Structured Notes According to

ANATOMY

Revision friendly **Fully Colored Book/Structured Notes**

For Best results, watch the video lectures along with reading notes

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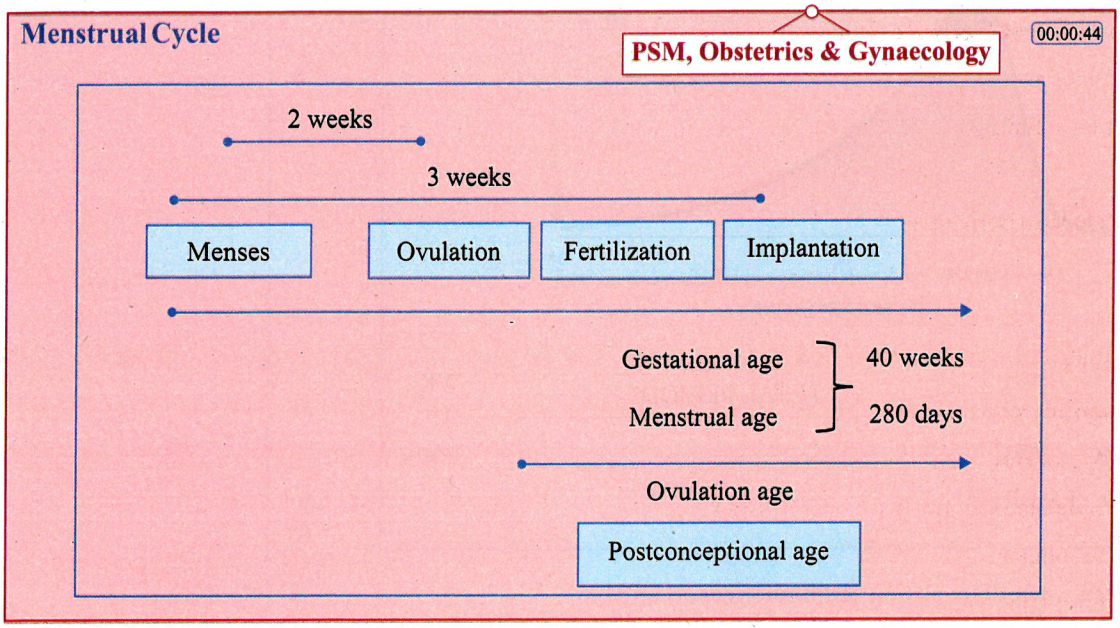
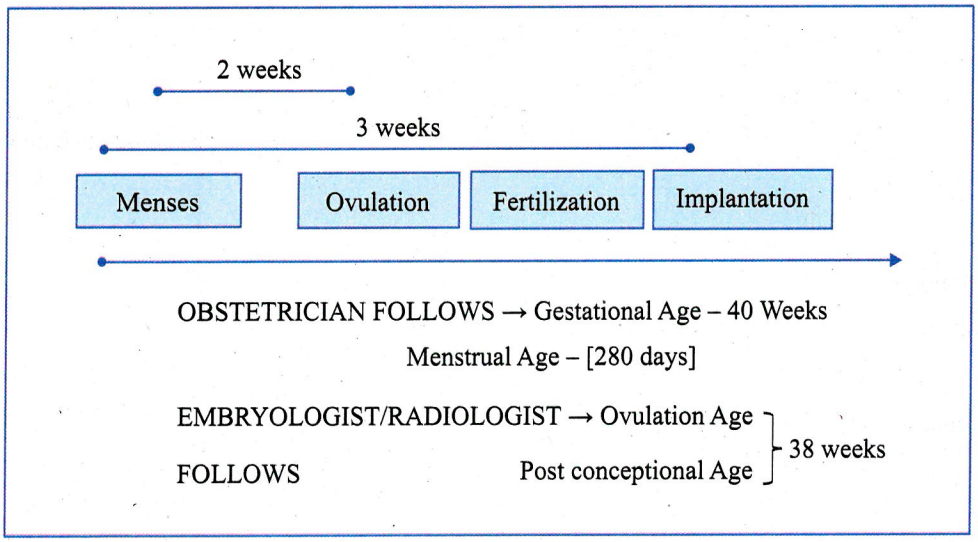
1 DEVELOPMENTAL TIMELINE



Developmental Timeline



Q. Heart development begins at week?

A. **4**
B. 5
C. 6
D. 7

Explanation:

- When calculated from Post conceptional age, the heartbeat can be detected earliest by 4th week post ovulation using TVS.
- When calculated from LMP, the heartbeat can be detected earliest by 6th week.

Graph representing Post conception Age

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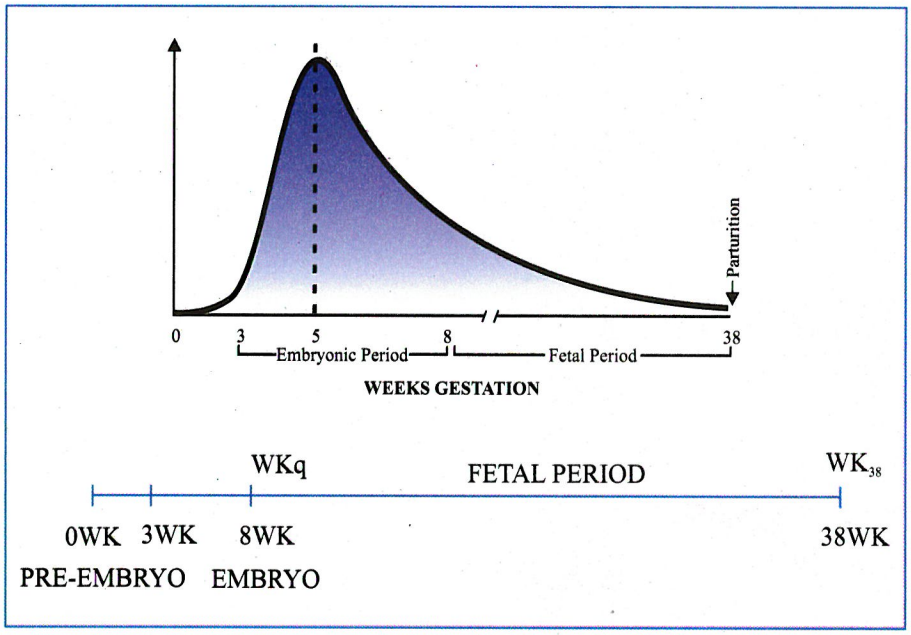

- In this graph, point 0 is where the ovulation/ fertilization has occurred.
- Embryonic period :3-8 weeks
- Pre embryonic period: before 3 weeks
- Foetal period: 9 weeks - 38 weeks

2 GAMETOGENESIS AND IN-VITRO FERTILIZATION

Chromosomes

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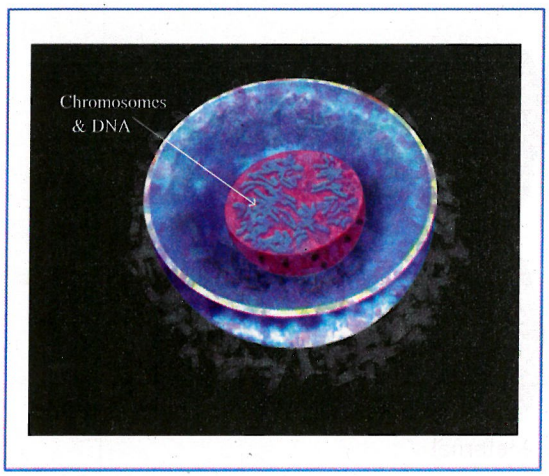
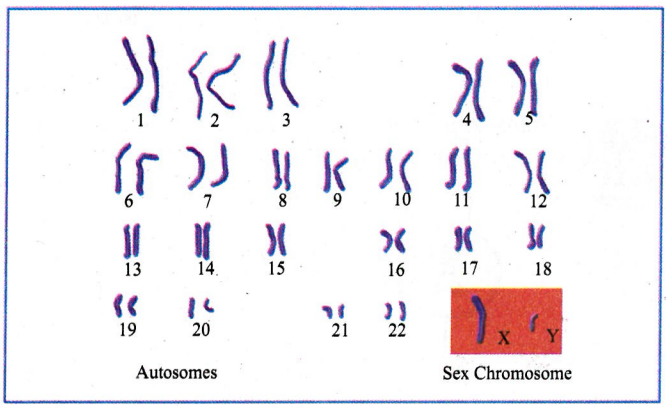
- Chromosomes are present in the nucleus of a cell.
- 23 pairs of chromosomes - 22 pairs of autosomes and 1 pair of sex chromosome.
- DNA Replication occurs in 'S [synthetic] phase of interphase.

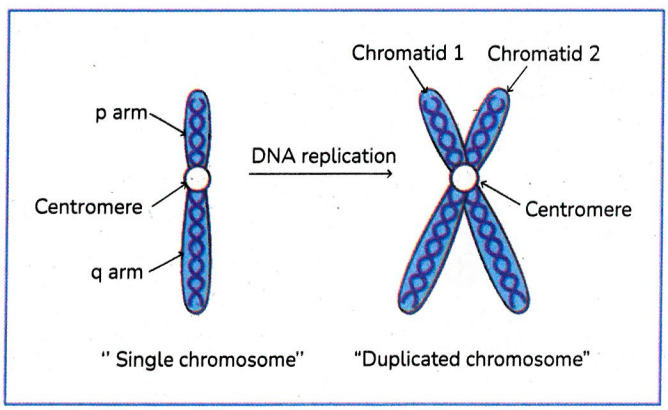


- There are 46 chromosome (2n) out of which 23 (n) are from mother and 23 (n) from father

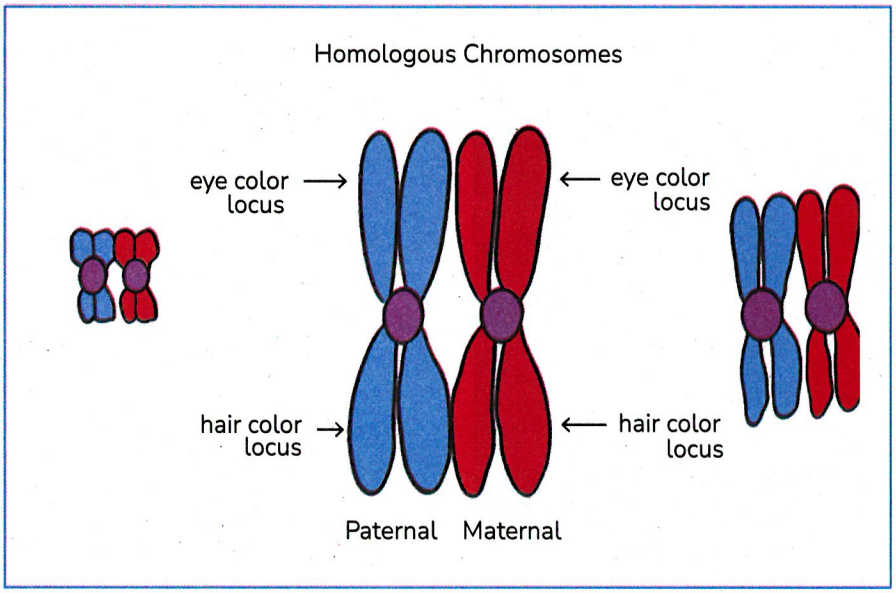


XX-FEMALE
XY-MALE

- Each chromosome has a short arm and a long arm.



- Centromere connects the short arm (P arm) and the long arm (q arm).
- The genetic designation given to any chromosome is n, N.
  - n = is the number of chromosomes.
  - N= is the amount of DNA
- During DNA replication, the number of chromosome will be n, 2N



Gametogenesis

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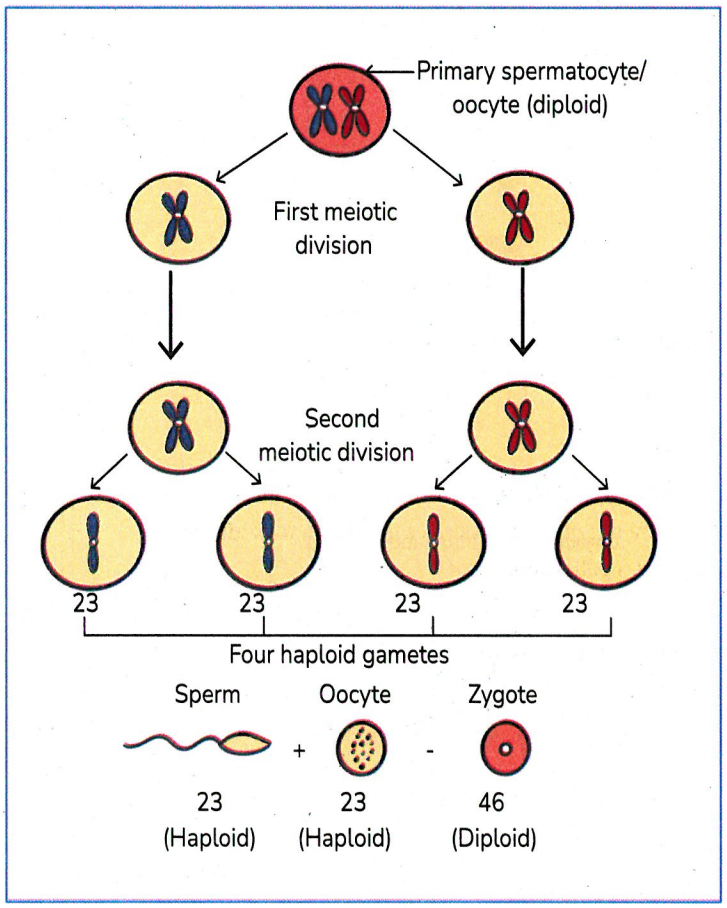
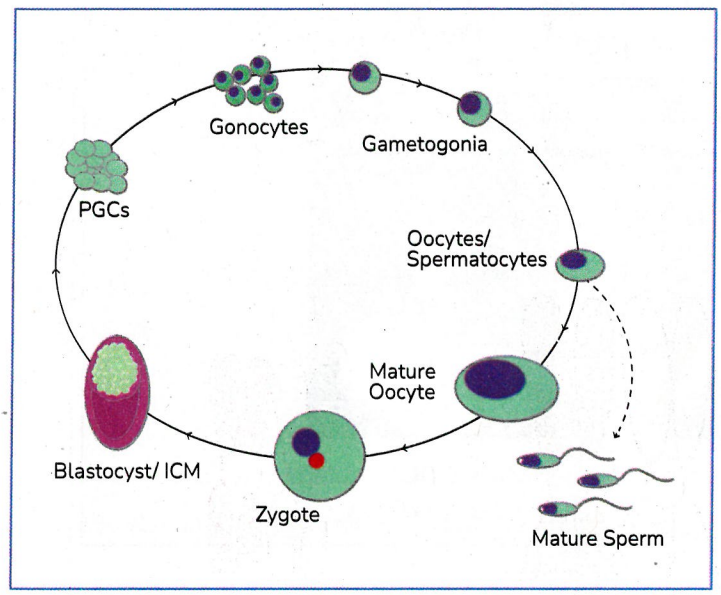
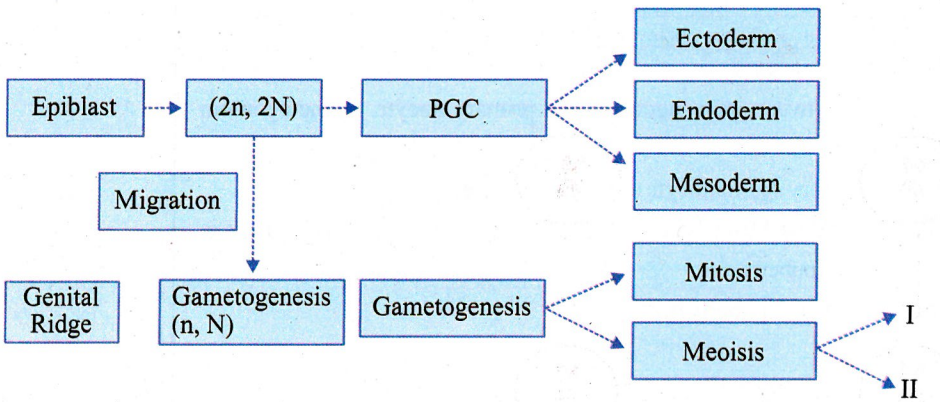


- Zygote will be having 46 chromosomes, 23 paternal and 23 maternal.



- The Zygote is continuously divides and forms the Blastocyst.
- The blastocyst contain some inner cell mass with epiblast cells which forms the primordial germ cell
- Primordial germs cells further form the Gonocyte and the Gametogonia
- PGC is the first sex cell of the body.
- Gonocyte and the Gametogonia further gives primary and secondary gametocytes.

Cell Divisions:



If migration doesn't reach to genital ridge PGC can reach other areas in ectoderm, endoderm, mesoderm leads germ cell tumor

- During Gametogenesis cells under cell division like mitosis and meiosis.
- Mitosis is an equational division (no change in no of chromosomes).
- Meiosis is a 2 stage process.
  - Meiosis 1 is a reduction division.
  - Meiosis 2 behaves like mitosis.
- Chromosomes separate during meiosis 1.
- Chromatid separates at meiosis 2.

Germ Cell Tumour

00:14:46

- Have all 3 germ layers because the primordial germ cell is a pluripotent cell.

OROPHARYNGEAL TERATOMA

SACROCOCCYGEAL TERATOMA

Cell Division: Mitosis and Meiosis

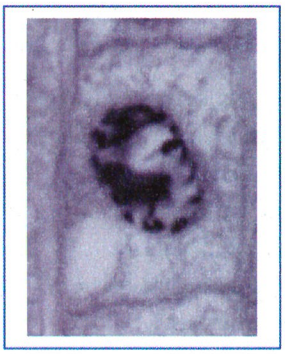
00:17:43

Mitosis	• PGC ↓ • Gametogonium ↓ • Primary gametocyte → (M) Spermatocyte / (F) Oocyte
Meiosis I	Original cell here is primary gametocyte

- There is no cell division occurring between gametogonium and primary oocyte. Gametogonium enlarges to form primary oocyte.
- The cell which enters meiosis 1 is primary spermatocyte or primary oocyte.
- Primary oocyte enters Meiosis 1 when female baby is in-utero as compared with the spermatogenesis in males , which begin Meiosis 1 only after puberty.
- Primordial germ cell remains dormant until puberty in males.

Mitosis

1. Prophase: The genetic material undergo condensation
2. Metaphase: Chromosome align at the equator
3. Anaphase: Sister chromatids separate away from midline
4. Telophase: Chromosome form 2 daughter cells

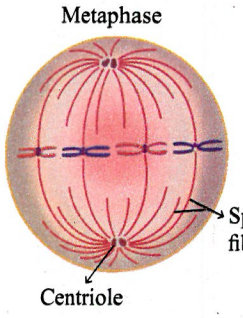


1. Prophase

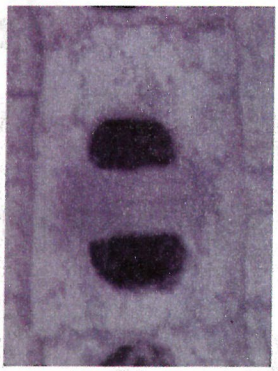
Prophase:

Chromosomes condense and nuclear envelope breaks down. Spindle fiber grow from centrioles. Centrioles migrate to opposite poles of cell.

2. Metaphase

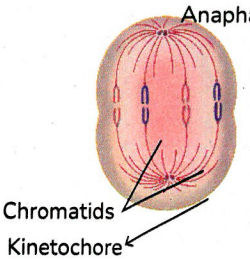


Metaphase
Chromosomes lie along midline of cell. Some spindle fibers attach to kinetochores
Fibers of aster attach to plasma membrane.



- Chromosomes lie along the midline of cell.
- Some spindle fibres attach to kinetochores.
- Fibre of aster attach to plasma membrane

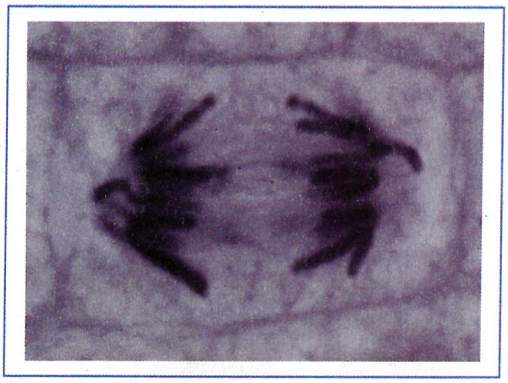
3. Anaphase



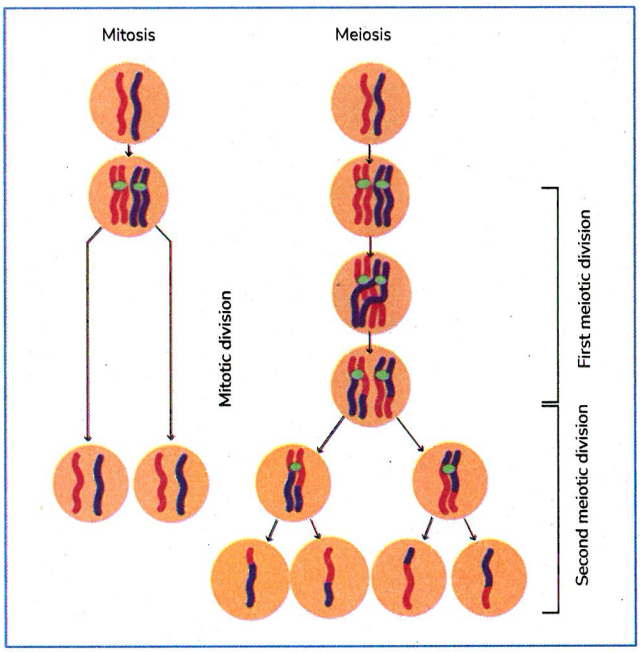
Anaphase
Centromeres divide in two. Spindle fibers pull sister chromatids to opposite poles of cell. Each pole (future daughter cell) now has an identical set of genes.

- Centromeres divide into two.
- Spindle fibres pull sister chromatids to opposite poles of cell
- Each pole (future daughter cell) now has an identical set of genes

4. Telophase



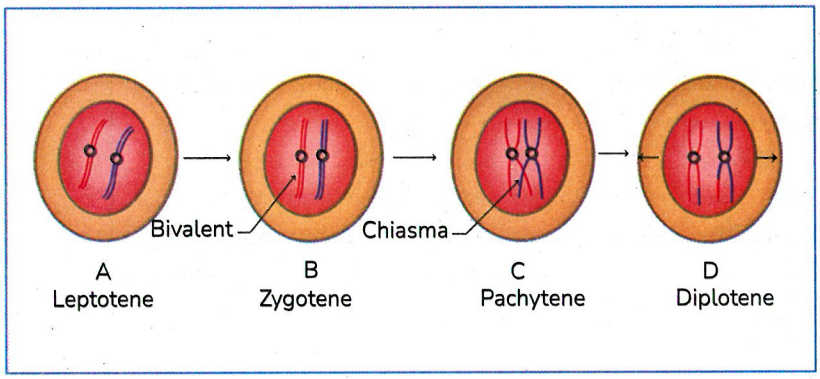
- Chromosomes gather at each pole of cell.
- Chromatin decondenses.
- New nuclear envelope appears at each pole.
- New nucleoli appear in each nucleus.
- At end of mitosis , two daughter cells present with same number of chromosone (2n) and amount of DNA(2N) as of parent cell (2n,2N).

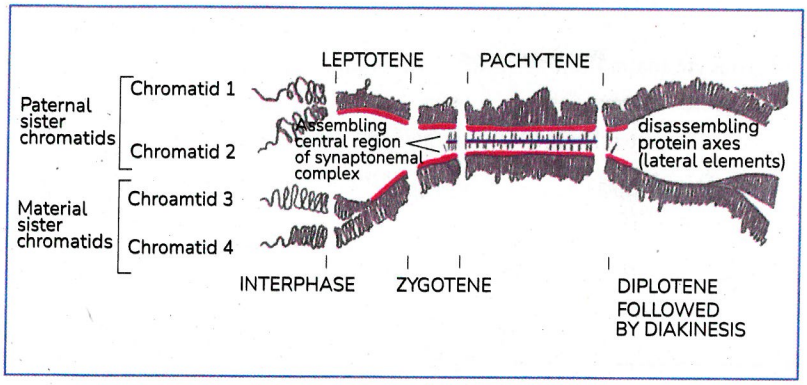


Mitosis	Meiosis
• Takes place in somatic cells completes in one sequence	• Takes place in germ cells completes in 2 sequences; • Meiosis I & meiosis II
• Crossing over of chromatids doesn't takes place	• Crossing over of chromatids takes place
• Daughter cells have same chromosomes as parent cells	• Daughter cells have half the no. of chromosomes as parent cells
• Daughter cells are identical to each other and to parent	• Daughter cells are not identical to each other & to parent cell
• Equational division	• Reductional division

- Meiosis is a 2-stage process, Meiosis 1 and Meiosis 2.
- Meiosis 1 has Prophase 1, Metaphase 1, Anaphase 1, Telophase 1
- Prophase 1 has subdivisions.
  - Leptotene- Here chromosome condensation occurs.
  - Zygotene- homologus chromosome appear as bivalent.
  - Pachytene- appear as tetrad.
  - Diplotene- mother father chromosomes sepetarion occurs.

In Interphase DNA duplication occur.





Gametogenesis: Male and Female

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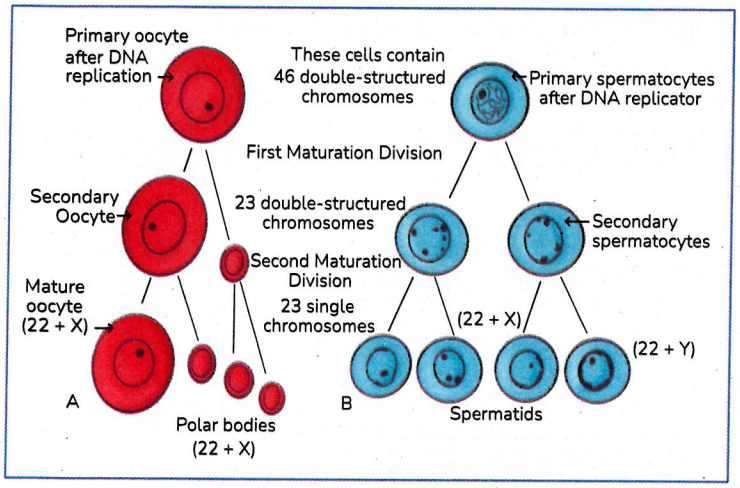
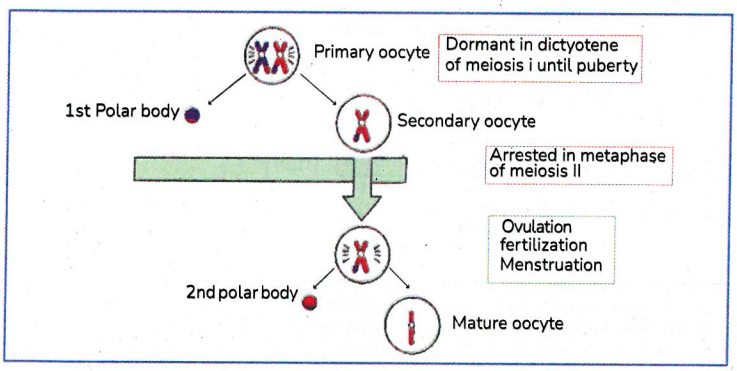




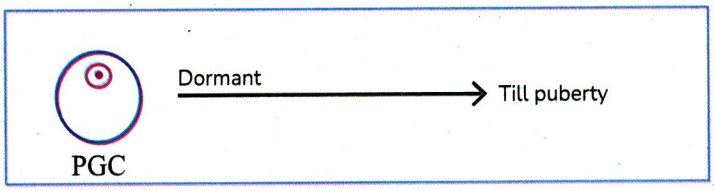
- In males primary spermatocytes rise to 4 spermatids each
- Primary oocytes get arrested in, when they enter prophase 1 of meiosis, until puberty
  - P - Primary oocyte
  - P1 - Prophase 1
  - P - Puberty
- After puberty females will have LH surge and the arrest will be broken as a result the primary oocyte forms secondary oocyte and 1st polar body
- Secondary oocyte will enter meiosis 2 but gets arrested in metaphase 2 of meiosis 2
  - Mnemonic: M2F (Secondary oocyte is arrested at Metaphase 2 until fertilization occurs)
  - If fertilization fails to happen then secondary oocyte gets degenerates, followed by mensturation
  - If fertilization happens, then meiosis 2 will resume, leading to formation of mature oocyte and 2nd polar body.

Ovary at Birth

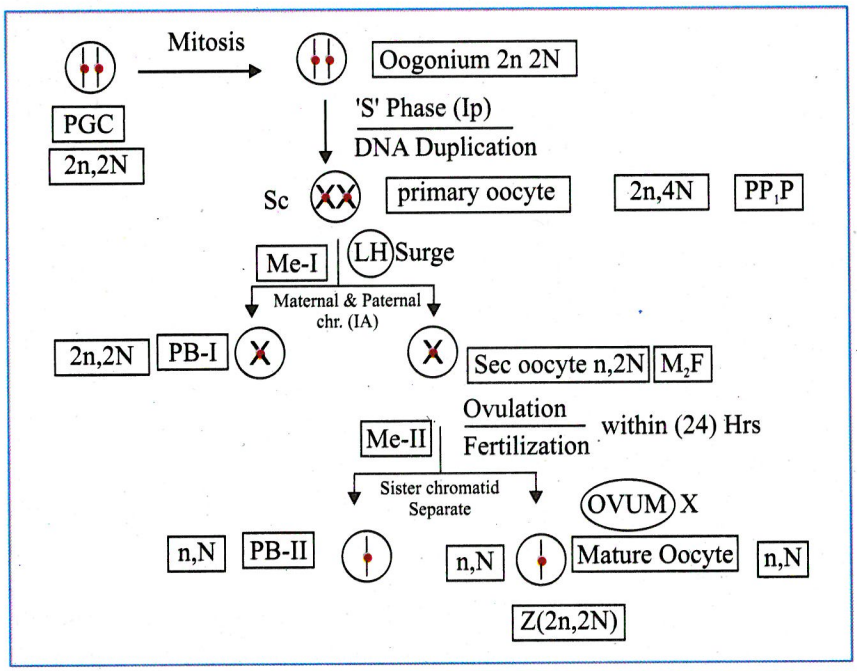
00:37:01

- This arrest is due to a factor k/a OMI (oocyte maturation inhibitor), which increases the level of cAMP thereby not allowing the cell to progress to the next stages.
- When puberty hit and LH surge occurs, it reduce level of cAMP and then cell can progress to next stages.

Testis at Birth



- PGC [Primordial germ cell] are present in Testis (at birth). It remains dormant till puberty.
- Spermatogenesis takes **74 days** for completion, oogenesis takes years for completion.

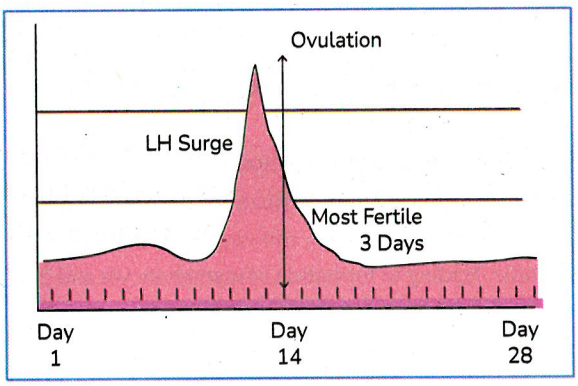


Important Information

- LH surge occurs 36 hrs before ovulation.
- 1st polar body gets released at LH peak.
- LH peak is achieved approximately 12 hrs before ovulation.

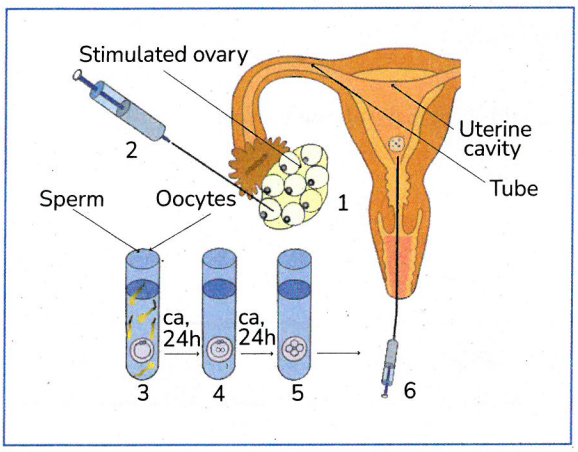
Menstruation

00:48:36



- Menstrual cycle is normally of 28 days.
- Day 14 will be day of ovulation.
- Sudden increase in LH concentration is the LH surge. It occur 36 hrs before Ovulation.
- LH peak occur 12 hrs before ovulation and 1st polar body gets released.
- 2nd Polar body gets released after fertilization.
- The most fertile 3 days of menstruation are around the days of ovulation.
- A sperm is capable of fertilization for 48hrs or 2 days, after ejaculation in female genital tract.

Bilateral Tubular Blockage



- In Bilateral tubular blockage invitro fertilization can be done.
- It is done by hyper stimulating the ovary using clomiphene citrate, leading to formation of multiple graafian follicle. Just before ovulation, these graafian follicles are aspirated and secondary oocytes are removed.
- These secondary oocytes are mixed with sperm in test tubes.
- One the embryo becomes a morula (8-cell stage), it is implanted into the uterus via transvaginal route.
- Also implanted at 32 cell stage. But it is difficult process.

Previous Year Question

Q. Which cell undergoing fertilization

A. Primary oocyte in prophase arrest
B. Primary oocyte in metaphase arrest
C. Secondary oocyte in prophase arrest
D. Secondary oocyte in metaphase arrest

Q. After entering first meiotic division, primary oocyte remains arrested in which stage?

A. Diplotene
B. Pachytene
C. Metaphase
D. Telophase

Q. Conceptus reaches uterine cavity at which stage

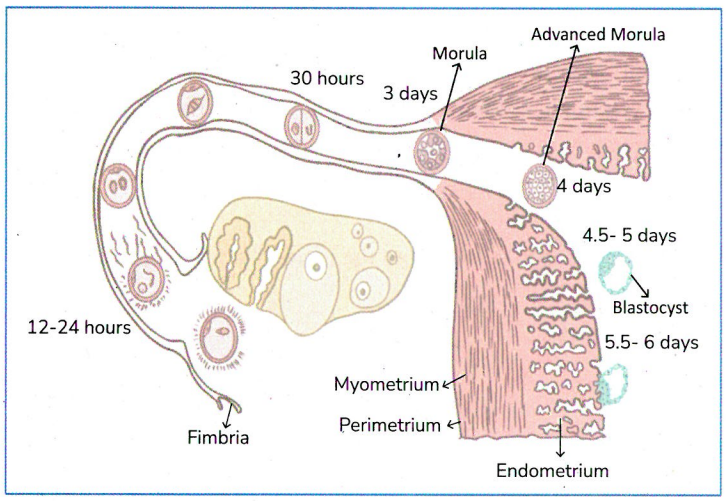
A. 1 cell
B. 2 Cell
C. 16 cell
D. 32 Cell

3 DEVELOPMENTAL PERIOD: WEEK 1 & 2

Introduction

- Ovary is undergoing ovulation
- The cell found is a secondary oocyte which is undergoing ovulation (surrounded by glycoprotein membrane)
  - This protein membrane is called zona pellucida (acellular structure)
  - This acellular structure attracts the sperm and helps in fertilization.
  - Fertilization occurs in the ampulla of the fallopian tubes.
- Roles of ZP:
  - Prevents abnormal implantation (because it should occur in the uterine cavity).
  - Doesn't allow Polyspermy
  - Attracts sperm
  - Glycoprotein
  - Implantation

Development During Week 1 | **PSM, Obstetrics & Gynaecology** | 00:01:17



Days	Explanation
Day 1	• Zygote (single cell structure) is formed after the fertilization • It is covered by zona pellucida
Day 2	• Two celled stage
Day 3	• Multicellular stage (morula-16 celled) • But morula can be 12/16/32/58 cell • Best answer: 16 cell stage
Day 4	• Advanced morula (16-64 cells) enters the uterine cavity • Usually considered as 32 cells

End of Day 4	• Then it will change into blastocyst formed (end of day 4) • Blastocyst has some blast cells with a cyst like cavity • It is still covered by zona pellucida, preventing implantation
Day 5	• Blastocyst hatched out of the zona pellucida
Day 6	• The blastocyst will be attached to the endometrium.

- Implantation is a week long process, starting from day 5 and completing on day 12
- At day 12 +/- 1, uterine placental circulation will also be established.

Q1. Choose the CORRECT sequence of the following embryonic events

A. Cortical reaction → Zona reaction → Acrosome reaction

B. Zona reaction → Acrosome reaction → Cortical reaction

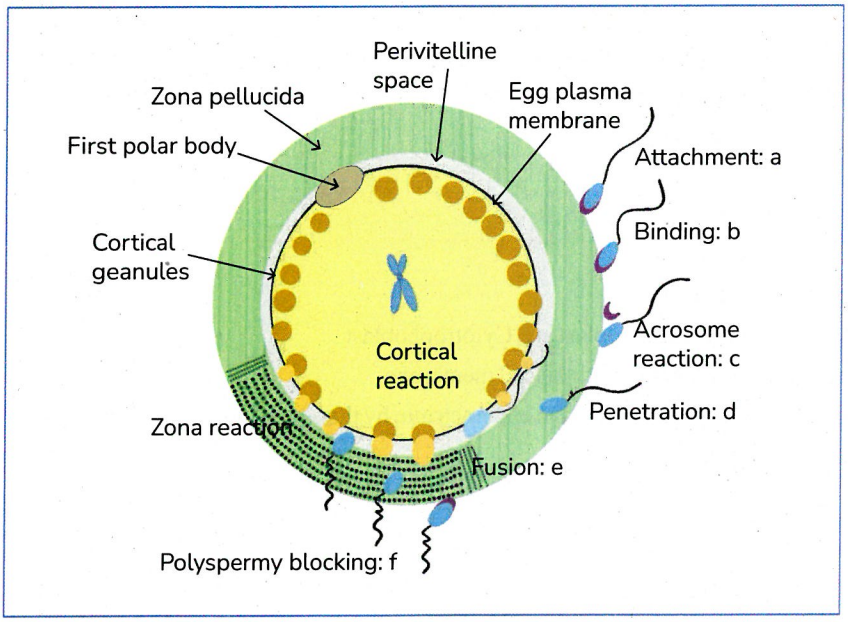
C. Acrosome reaction → Cortical reaction → Zona reaction

D. Acrosome reaction → Zona reaction → Cortical reaction

Answer C: Acrosome reaction → Cortical reaction → Zona reaction

Explanation:

- Secondary oocyte covered by zona pellucida
- After attaching and binding with zona pellucida, sperm loses the acrosomal cap, releasing enzymes Acrosome reaction
- Those enzymes will help the sperm penetrate zona pellucida and the sperm membrane will fuse with the oocyte membrane.
- This will result in the release of calcium membranes and further lead to release of cortical granules known as the Cortical reaction
- Once cortical granules are released, it changes the permeability of zona pellucida membrane called as Zona reaction
- Now, zona pellucida will not allow any more sperm to enter the oocyte, hence preventing Polyspermy



Implantation

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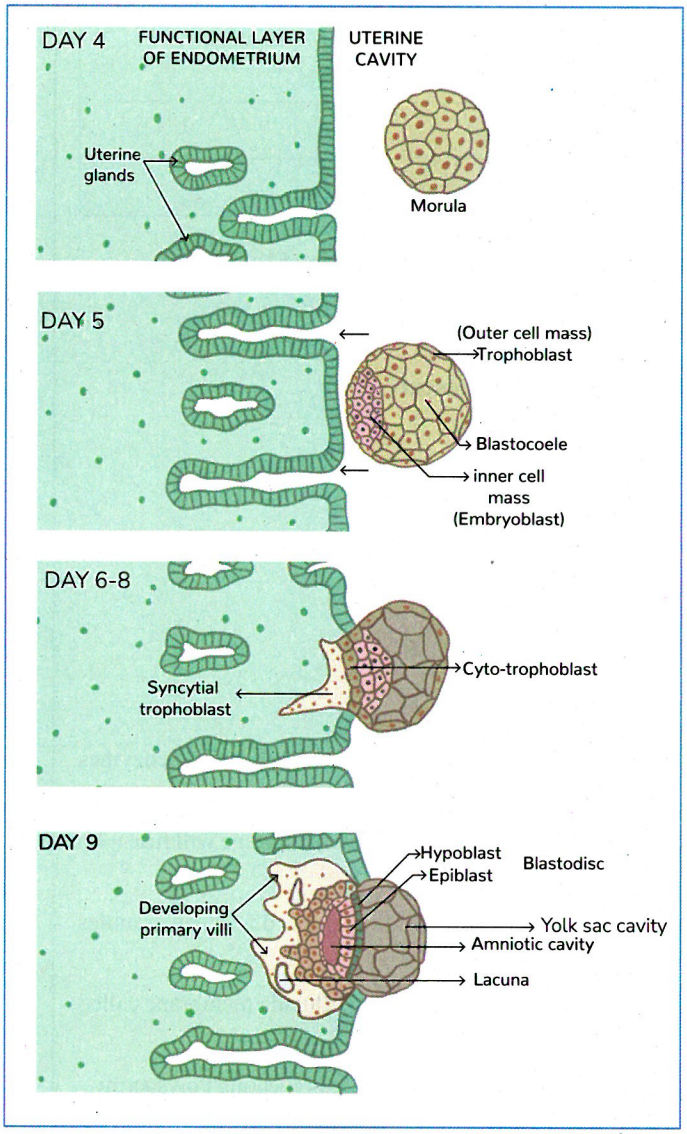

- On day 4, advanced morula (32 cell) changes at the end of the day into Blastocyst
- It starts when the blastocyst comes out from the zona pellucida
- Blastocyst has some blast cells with a cyst like cavity
- Blast cells of 2 types
  - Inner cell mass (Embryoblast)
  - Outer cell mass (Trophobast)
    → Trophoblast cell helps in placenta formation
- On Day 6 to 8, Trophoblast divides into Syncytiotrophoblast and Cytotrophoblast
  - Syncytiotrophoblast: Structure with cell organelles without cell membrane
    → This will help in penetration and attachment to maternal endometrium by the conceptus
  - Cytotrophoblast have intact cell boundaries
- Inner cell mass: Embryoblast
  - Dorsal cell (Epiblast)
  - Ventral cell (Hypoblast)