (birth is the last event).

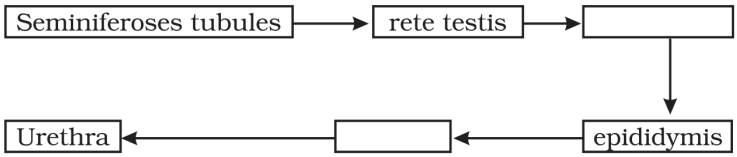
Step 3. Fill the middle by cause and effect: insemination → fertilisation → implantation → gestation.

Why this matters. Sequencing questions are reliably solved by fixing the first and last steps, then chaining the middle by what must happen before what.
A useful classroom check: write each event with the body location where it happens — gametogenesis (gonads), insemination (vagina), fertilisation (oviduct), implantation (uterus), gestation (uterus), parturition (birth canal). Mismatched locations flag a misordered sequence.

> **Final Answer:** Gametogenesis, Insemination, Fertilisation, Implantation, Gestation, Parturition.

Q 2.2 **The path of sperm transport is given below. Provide the missing steps in blank boxes.**

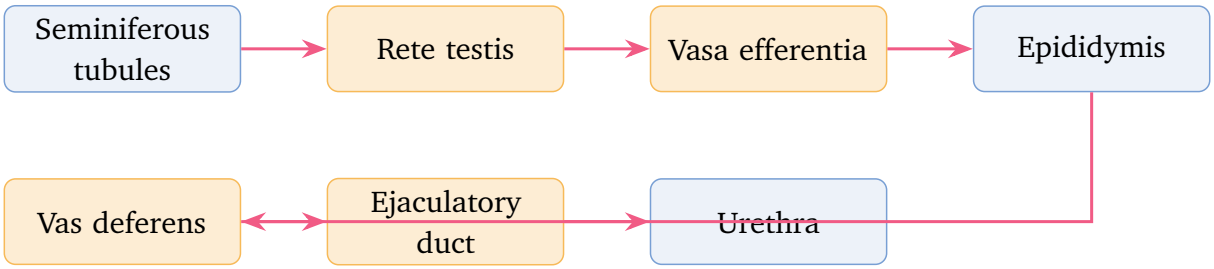
Seminiferous tubules → _____ → _____ → _____ → Epididymis (and onward).



Source flow chart, NCERT Exemplar Class 12 Biology, Chapter 3 Human Reproduction (VSA Q2).

SOLUTION

Concept used. The **sperm transport pathway** in the male begins where sperm are made and ends where semen leaves the body: seminiferous tubules → **rete testis** → **vasa efferentia** → **epididymis** → **vas deferens** → ejaculatory duct → urethra. We fill the missing links between the seminiferous tubules and the epididymis (and beyond).



Step 1. Sperm leave the seminiferous tubules and collect in the **rete testis** (a network of tubules).

Step 2. From the rete testis they pass through the **vasa efferentia** (small ducts).

Step 3. The vasa efferentia open into the **epididymis**, where sperm mature and gain motility.

Step 4. From the epididymis sperm move on through the **vas deferens**, then the **ejaculatory duct**, and finally the **urethra**.

Final Answer: Seminiferous tubules → rete testis → vasa efferentia → epididymis → vas deferens → ejaculatory duct → urethra.

☞ Exam Tip

Mnemonic: **S**eminiferous, **R**ete, **V**asa efferentia, **E**pididymis, **V**as deferens, **E**jaculatory,

Urethra ("SRV-EVEU"). Once memorised it answers every male-duct sequencing MCQ.

EXPERT'S SOLUTION *: Dev Patel, M.Sc Biotechnology, AIIMS Delhi*

Picture-first. Trace one sperm from its birthplace to the exit.

Step 1. Birthplace: seminiferous tubule. First collecting station: rete testis.

Step 2. Connecting ducts: vasa efferentia carry sperm to the epididymis.

Step 3. Onward: epididymis → vas deferens → ejaculatory duct → urethra to the exterior.

Why this matters. A single mental "journey of a sperm" fixes the whole male duct order for every related question.
A handy sanity check is the order of "male duct sizes": tubules in the testis are microscopic (rete testis, vasa efferentia), the epididymis is a long highly-coiled tube on the testis, then the vas deferens becomes a thicker muscular tube, and finally the ejaculatory duct opens into the urethra. Diameter and structure increase along the path.

> **Final Answer:** Missing links: rete testis, vasa efferentia (then vas deferens, ejaculatory duct, urethra after the epididymis).

Q 2.3 What is the role of cervix in the human female reproductive system?

SOLUTION

Concept used. The **cervix** is the narrow lower part of the uterus that opens into the vagina through the **cervical canal**. Its functions follow from this position between the uterus and the vagina.

Step 1. It forms the passage that connects the uterus to the vagina, so sperm deposited in the vagina can enter the uterus through the cervical canal.

Step 2. During childbirth the cervix dilates widely to form part of the **birth canal** through which the baby is delivered.

> **Final Answer:** The cervix connects the uterus to the vagina; its canal is the route for sperm entry, and it forms part of the birth canal during parturition.

♥ Why This Matters

Cervical mucus also changes through the cycle: thin and stretchy near ovulation (helps

sperm pass), thick at other times (blocks sperm). This is why cervix-based methods of fertility tracking work.

EXPERT'S SOLUTION *: Riya Banerjee, M.Sc Zoology, Banaras Hindu University*

Quick reading. Read its role straight off its location: a gateway between uterus and vagina.

Step 1. Position: lower neck of the uterus opening into the vagina.

Step 2. Therefore inward: a passage for sperm into the uterus.

Step 3. And outward: it dilates to become part of the birth canal at delivery.

Why this matters. For a structure connecting two organs, its functions are simply "what passes each way through it."

> **Final Answer:** Cervix: passage for sperm into the uterus and part of the birth canal at childbirth.

Q 2.4 Why are menstrual cycles absent during pregnancy?

SOLUTION

Concept used. Menstruation happens only when the endometrium is shed because no pregnancy has occurred. During pregnancy, high progesterone (from the corpus luteum, then the placenta) maintains the endometrium and suppresses the gonadotropins (FSH, LH) that would otherwise start a new follicular cycle. We explain why no cycle runs during pregnancy.

Step 1. After fertilisation and implantation, the corpus luteum (later the placenta) secretes large amounts of progesterone.

Step 2. High progesterone maintains the endometrium (it is not shed) and, by negative feedback, suppresses FSH and LH from the pituitary.

Step 3. Without the FSH/LH-driven follicular development and ovulation, no new menstrual cycle can occur, so menstruation stops throughout pregnancy.

> **Final Answer:** High progesterone during pregnancy maintains the endometrium and suppresses FSH/LH, so no follicular cycle or menstruation occurs.

♥ Why This Matters

This is why a missed period is an early sign of pregnancy: the endometrium is being maintained, not shed.

EXPERT'S SOLUTION : *Ankit Verma, M.Sc Biotechnology, AIIMS Delhi*

Strategic angle. Menstruation = shedding the endometrium. Pregnancy needs the endometrium kept, so shedding is switched off.

Step 1. Pregnancy hormone: progesterone is sustained at high levels (corpus luteum, then placenta).

Step 2. High progesterone keeps the endometrium intact (no shedding = no menstruation) and inhibits FSH/LH.

Step 3. No FSH/LH means no new follicle or ovulation, so the cycle cannot restart until after delivery.

Why this matters. The endometrium is built for the embryo; the body will not demolish it while a pregnancy is being supported.

> **Final Answer:** Sustained high progesterone maintains the endometrium and blocks FSH/LH, halting the menstrual cycle during pregnancy.

Q 2.5 **Female reproductive organs and associated functions are given below in column A and B. Fill the blank boxes.**
Column A: Ovaries, Oviduct, _____ (b), Vagina. Column B: _____ (a), Pregnancy, _____, Birth.

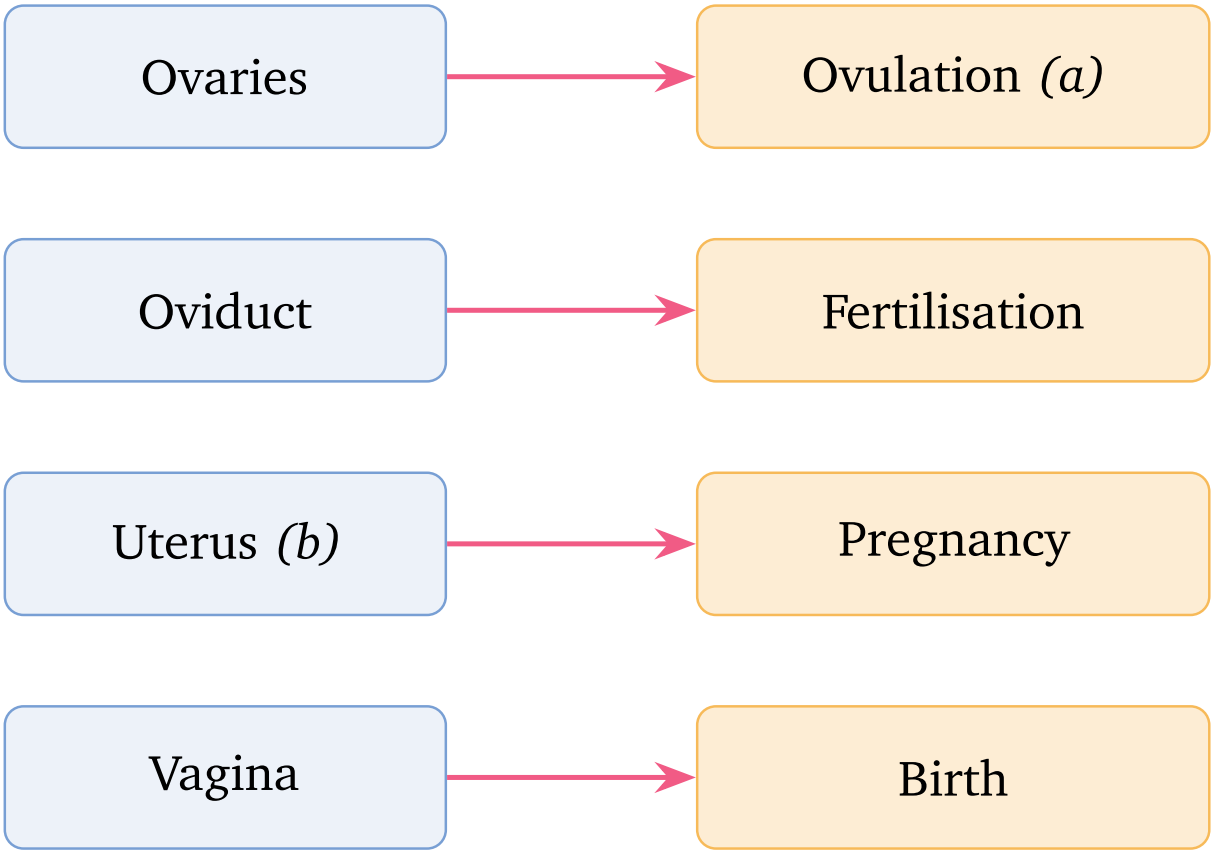
Column A	Column B
Ovaries	Ovulation
Oviduct	a
b	Pregnancy
Vagina	Birth

Source figure, NCERT Exemplar Class 12 Biology, Chapter 3 Human Reproduction (VSA Q5).

SOLUTION

Concept used. Each major **female reproductive organ** has a defining function: **ovaries** (ovulation, i.e. release of the ovum), **oviduct** (site of fertilisation), **uterus** (pregnancy/implantation and development), **vagina** (birth canal). We fill the blanks by

pairing each organ with its function.



Step 1. Ovaries → **Ovulation** (blank a): the ovary releases the secondary oocyte.

Step 2. Oviduct → **Fertilisation**: the third blank in column B; fusion of sperm and egg occurs at the ampullary-isthmic junction.

Step 3. Column A blank b → **Uterus**, whose function is **Pregnancy** (implantation and development).

Step 4. Vagina → **Birth**: it serves as the birth canal.

> **Final Answer:** (a) Ovulation; (b) Uterus; missing column-B function = Fertilisation (Oviduct).

☞ Exam Tip

Pair every female organ with its signature event: ovary = ovulation, oviduct = fertilisation, uterus = pregnancy/implantation, vagina = birth. This 1-to-1 map clears most female-anatomy matching MCQs.

EXPERT'S SOLUTION *: Priya Iyer, M.Sc Zoology, Banaras Hindu University*

Structural observation. Pair each organ with the one job it is famous for.

Step 1. Ovary is famous for releasing the egg → ovulation (blank a).

Step 2. Oviduct is famous as the fertilisation site → fertilisation (missing B).

Step 3. Uterus is famous for housing pregnancy → so the organ blank (b) is the uterus.

Step 4. Vagina is the birth canal → birth.

Why this matters. A one-organ-one-signature-function map clears every female-anatomy matching question.
An easy mnemonic for the function map is "OOUV → OFPB": Ovary → Ovulation, Oviduct → Fertilisation, Uterus → Pregnancy, Vagina → Birth. The matching letter pairs make the table easy to recall during exams.

> **Final Answer:** (a) Ovulation, (b) Uterus, and Oviduct → Fertilisation.

Q 2.6 From where do the parturition signals arise, mother or foetus? Mention the main hormone involved in parturition.

SOLUTION

Concept used. Parturition (childbirth) is triggered by signals that originate from the fully developed foetus and the placenta. These set off a neuroendocrine foetal ejection reflex, in which oxytocin from the maternal pituitary is the main hormone driving uterine contractions.

Step 1. The signals for parturition arise from the **foetus** (and placenta), not the mother. They build up only when the foetus is fully developed.

Step 2. These signals trigger the foetal ejection reflex; in response the maternal posterior pituitary releases **oxytocin**.

Step 3. Oxytocin causes strong contractions of the uterine muscles, leading to delivery of the baby.

> **Final Answer:** Parturition signals arise from the foetus (and placenta); the main hormone is oxytocin.

♥ Why This Matters

The foetus signalling its own readiness is a rare positive feedback example in human

physiology. Synthetic oxytocin (Pitocin) is used in hospitals to induce or strengthen labour when needed.

EXPERT'S SOLUTION *: Rahul Nair, M.Sc Biotechnology, AIIMS Delhi*

Quick reading. Two facts: who signals (foetus) and which hormone delivers (oxytocin).

Step 1. Source of signal: the mature foetus and placenta (mild uterine contractions begin here).

Step 2. Reflex: the foetal ejection reflex triggers oxytocin release from the mother's pituitary.

Step 3. Effect: oxytocin strengthens uterine contractions until the baby is born.

Why this matters. The baby effectively signals its own readiness for birth; oxytocin is the contraction driver throughout labour.

> **Final Answer:** Signals: from the foetus (and placenta). Main hormone: oxytocin.

Q 2.7 What is the significance of epididymis in male fertility?

SOLUTION

Concept used. The **epididymis** is a long coiled tube on the back of each testis that receives sperm from the vasa efferentia. Sperm leaving the testis are immature and non-motile; the epididymis is where they finish maturing.

Step 1. Sperm from the seminiferous tubules are immature and immotile.

Step 2. In the epididymis they undergo maturation and acquire **motility** and the ability to fertilise.

Step 3. The epididymis also stores sperm temporarily until ejaculation.

> **Final Answer:** The epididymis matures and stores sperm, giving them motility and fertilising ability, which is essential for male fertility.

✗ Common Mistake

Sperm leaving the seminiferous tubules *cannot* fertilise an egg: they have neither full motility nor mature surface proteins. The epididymis, not the testis, makes the sperm functionally ready.

EXPERT'S SOLUTION *: Aarav Sharma, M.Sc Zoology, Banaras Hindu University*

Strategic angle. Sperm leave the testis "unfinished"; the epididymis is the finishing line.

Step 1. Input: immature, non-motile sperm from the testis.

Step 2. Process in epididymis: maturation, gain of motility and fertilising capacity.

Step 3. Output and storage: functional sperm held until ejaculation.

Why this matters. Without epididymal maturation, sperm cannot swim to or fertilise the egg, so it is central to fertility.

> **Final Answer:** Epididymis matures, activates and stores sperm, making them fertile and motile.

Q 2.8 **Give the names and functions of the hormones involved in the process of spermatogenesis. Write the names of the endocrine glands from where they are released.**

SOLUTION

Concept used. Spermatogenesis is controlled by the hypothalamo-hypophyseal axis. GnRH from the hypothalamus stimulates the anterior pituitary to release FSH and LH; LH acts on Leydig cells to make androgens (testosterone), and FSH acts on Sertoli cells. We name each hormone, its gland and its role.

Step 1. **GnRH** (gonadotropin releasing hormone), from the **hypothalamus**: stimulates the anterior pituitary to secrete FSH and LH.

Step 2. **LH** (luteinising hormone), from the **anterior pituitary**: acts on Leydig (interstitial) cells to secrete androgens (testosterone).

Step 3. **Testosterone/androgens**, from the **Leydig cells of the testis**: stimulate the process of spermatogenesis.

Step 4. **FSH** (follicle stimulating hormone), from the **anterior pituitary**: acts on Sertoli cells, which release factors needed for spermiogenesis (sperm maturation).

> **Final Answer:** GnRH (hypothalamus) → FSH & LH (anterior pituitary); LH → androgens from Leydig cells (drive spermatogenesis); FSH → Sertoli cells (support sperm maturation).

☞ Exam Tip

Remember the cell-target pairing: **L**H → **L**eydig cells (testosterone), **F**SH → Sertoli cells (sperm nursing). The matching first-letter "L–L" is a reliable memory hook.

EXPERT'S SOLUTION *: Kavya Reddy, M.Sc Biotechnology, AIIMS Delhi*

Strategic angle. Follow the control chain top-down: brain → pituitary → testis.

Step 1. Hypothalamus: GnRH starts the chain.

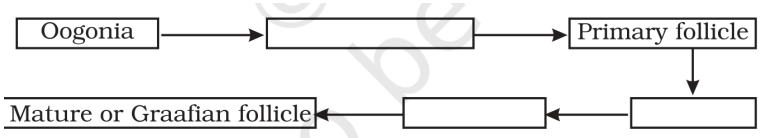
Step 2. Anterior pituitary: FSH (Sertoli cells) and LH (Leydig cells).

Step 3. Testis: LH-driven testosterone from Leydig cells directly powers spermatogenesis; FSH-driven Sertoli cells nourish maturing sperm.

Why this matters. Every gonad-hormone question becomes easy once you draw the hypothalamus → pituitary → gonad axis.
Note that testosterone itself feeds back negatively to both the hypothalamus (less GnRH) and the pituitary (less LH), keeping levels stable. This negative-feedback loop is why exogenous testosterone use can suppress natural spermatogenesis.

> **Final Answer:** GnRH (hypothalamus), FSH & LH (anterior pituitary), androgens (Leydig cells); FSH → Sertoli cells, LH → testosterone → spermatogenesis.

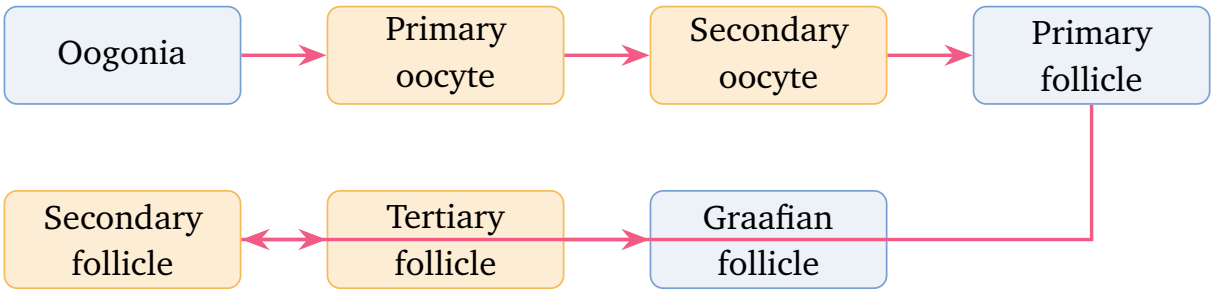
Q 2.9 **The mother germ cells are transformed into a mature follicle through a series of steps. Provide the missing steps in the blank boxes.**
Oogonia → _____ → _____ → **Primary follicle** → _____ → **Mature (Graafian) follicle.**



Source flow chart, NCERT Exemplar Class 12 Biology, Chapter 3 Human Reproduction (VSA Q9).

SOLUTION

Concept used. In **oogenesis**, the **oogonia** (mother germ cells) multiply and enter meiosis I to become **primary oocytes**. A primary oocyte gets surrounded by granulosa cells to form a **primary follicle**, which grows into a **secondary follicle** and then a **tertiary follicle** with a fluid-filled antrum, finally becoming the **Graafian follicle**. We supply the missing stages.



Step 1. Oogonia divide and enlarge into **primary oocytes** (which enter and pause in meiosis I).

Step 2. The primary oocyte completes meiosis I (around ovulation) to give the **secondary oocyte**.

Step 3. The oocyte surrounded by a granulosa layer is the **primary follicle**; this grows into a **secondary follicle**, then a **tertiary follicle** (with antrum), and finally the **Graafian follicle**.

Final Answer: Oogonia → primary oocyte → secondary oocyte → primary follicle → secondary follicle → tertiary follicle → Graafian follicle.

✗ Common Mistake

The oocyte and its follicle are two different things: "primary oocyte" is the egg cell, "primary follicle" is the egg plus its surrounding granulosa layer. Mixing them up scrambles the oogenesis sequence.

EXPERT'S SOLUTION *: Siddharth Bhat, M.Sc Zoology, Banaras Hindu University*

Picture-first. Separate the two parallel tracks: the egg cell line and the follicle wrapper line.

Step 1. Cell line: oogonia → primary oocyte → secondary oocyte.

Step 2. Wrapper line: primary follicle → secondary follicle → tertiary follicle → Graafian follicle.

Step 3. The missing boxes are primary oocyte, secondary oocyte, and the secondary/tertiary follicle stages.

Why this matters. Tracking the egg cell and its follicle wrapper separately avoids mixing the two oogenesis sequences.
It is important to remember that the human oocyte already pauses at meiosis I prophase during fetal life and can stay arrested for decades. So the "oogonia → primary oocyte" transition listed here happens *before birth*, not at puberty.

Final Answer: Missing steps: primary oocyte, secondary oocyte (cell line); secondary and tertiary follicle (wrapper line).

Q 2.10 **During reproduction, the chromosome number ($2n$) reduces to half (n) in the gametes and again the original number ($2n$) is restored in the offspring. What are the processes through which these events take place?**

SOLUTION

Concept used. Meiosis is a reduction division that halves the chromosome number, producing haploid (n) gametes from diploid ($2n$) germ cells. Fertilisation is the fusion of two haploid gametes, which restores the diploid ($2n$) number in the zygote. We name the process for each event.

Step 1. Halving ($2n \to n$): occurs during **gametogenesis** by **meiosis**, which separates homologous chromosomes so each gamete gets only $n = 23$ chromosomes.

Step 2. Restoring ($n + n \to 2n$): occurs at **fertilisation**, when a haploid sperm (n) fuses with a haploid egg (n) to form a diploid zygote ($2n = 46$).

Final Answer: Reduction to n: meiosis (during gametogenesis). Restoration to $2n$: fertilisation (fusion of two haploid gametes).

♥ Why This Matters

If meiosis did not halve the chromosome number, the offspring would have $4n$, then $8n$, doubling every generation. Meiosis + fertilisation together hold the species karyotype constant.

EXPERT'S SOLUTION *: Pooja Desai, M.Sc Zoology, Banaras Hindu University*

Strategic angle. Two opposite operations: one divides the number, the other adds it back.

Step 1. Divide by two: meiosis in the germ cells gives n gametes.

Step 2. Add back: fertilisation fuses two n gametes to give $2n$.

Step 3. Net effect: the species chromosome number stays constant generation after generation.

Why this matters. Meiosis and fertilisation together keep the chromosome number stable across generations.

Without meiosis, every generation would double the chromosome number; without fertilisation, the species would lose the diploid state. The two processes are inverses of each other and together hold the karyotype constant.

Final Answer: Meiosis halves it; fertilisation restores it.

Q 2.11 What is the difference between a primary oöcyte and a secondary oöcyte?

SOLUTION

Concept used. In **oogenesis**, the **primary oocyte** is the cell that enters meiosis I; the **secondary oocyte** is formed after meiosis I is completed. They differ in ploidy and the meiotic stage they are at.

Step 1. **Primary oocyte:** diploid ($2n = 46$); it is arrested in prophase of meiosis I until just before ovulation.

Step 2. **Secondary oocyte:** haploid ($n = 23$); it is formed when the primary oocyte completes meiosis I (with an unequal split giving one large secondary oocyte and a small first polar body). It then begins meiosis II and is arrested at metaphase II until fertilisation.

Final Answer: Primary oocyte: diploid ($2n$), in meiosis I. Secondary oocyte: haploid (n), formed after meiosis I, arrested in meiosis II until fertilisation.

☞ Exam Tip

Two arrests in oogenesis: meiosis I arrest (in primary oocyte, since fetal life) and meiosis II arrest (in secondary oocyte, until fertilisation). Both arrests are a NEET favourite.

EXPERT'S SOLUTION *: Vivaan Joshi, Ph.D Molecular Biology, NCBS Bangalore*

Structural observation. The dividing line is meiosis I: before it vs after it.

Step 1. Before meiosis I: primary oocyte, diploid ($2n$).

Step 2. After meiosis I: secondary oocyte, haploid (n), plus a tiny first polar body.

Step 3. The secondary oocyte then waits at metaphase II for a sperm.

Why this matters. Every oogenesis comparison reduces to "which side of meiosis I" the cell is on.
Also note the cytoplasmic difference: the secondary oocyte keeps almost all the

cytoplasm from the primary oocyte; the leftover cytoplasm goes into the tiny first polar body. This unequal split is unique to oogenesis.

> **Final Answer:** Primary $= 2n$, pre-meiosis-I; Secondary $= n$, post-meiosis-I, paused in meiosis II.

Q 2.12 What is the significance of ampullary–isthmic junction in the female reproductive tract?

SOLUTION

Concept used. The **fallopian tube** has, near the ovary, a wide **ampulla** and, near the uterus, a narrow **isthmus**. Where these meet is the **ampullary-isthmic junction**, the normal site of fertilisation.

Step 1. The ovum released at ovulation is picked up by the fimbriae and moves into the ampulla.

Step 2. Sperm swim up the female tract to the same region.

Step 3. Fertilisation (fusion of sperm and ovum) normally occurs at the **ampullary-isthmic junction**.

> **Final Answer:** The ampullary-isthmic junction is the usual site of fertilisation in the female reproductive tract.

♥ Why This Matters

If an embryo implants in the tube (instead of the uterus) at this junction, it is an *ectopic* (tubal) pregnancy: a medical emergency. Knowing the junction location explains why this complication exists.

EXPERT'S SOLUTION *: Aanya Mehta, M.Sc Zoology, Banaras Hindu University*

Quick reading. One fact to remember: it is where sperm meets egg.

Step 1. Ovum travels into the ampulla after ovulation.

Step 2. Sperm ascend to the junction of ampulla and isthmus.

Step 3. They fuse here: the junction is the fertilisation site.

Why this matters. Knowing the exact fertilisation site explains why this junction is clinically important (e.g. ectopic tubal pregnancy).

Final Answer: It is the site where fertilisation normally takes place.

Q 2.13 How does zona pellucida of ovum help in preventing polyspermy?

SOLUTION

Concept used. The **zona pellucida** is the glycoprotein coat around the ovum. When the first sperm contacts and fuses with the egg, the egg's **cortical reaction** releases enzymes that change the zona pellucida (the **zona reaction**), blocking further sperm entry. This prevents **polyspermy** (entry of more than one sperm).

Step 1. The first sperm binds the zona pellucida and induces the acrosomal reaction, then fuses with the egg membrane.

Step 2. Fusion triggers the cortical reaction: cortical granules release enzymes into the zona pellucida.

Step 3. These enzymes harden the zona pellucida and inactivate its sperm receptors (the zona reaction), so no other sperm can bind or penetrate. This blocks polyspermy.

Final Answer: Sperm fusion triggers the cortical/zona reaction, hardening the zona pellucida and inactivating its sperm receptors, so additional sperm cannot enter, preventing polyspermy.

♥ Why This Matters

Blocking polyspermy keeps the zygote diploid ($2n$). Multiple sperm would give an abnormal chromosome number and a non-viable embryo.

EXPERT'S SOLUTION *: Sneha Rao, M.Sc Biotechnology, AIIMS Delhi*

Strategic angle. The zona changes the instant the first sperm arrives, locking the door behind it.

Step 1. First sperm fuses: this is the trigger.

Step 2. Cortical granules dump enzymes into the zona pellucida.

Step 3. Zona hardens and its receptors are destroyed: no second sperm can attach or pass.

Why this matters. A single, self-triggered chemical lock guarantees exactly one sperm

fertilises the egg.
If polyspermy were not blocked, the zygote would form with $3n$ or $4n$ chromosomes — a state called triploidy or tetraploidy — and would be developmentally non-viable. So the zona reaction is essentially a chromosomal-quality control mechanism.

> **Final Answer:** The zona reaction hardens the zona pellucida and removes sperm receptors after the first sperm enters, preventing polyspermy.

Q 2.14 Mention the importance of LH surge during the menstrual cycle.

SOLUTION

Concept used. **LH** (luteinising hormone) rises sharply around the middle of the menstrual cycle; this rapid rise is the **LH surge**. Its main job is to cause **ovulation** and to form the **corpus luteum**.

Step 1. The LH surge peaks around day 14 of a 28-day cycle.

Step 2. It causes the mature Graafian follicle to rupture and release the secondary oocyte: this is **ovulation**.

Step 3. After ovulation, LH converts the empty follicle into the **corpus luteum**, which secretes progesterone to prepare the endometrium.

> **Final Answer:** The LH surge triggers ovulation (rupture of the Graafian follicle) and the formation of the corpus luteum.

☞ Exam Tip

A very common NEET one-liner: "Which event is directly caused by the LH surge?" Answer: ovulation (around day 14).

EXPERT'S SOLUTION *: Karan Pillai, Ph.D Molecular Biology, NCBS Bangalore*

Quick reading. The LH surge is the cycle's "release trigger."

Step 1. Timing: a sharp mid-cycle peak (about day 14).

Step 2. Immediate effect: ruptures the Graafian follicle, releasing the oocyte (ovulation).

Step 3. After-effect: forms the corpus luteum for progesterone secretion.

Why this matters. The LH surge is the single hormonal event that defines mid-cycle and

links the follicular and luteal phases.

Final Answer: LH surge: causes ovulation and corpus-luteum formation.

Q 2.15 Which type of cell division forms spermatids from the secondary spermatocytes?

SOLUTION

Concept used. A **secondary spermatocyte** is haploid ($n = 23$), formed after meiosis I. It next undergoes the **second meiotic division (meiosis II)**, which is like a mitotic division (separates sister chromatids without changing chromosome number), to form two **spermatids**.

Step 1. The secondary spermatocyte is already haploid ($n = 23$) after meiosis I.

Step 2. It divides by **meiosis II** (the second meiotic division), separating sister chromatids.

Step 3. This produces two haploid **spermatids** ($n = 23$) from each secondary spermatocyte.

Final Answer: Spermatids are formed from secondary spermatocytes by the second meiotic division (meiosis II).

✗ Common Mistake

Meiosis II does not reduce the chromosome number again. The reduction already happened in meiosis I; both secondary spermatocyte and spermatid are haploid ($n = 23$).

EXPERT'S SOLUTION *: Aditi Singh, M.Sc Zoology, Banaras Hindu University*

Quick reading. Identify the stage, then the division that follows it.

Step 1. Secondary spermatocyte = post-meiosis-I cell, haploid.

Step 2. The only division left is meiosis II.

Step 3. Meiosis II splits it into two spermatids (still $n = 23$).

Why this matters. Pinning whether a cell is pre- or post-meiosis-I tells you exactly which division comes next.

Final Answer: Meiosis II (the second meiotic division).

Short Answer Type Questions

Q 2.1 **A human female experiences two major changes, menarche and menopause during her life. Mention the significance of both the events.**

SOLUTION

Concept used. Menarche is the first menstruation, marking the start of the reproductive (fertile) period. Menopause is the permanent stopping of menstruation, marking the end of the reproductive period. Their significance lies in the boundaries they set on a woman's fertile years.

Step 1. **Menarche:** occurs at puberty (about 10–14 years). It signals that the ovaries have begun cyclic activity and the female has become capable of reproduction (the start of the fertile phase).

Step 2. **Menopause:** occurs around 45–50 years. It signals the end of ovarian cycles and ovulation, so natural reproduction is no longer possible after it.

Final Answer: Menarche marks the onset of the reproductive (fertile) phase; menopause marks its end. Together they define a woman's reproductive lifespan.

☞ **Exam Tip**

Approximate ages to remember: menarche around 10–14 years; menopause around 45–50 years. The 30–40 year window in between is the natural reproductive lifespan.

EXPERT'S SOLUTION *: Tara Chatterjee, M.Sc Zoology, Banaras Hindu University*

Strategic angle. Treat the two events as the opening and closing brackets of fertility.

Step 1. Opening bracket, menarche: ovaries start cycling; fertility begins at puberty.

Step 2. Closing bracket, menopause: ovarian cycles cease around 45–50 years; fertility ends.

Step 3. Between the two lies the entire reproductive lifespan.

Why this matters. These two milestones frame every menstrual-cycle and fertility question on the female timeline.
Between the two boundaries lies roughly 30–40 years of cyclic fertility. Tracking this

window helps clinicians counsel on ideal reproductive age and on age-related reproductive risks at either end.

Final Answer: Menarche = start of fertile life; Menopause = end of fertile life.

Q 2.2 **(a) How many spermatozoa are formed from one secondary spermatocyte? (b) Where does the first cleavage division of zygote take place?**

SOLUTION

Concept used. (a) In **spermatogenesis**, one secondary spermatocyte undergoes **meiosis II** to give spermatids, which mature into spermatozoa. (b) After fertilisation in the oviduct, the zygote begins **cleavage** while still moving through the fallopian tube towards the uterus.

Step 1. (a) One secondary spermatocyte ($n = 23$) undergoes meiosis II $\rightarrow$ **2 spermatids** $\rightarrow$ each matures into 1 spermatozoon. So **2 spermatozoa** are formed from one secondary spermatocyte.

Step 2. (b) Fertilisation occurs in the ampulla of the fallopian tube. The zygote then starts cleavage as it travels down the tube, so the **first cleavage division takes place in the fallopian tube (oviduct)**.

Final Answer: (a) 2 spermatozoa. (b) In the fallopian tube (oviduct), while the zygote moves towards the uterus.

✗ Common Mistake

Do not confuse this with primary spermatocyte (which gives 4 sperms). One *secondary* spermatocyte gives only 2 sperms because meiosis I has already happened.

EXPERT'S SOLUTION *: Yash Banerjee, Ph.D Molecular Biology, NCBS Bangalore*

Quick reading. Two short factual sub-parts; anchor each on its definition.

Step 1. (a) Meiosis II of one secondary spermatocyte = 2 cells $\rightarrow$ 2 spermatozoa.

Step 2. (b) Fertilisation site is the oviduct; cleavage starts immediately there, before reaching the uterus.

Why this matters. The "$\times 2$ per secondary spermatocyte" and "cleavage starts in the oviduct" facts recur across development questions.
The first cleavage happens within roughly 30 hours of fertilisation, while the embryo is

still travelling through the oviduct. The morula stage is typically reached only as the embryo enters the uterus, around days 3–4.

Final Answer: (a) Two. (b) Fallopian tube (oviduct).

Q 2.3 Corpus luteum in pregnancy has a long life. However, if fertilisation does not take place, it remains active only for 10–12 days. Explain.

SOLUTION

Concept used. The corpus luteum secretes progesterone. Its survival depends on hCG (human chorionic gonadotropin): hCG is secreted only when an embryo has implanted, so the corpus luteum is maintained only during pregnancy.

Step 1. If fertilisation occurs and the embryo implants, the trophoblast secretes **hCG**, which keeps the corpus luteum active and secreting progesterone for several months (a long life).

Step 2. If fertilisation does not occur, there is no embryo and so no hCG.

Step 3. Without hCG support, the corpus luteum degenerates after about **10–12 days**, progesterone falls, the endometrium is shed, and menstruation begins.

Final Answer: hCG from the implanted embryo maintains the corpus luteum during pregnancy; without fertilisation there is no hCG, so it degenerates in 10–12 days.

♥ Why This Matters

hCG is the basis of pregnancy test kits: it appears only when an embryo has implanted, signalling that the corpus luteum (and pregnancy) is being maintained.

EXPERT'S SOLUTION *: Riya Verma, M.Sc Biotechnology, AIIMS Delhi*

Strategic angle. The corpus luteum lives only as long as it gets the hCG "keep-alive" signal.

Step 1. Pregnant: embryo makes hCG → corpus luteum kept alive (long life, sustained progesterone).

Step 2. Not pregnant: no embryo, no hCG → corpus luteum degenerates in about 10–12 days.

Step 3. Falling progesterone then triggers menstruation.

Why this matters. The hCG dependency explains both the long luteal life in pregnancy and the regular monthly degeneration otherwise.

> **Final Answer:** hCG (from the embryo) sustains the corpus luteum; no fertilisation = no hCG = 10–12 day lifespan.

Q 2.4 What is foetal ejection reflex? Explain how it leads to parturition.

SOLUTION

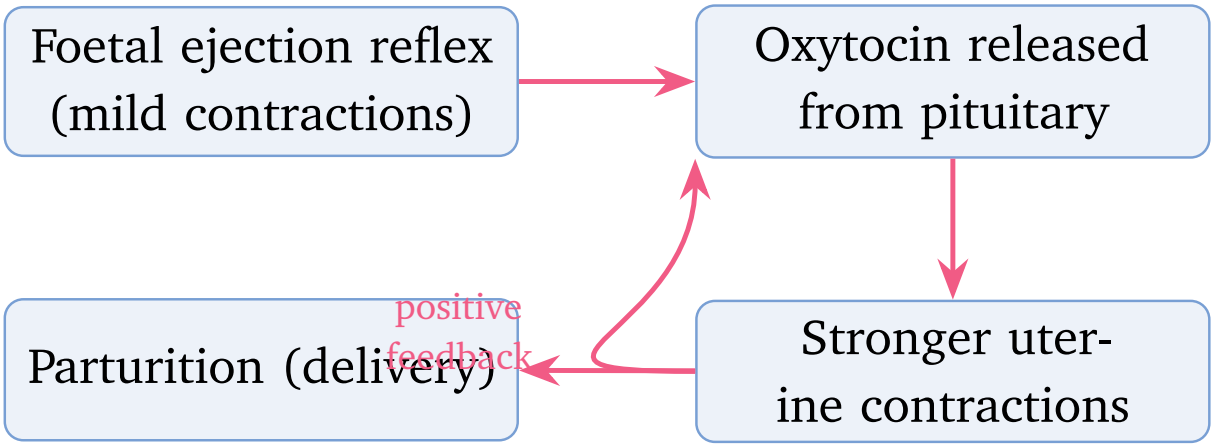
Concept used. The **foetal ejection reflex** is the mild signal from the fully developed foetus and placenta that begins uterine contractions. It sets up a positive feedback loop with **oxytocin** that drives **parturition** (childbirth).

Step 1. When the foetus is fully developed, signals from the foetus and placenta cause mild contractions of the uterus: this is the **foetal ejection reflex**.

Step 2. These contractions stimulate the maternal posterior pituitary to release **oxytocin**.

Step 3. Oxytocin causes stronger uterine contractions, which in turn trigger more oxytocin release: a **positive feedback** loop.

Step 4. This loop intensifies contractions until the cervix dilates and the baby is expelled, i.e. parturition.



> **Final Answer:** The foetal ejection reflex is the foetus/placenta signal that starts uterine contractions; via an oxytocin positive feedback loop it intensifies contractions until childbirth (parturition).

☞ Exam Tip

Childbirth is the standard textbook example of *positive* feedback in human physiology. Most other hormonal axes (FSH/LH, T3/T4, cortisol) use negative feedback.

EXPERT'S SOLUTION *: Dev Iyer, M.Sc Zoology, Banaras Hindu University*

Strategic angle. Picture a self-reinforcing loop that ends only when the baby is delivered.

Step 1. Trigger: mature foetus + placenta cause mild uterine contractions (foetal ejection reflex).

Step 2. Amplifier: contractions → oxytocin → stronger contractions → more oxytocin (positive feedback).

Step 3. Outcome: the escalating contractions deliver the baby (parturition).

Why this matters. It is a textbook example of a positive feedback loop, contrasted with the negative feedback that governs most hormones.
The positive-feedback nature is the key feature: each contraction triggers more oxytocin, which triggers stronger contractions, with no negative brake. The loop ends only when the baby is delivered and the uterus empties, removing the stimulus.

> **Final Answer:** Foetal ejection reflex → oxytocin positive feedback → escalating contractions → parturition.

Q 2.5 Except endocrine function, what are the other functions of placenta?

SOLUTION

Concept used. The placenta is the structural and functional connection between the foetus and the mother's uterine wall. Apart from secreting hormones (its endocrine role), it serves exchange and protective roles.

Step 1. **Nutrition:** it supplies the foetus with nutrients (glucose, amino acids) from the mother's blood.

Step 2. **Respiration (gas exchange):** oxygen passes from mother to foetus and carbon dioxide from foetus to mother across the placenta.

Step 3. **Excretion:** foetal nitrogenous wastes are removed into the mother's blood through the placenta.

Step 4. **Barrier/protection:** it acts as a selective barrier that lets some materials (including some antibodies) pass while restricting others.

Final Answer: Besides endocrine function, the placenta provides nutrition, gas exchange (respiration), excretion of foetal wastes, and acts as a protective selective barrier.

☞ Exam Tip

Group placental functions by the maternal organ they substitute: gut (nutrition), lung (gas exchange), kidney (excretion), liver/skin (barrier). Four jobs, four substitutions.

EXPERT'S SOLUTION *: Ananya Joshi, M.Sc Biotechnology, AIIMS Delhi*

Strategic angle. The placenta is the foetus's combined "lung, gut and kidney" plus a filter.

Step 1. Gut role: delivers nutrients to the foetus.

Step 2. Lung role: exchanges O_2 and CO_2.

Step 3. Kidney role: removes foetal wastes.

Step 4. Filter role: selective barrier giving some protection.

Why this matters. Grouping placental jobs by the organ they replace makes the list easy to recall in an exam.
The placenta is therefore the foetus's substitute for almost every adult organ — lung, gut, kidney, liver and immune barrier — all packaged into a single transient structure. After birth, each of these jobs reverts to the newborn's own organs.

Final Answer: Nutrition, respiration (gas exchange), excretion, and protective barrier functions.

Q 2.6 Why do doctors recommend breast feeding during the initial period of infant growth?

SOLUTION

Concept used. The first milk after childbirth is **colostrum**, followed by mature breast milk. Both are tailored to the newborn; colostrum in particular gives **passive immunity**.

Step 1. Colostrum (the first few days' milk) is rich in **antibodies**, especially IgA, which give the newborn passive immunity against infections.

Step 2. Breast milk provides balanced and easily digestible nutrition ideal for the infant's growth.

Step 3. It is clean, at the right temperature, and strengthens the mother-infant bond.

> **Final Answer:** Breast milk (especially colostrum) supplies antibodies for passive immunity plus complete, easily digested nutrition, so doctors recommend it in early infancy.

☞ Exam Tip

A frequent one-mark answer: colostrum contains IgA antibodies that provide the newborn with passive immunity.

EXPERT'S SOLUTION *: Aarav Pillai, M.Sc Microbiology, JNU*

Quick reading. Two reasons: immunity and ideal nutrition.

Step 1. Immunity: colostrum's IgA antibodies protect the newborn before its own immune system matures.

Step 2. Nutrition: breast milk is the complete, digestible food for early growth.

Why this matters. Passive immunity from colostrum is the key reason "first milk" must not be discarded.
Discarding the first milk (a common cultural practice in some regions) deprives the newborn of IgA antibodies just when its own immune system is least mature. Modern paediatric guidelines explicitly recommend feeding colostrum within the first hour after birth.

> **Final Answer:** Colostrum gives antibody-based passive immunity, and breast milk gives ideal nutrition for the infant.

Q 2.7 What are the events that take place in the ovary and uterus during the follicular phase of the menstrual cycle?

SOLUTION

Concept used. The **follicular phase** is the first half of the menstrual cycle (about days 1–13). **FSH** drives follicle growth in the ovary, the growing follicle secretes **estrogen**, and estrogen rebuilds the **endometrium** in the uterus.

Step 1. In the ovary: FSH from the pituitary stimulates a primary follicle to grow into a mature **Graafian follicle**; the follicle secretes increasing **estrogen**.

Step 2. In the uterus: the rising estrogen makes the endometrium **proliferate** (regrow

and thicken) after the previous menstruation, preparing it for a possible pregnancy.

Step 3. The phase ends with the LH surge that causes ovulation around day 14.

> **Final Answer:** Ovary: FSH-driven growth of the Graafian follicle with rising estrogen. Uterus: estrogen-driven proliferation (thickening) of the endometrium.

☞ Exam Tip

Estrogen is the messenger that links the two: ovary makes it (in the growing follicle) and the uterus responds to it (endometrium thickens). One hormone synchronises both organs.

EXPERT'S SOLUTION *: Priya Rao, M.Sc Zoology, Banaras Hindu University*

Structural observation. Track two organs in parallel during days 1–13.

Step 1. Ovary track: FSH → follicle matures → estrogen rises.

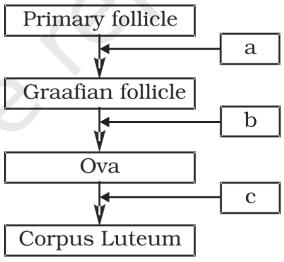
Step 2. Uterus track: estrogen → endometrium proliferates and thickens.

Step 3. Linkage: ovarian estrogen is the messenger that rebuilds the uterine lining.

Why this matters. Seeing the ovary and uterus as linked by estrogen explains the whole follicular phase in one line.
The phase is also called the proliferative phase from the uterine viewpoint, and the follicular phase from the ovarian viewpoint — two names for the same days 1–13 window. Estrogen is the linking signal that synchronises both organs.

> **Final Answer:** Follicle matures (FSH, rising estrogen) in the ovary; the endometrium proliferates in the uterus.

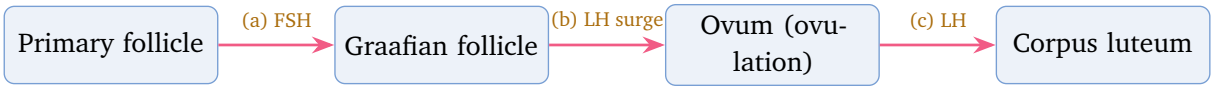
Q 2.8 **Given below is a flow chart showing ovarian changes during menstrual cycle. Fill in the spaces giving the name of the hormones responsible for the events shown.**
Primary follicle $\xrightarrow{(a)}$ Graafian follicle $\xrightarrow{(b)}$ Ovum (ovulation) $\xrightarrow{(c)}$ Corpus luteum.



Source flow chart, NCERT Exemplar Class 12 Biology, Chapter 3 Human Reproduction (SA Q8).

SOLUTION

Concept used. Ovarian changes are driven by pituitary gonadotropins. **FSH** matures the follicle, the **LH surge** causes ovulation, and **LH** maintains the corpus luteum. We name the hormone for each transition.



Step 1. (a) Primary follicle → Graafian follicle: driven by **FSH** (follicle stimulating hormone), which promotes follicular growth and maturation.

Step 2. (b) Graafian follicle → ovulation: driven by the **LH surge**, which ruptures the mature follicle and releases the ovum.

Step 3. (c) After ovulation → corpus luteum: maintained by **LH**, which converts the empty follicle into the corpus luteum.

Final Answer: (a) FSH; (b) LH surge; (c) LH.

✗ Common Mistake

Note the two distinct roles of LH: the brief mid-cycle *surge* causes ovulation, while a steady low-level LH then maintains the corpus luteum. Same hormone, two effects.

EXPERT'S SOLUTION : *Siddharth Reddy, M.Sc Biotechnology, AIIMS Delhi*

Quick reading. Two hormones do all the work: FSH builds, LH releases and maintains.

Step 1. Build the follicle: FSH (transition a).

Step 2. Release the ovum: LH surge (transition b).

Step 3. Maintain the corpus luteum: LH (transition c).

Why this matters. The FSH-then-LH pattern is the backbone of every ovarian-cycle diagram.

FSH leads and LH closes: think of the cycle as a relay race. FSH grows the follicle in the

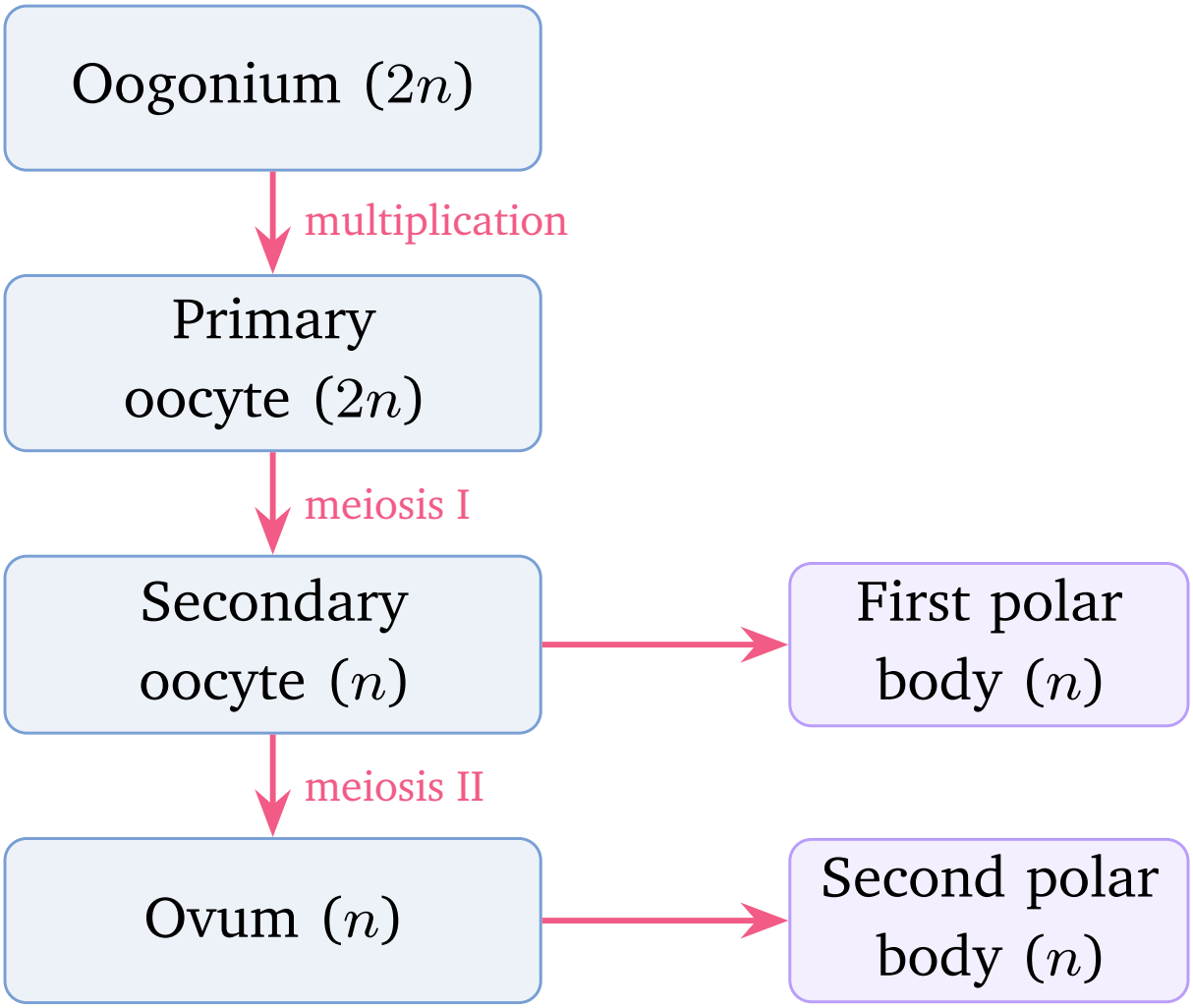
first half; the LH surge fires the gun at ovulation; steady LH then maintains the corpus luteum and the luteal-phase progesterone supply. Three hormone events drive the entire ovarian cycle.

Final Answer: (a) FSH, (b) LH surge, (c) LH.

Q 2.9 **Give a schematic labelled diagram to represent oögenesis (without descriptions).**

SOLUTION

Concept used. **Oogenesis** is the formation of the ovum from an oogonium through multiplication, growth and maturation, producing one ovum and three polar bodies from one primary oocyte. We present it as a labelled schematic.



Step 1. Oogonium $(2n)$ grows into a primary oocyte $(2n)$.

Step 2. Meiosis I gives an unequal split: a large secondary oocyte (n) and a small first polar body (n).

Step 3. Meiosis II of the secondary oocyte (completed at fertilisation) gives the ovum (n) and a second polar body (n).

> **Final Answer:** Oogonium ($2n$) $\rightarrow$ primary oocyte ($2n$) $\rightarrow$ [meiosis I] $\rightarrow$ secondary oocyte (n) + 1st polar body $\rightarrow$ [meiosis II] $\rightarrow$ ovum (n) + 2nd polar body.

♥ Why This Matters

The polar bodies are degenerative: they carry chromosomes but very little cytoplasm and soon die. This is how oogenesis funnels all the nutrient reserves into a single, well-stocked ovum.

EXPERT'S SOLUTION *: Meera Bhat, M.Sc Zoology, Banaras Hindu University*

Picture-first. The key visual is the *unequal* split that conserves cytoplasm for the ovum.

Step 1. One primary oocyte enters meiosis.

Step 2. Meiosis I: most cytoplasm goes to the secondary oocyte; the leftover is the tiny first polar body.

Step 3. Meiosis II: again unequal, yielding one large ovum and a second small polar body.

Why this matters. The unequal divisions explain why one primary oocyte makes only one functional egg (unlike four sperms in spermatogenesis).
The biological pay-off is large: by sacrificing three polar bodies, the female system ensures that the single surviving ovum is loaded with all the cytoplasmic reserves needed to support the early embryo before implantation and placental nutrition take over.

> **Final Answer:** One primary oocyte $\rightarrow$ one ovum + three polar bodies (unequal meiotic divisions).

Q 2.10 What are the changes in the oogonia during the transition of a primary follicle to Graafian follicle?

SOLUTION

Concept used. As a primary follicle develops into a Graafian follicle, the oocyte inside and the surrounding follicular cells both change. We list the changes.

Step 1. The oocyte enlarges and a thick glycoprotein layer, the **zona pellucida**, forms around it.

Step 2. The single layer of follicular (granulosa) cells multiplies into many layers, and a connective tissue **theca** forms around the follicle.

Step 3. A fluid-filled cavity, the **antrum**, develops among the granulosa cells (secondary → tertiary follicle).

Step 4. The follicle enlarges greatly to become the mature **Graafian follicle**, with the oocyte surrounded by the corona radiata and a stalk of granulosa cells, ready for ovulation.

> **Final Answer:** The oocyte enlarges with a zona pellucida; granulosa cells multiply into many layers with a theca; an antrum forms; the follicle enlarges into the Graafian follicle ready for ovulation.

☞ Exam Tip

The hallmark of a Graafian follicle is the large fluid-filled **antrum**. "Antrum present" is the visual cue that the follicle has reached the Graafian (preovulatory) stage.

EXPERT'S SOLUTION *: Ankit Desai, Ph.D Molecular Biology, NCBS Bangalore*

Structural observation. Track three things: the egg, its coat, and the surrounding cells.

Step 1. Egg: enlarges; gains a zona pellucida.

Step 2. Cells: granulosa layer multiplies; a theca forms; an antrum (fluid cavity) appears.

Step 3. Whole follicle: swells into the large Graafian follicle ready to ovulate.

Why this matters. Watching the egg, coat and cell layers separately makes the follicular-maturation sequence easy to recall.
Notice three structural milestones during the primary → Graafian transition: appearance of the zona pellucida, formation of the theca layer, and development of the antral cavity. Any of these three features in a histology slide indicates an advanced follicular stage.

> **Final Answer:** Oocyte enlarges with zona pellucida; granulosa multiplies, theca and antrum form; follicle matures into Graafian follicle.

Long Answer Questions

Q 2.1 What role do pituitary gonadotropins play during follicular and ovulatory phases of the menstrual cycle? Explain the shifts in steroidal secretions.

SOLUTION

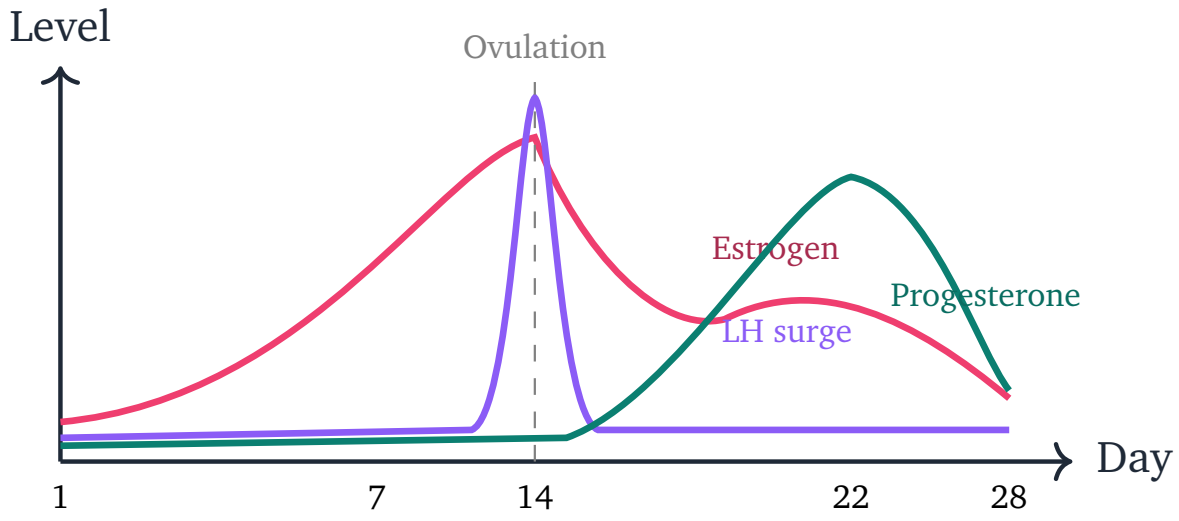
Concept used. The pituitary gonadotropins are FSH (follicle stimulating hormone) and LH (luteinising hormone). In the follicular phase FSH dominates and drives follicle growth; the LH surge causes ovulation. The steroids estrogen and progesterone shift in step with these gonadotropins. We trace gonadotropin and steroid changes across the first half of the cycle.

Step 1. **Follicular phase (days 1–13): role of FSH.** FSH from the anterior pituitary stimulates a primary follicle to grow into a Graafian follicle. The growing follicle secretes increasing amounts of the steroid **estrogen**.

Step 2. **Effect of rising estrogen.** Estrogen rebuilds and thickens the endometrium (proliferative phase). Estrogen rises steadily through the follicular phase and peaks just before mid-cycle.

Step 3. **Ovulatory phase (around day 14): role of LH.** The high estrogen level triggers a sharp surge of **LH** (and a smaller FSH rise). This **LH surge** causes the mature Graafian follicle to rupture and release the secondary oocyte: **ovulation**.

Step 4. **Steroid shift after ovulation.** LH converts the ruptured follicle into the corpus luteum, which now secretes large amounts of the steroid **progesterone** (with some estrogen). So the dominant steroid shifts from estrogen (follicular) to progesterone (post-ovulatory).



> **Final Answer:** FSH drives follicular growth and rising estrogen in the follicular phase; high estrogen triggers the LH surge that causes ovulation. The dominant steroid shifts from estrogen (follicular phase) to progesterone (post-ovulatory, from the corpus luteum).

♥ Why This Matters

This FSH → estrogen → LH surge → progesterone cascade is the master diagram of the menstrual cycle; almost every cycle question is one piece of it.

EXPERT'S SOLUTION *: Pranav Chatterjee, M.Sc Zoology, Banaras Hindu University*

Strategic angle. Follow two gonadotropins (FSH, LH) and watch the steroid baton pass from estrogen to progesterone.

Step 1. Follicular phase: FSH is the lead gonadotropin; it grows the follicle, which pours out estrogen. Estrogen climbs and rebuilds the endometrium.

Step 2. Mid-cycle: estrogen peaks and, by positive feedback, triggers a sharp LH surge (with a small FSH rise).

Step 3. Ovulation: the LH surge ruptures the Graafian follicle, releasing the oocyte around day 14.

Step 4. Steroid baton pass: LH then forms the corpus luteum, which switches the dominant steroid from estrogen to progesterone for the luteal phase.

Why this matters. Reading the cycle as "FSH then LH" gonadotropins and "estrogen then progesterone" steroids answers nearly every menstrual-cycle question.
Notice the elegant feedback switch: estrogen mostly exerts negative feedback at low/medium levels, but at a sustained high peak it flips to positive feedback and triggers the LH surge. This switch is the single most important regulatory event in the menstrual cycle. The same FSH → estrogen → LH surge → progesterone cascade explains why hormonal contraceptives work — they suppress the surge by keeping estrogen and progesterone artificially steady.

> **Final Answer:** FSH → follicle growth and estrogen rise (follicular); estrogen peak → LH surge → ovulation; then LH → corpus luteum → progesterone dominance.

Q 2.2 Meiotic division during oogenesis is different from that in spermatogenesis. Explain how and why.

SOLUTION

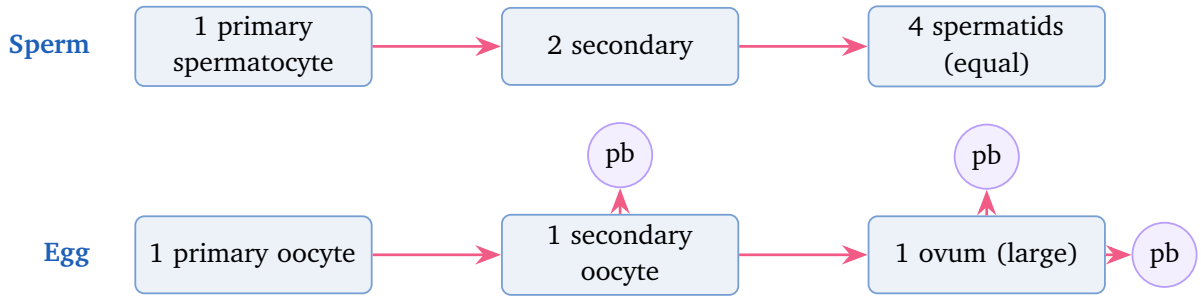
Concept used. Both **oogenesis** and **spermatogenesis** use meiosis to make haploid gametes, but the cytoplasmic division and timing differ. The difference exists to give the egg a large cytoplasmic store for the early embryo. We compare them point by point.

Step 1. **Equal vs unequal division.** In spermatogenesis the meiotic divisions are **equal**: one primary spermatocyte → 4 equal-sized functional spermatids → 4 sperms. In oogenesis the divisions are **unequal**: one primary oocyte → 1 large functional ovum + 3 tiny non-functional polar bodies.

Step 2. **Number of functional gametes.** Spermatogenesis yields **4** functional gametes per primary cell; oogenesis yields only **1** functional gamete (the ovum) per primary cell.

Step 3. **Timing/continuity.** Spermatogenesis is continuous and completed within the testis. Oogenesis is discontinuous: it begins before birth, the primary oocyte is arrested in meiosis I for years, meiosis I completes only at ovulation, and meiosis II completes only if fertilisation occurs.

Step 4. **Why the difference.** The unequal division conserves almost all the cytoplasm and nutrients in one cell, so the ovum carries enough food and organelles to support the zygote and early embryo before implantation. Sperms only need to deliver a nucleus, so equal division giving many small motile cells is efficient.



Final Answer: Spermatogenesis: equal divisions → 4 functional sperms, continuous. Oogenesis: unequal divisions → 1 ovum + 3 polar bodies, discontinuous (arrested in meiosis I, finishing at ovulation/fertilisation). The unequal split conserves cytoplasm so the ovum can nourish the early embryo.

☞ Exam Tip

Contrast table for exams: spermatogenesis (equal, continuous, 4 sperms) vs oogenesis (unequal, discontinuous/arrested, 1 ovum + 3 polar bodies). One row covers most compare-and-contrast questions.

EXPERT'S SOLUTION *: Ishaan Banerjee, Ph.D Molecular Biology, NCBS Bangalore*

Strategic angle. Compare on three axes: how the cytoplasm splits, how many gametes result, and when meiosis happens; then give the single reason behind all of it.

Step 1. Cytoplasm: sperm meiosis is symmetric (4 equal cells); egg meiosis is asymmetric (1 big ovum, 3 minute polar bodies).

Step 2. Yield: 4 functional sperms vs 1 functional ovum per primary cell.

Step 3. Timing: sperm meiosis is continuous; egg meiosis is paused for years (arrest in meiosis I) and finishes only at ovulation and fertilisation.

Step 4. The single reason: the ovum must hoard cytoplasm and nutrients for the zygote, so its divisions are unequal; sperm only deliver DNA, so equal divisions maximise numbers and motility.

Why this matters. The "egg keeps the cytoplasm" idea explains the unequal divisions, the single ovum, and even the arrest points in one stroke.
A final consequence worth remembering: because the secondary oocyte only finishes meiosis II at fertilisation, a sperm-egg fusion event triggers both the completion of female meiosis and the start of zygotic life. So in a strict sense, the egg becomes an ovum only at the moment of fertilisation. This single fact answers many "when is meiosis completed?" questions on NEET.

> **Final Answer:** Egg meiosis is unequal, slow and arrested (1 ovum + 3 polar bodies) to conserve cytoplasm for the embryo; sperm meiosis is equal and continuous (4 sperms).

Q 2.3 **The zygote passes through several developmental stages till implantation. Describe each stage briefly with suitable diagrams.**

SOLUTION

Concept used. After fertilisation in the oviduct, the **zygote** undergoes **cleavage** (rapid mitotic divisions without growth) to form a **morula**, then a **blastocyst**, which finally undergoes **implantation** in the uterine endometrium. We describe each stage in order.

Step 1. **Zygote:** the single diploid cell ($2n$) formed by fusion of sperm and egg, in the ampulla of the oviduct.

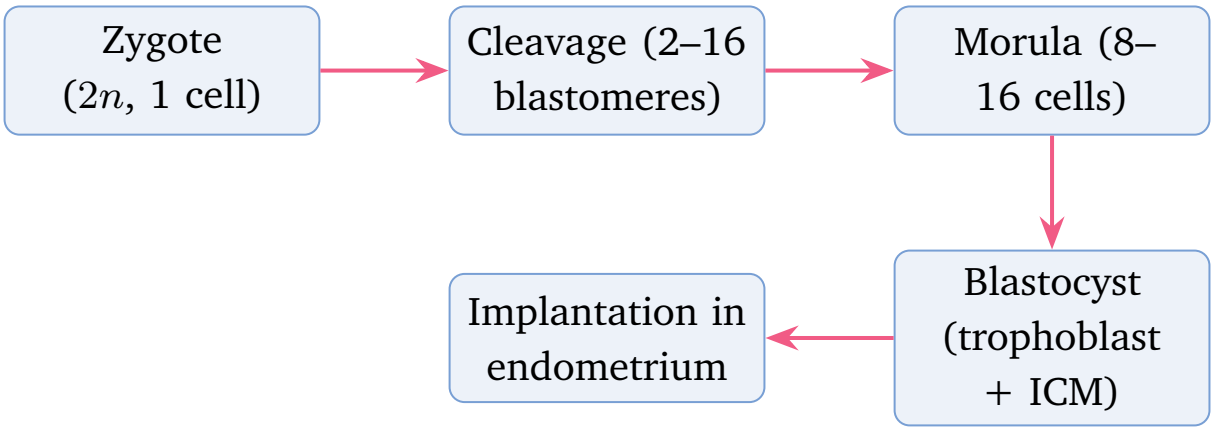
Step 2. **Cleavage:** the zygote divides mitotically into 2, 4, 8, 16 cells called **blastomeres**, while moving down the oviduct. No growth occurs, so cells get smaller.

Step 3. **Morula:** a compact ball of 8–16 blastomeres, still surrounded by the zona

pellucida, reaching the uterus.

Step 4. **Blastocyst:** the morula develops a fluid-filled cavity; cells arrange into an outer **trophoblast** and an **inner cell mass** (the future embryo).

Step 5. **Implantation:** the blastocyst loses its zona pellucida and the trophoblast attaches to and embeds in the uterine endometrium, about 7 days after fertilisation.



Final Answer: Zygote → cleavage (blastomeres) → morula → blastocyst (trophoblast + inner cell mass) → implantation in the endometrium (about day 7).

✗ Common Mistake

Cleavage does not increase total size: the cells only divide, they do not grow. The morula is about the same size as the zygote, just with many small cells.

EXPERT'S SOLUTION *: Aditi Pillai, M.Sc Zoology, Banaras Hindu University*

Picture-first. Follow the embryo as a moving ball that subdivides, hollows out, then sticks.

Step 1. Start: one cell (zygote) in the oviduct.

Step 2. Subdivide: cleavage makes a cluster of blastomeres (2→16), then a solid morula.

Step 3. Hollow out: a cavity forms, giving the blastocyst with trophoblast (outside) and inner cell mass (inside).

Step 4. Stick: the blastocyst implants into the endometrium around day 7.

Why this matters. The "subdivide → hollow → stick" storyline fixes the entire pre-implantation sequence.
An interesting feature is that the embryo gets smaller (per blastomere) during cleavage

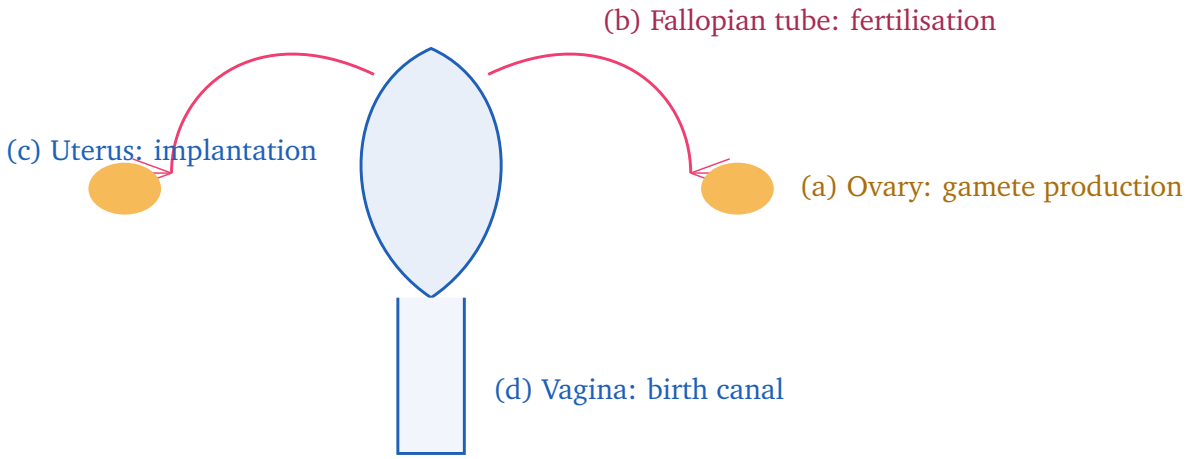
because the zona pellucida prevents growth: cells divide but the total volume stays constant. Only after the embryo hatches from the zona and implants can it grow by drawing nutrients from the endometrium and, later, the placenta.

Final Answer: Zygote → cleavage → morula → blastocyst → implantation.

Q 2.4 **Draw a neat diagram of the female reproductive system and label the parts associated with the following: (a) production of gamete, (b) site of fertilisation, (c) site of implantation, and (d) birth canal.**

SOLUTION

Concept used. In the **female reproductive system**, the **ovary** produces the gamete (ovum), the **fallopian tube (ampullary-isthmic junction)** is the fertilisation site, the **uterus (endometrium)** is the implantation site, and the **vagina (with cervix)** is the birth canal. We present a labelled schematic identifying each part.



Step 1. **(a) Ovary** produces the gamete (ovum) by oogenesis.

Step 2. **(b) Fallopian tube** (ampullary-isthmic junction) is the site of fertilisation.

Step 3. **(c) Uterus** (its endometrium) is the site of implantation of the blastocyst.

Step 4. **(d) Vagina** (with the cervix) forms the birth canal during parturition.

Final Answer: (a) Ovary = gamete production; (b) Fallopian tube = fertilisation; (c) Uterus = implantation; (d) Vagina = birth canal.

♥ Why This Matters

Labelling diagrams in exams carries full marks only when the function tag is correct (e.g. "ovary = ovum production", not just "ovary"). The function justifies why the structure is significant.

EXPERT'S SOLUTION *: Kavya Iyer, M.Sc Zoology, Banaras Hindu University*

Picture-first. Tag the four functional zones onto one outline, ovary outward to vagina downward.

Step 1. Side organs (ovaries): make the egg (a).

Step 2. Tubes (fallopian tubes): catch the egg and host fertilisation (b).

Step 3. Central organ (uterus): receives the blastocyst for implantation (c).

Step 4. Exit channel (vagina + cervix): the birth canal (d).

Why this matters. Mapping function onto position turns an anatomy-labelling question into a quick four-tag exercise.
When you label a diagram in an exam, write the structure *and* its function together (e.g. "ovary = gamete production"). The function tag justifies why the structure is being labelled and earns the full mark; the structure name alone usually earns only half. This four-tag function map is also the easiest way to remember the entire female reproductive anatomy.

> **Final Answer:** Ovary (a), Fallopian tube (b), Uterus (c), Vagina (d).

Q 2.5 With a suitable diagram, describe the organisation of mammary gland.

SOLUTION

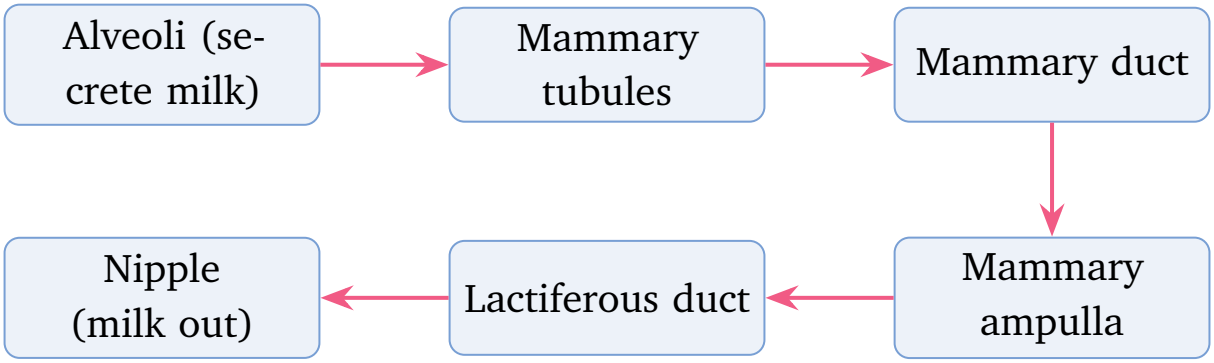
Concept used. The **mammary gland** is a modified sweat gland present in pairs in females. It is made of glandular tissue (**mammary lobes** → **lobules** → **alveoli**) and a duct system that carries milk to the nipple. We describe its organisation with a labelled schematic.

Step 1. Each mammary gland has 15–20 **mammary lobes**, each containing clusters of **lobules**.

Step 2. Each lobule is made of grape-like **alveoli**; the cells of the alveoli secrete **milk**, which is stored in the alveolar lumen.

Step 3. Milk passes from the alveoli into **mammary tubules**; tubules of a lobe join to form a **mammary duct**.

Step 4. Several mammary ducts join to form a wider **mammary ampulla**, which leads through a **lactiferous duct** to the nipple, from where milk is released.



Final Answer: Alveoli (milk-secreting) → mammary tubules → mammary ducts → mammary ampulla → lactiferous duct → nipple. Lobules of alveoli form lobes (15–20 per gland).

♥ Why This Matters

This duct hierarchy is why milk produced deep in the alveoli can be delivered, on suckling, all the way out through the single nipple opening.

EXPERT'S SOLUTION *: Rahul Bhat, M.Sc Biotechnology, AIIMS Delhi*

Structural observation. Read it as a branching tree: leaves (alveoli) make milk, branches (ducts) carry it to the trunk (nipple).

Step 1. Leaves: alveoli secrete and store milk; clusters of alveoli = lobules; lobules = lobes (15–20).

Step 2. Twigs to branches: alveoli → mammary tubules → mammary ducts.

Step 3. Trunk: ducts → mammary ampulla → lactiferous duct → nipple.

Why this matters. The tree analogy makes the lobe→lobule→alveolus→duct→nipple hierarchy easy to reproduce in an exam.

A useful comparison: a mammary gland is essentially a modified sweat gland that secretes milk instead of sweat. The hierarchy (alveoli → ducts) mirrors that of any exocrine gland, but the secretion (milk) and the trigger (prolactin + oxytocin) are unique to lactation.

Final Answer: Lobes → lobules → alveoli (milk) → tubules → ducts → ampulla → lactiferous duct → nipple.

Key Takeaways

- The male tract carries sperm: seminiferous tubules → rete testis → vasa efferentia → epididymis → vas deferens → ejaculatory duct → urethra; the three accessory glands are seminal vesicle, prostate and bulbourethral.
- Spermatogenesis gives 4 functional sperms per primary spermatocyte (equal divisions); oogenesis gives 1 ovum + 3 polar bodies per primary oocyte (unequal divisions, arrested in meiosis I).
- Menstrual cycle: FSH grows the follicle and raises estrogen (follicular phase); a high-estrogen-triggered LH surge causes ovulation around day 14; the corpus luteum then raises progesterone (luteal phase).
- Fertilisation occurs at the ampullary-isthmic junction; the zona/cortical reaction blocks polyspermy; development runs zygote → morula → blastocyst → implantation (about day 7).
- Placenta is endocrine (hCG, hPL, estrogen, progesterone) and also handles nutrition, gas exchange and excretion; parturition is driven by the foetal ejection reflex and an oxytocin positive feedback loop.

End of NCERT Exemplar Problems • Human Reproduction