3b. Apara (Placenta) and Garbha Nabhinadi (umbilical cord), Garbhodaka (amniotic fluid)

(b) Aparā (Placenta) & Garbha-Nābhināḍī (Umbilical Cord), Garbhodaka (Amniotic Fluid) — Formation, Functions & Abnormalities

Terminology crosswalk: **Aparā / Jarāyu** ≈ placenta–membranes complex; **Garbha-nābhināḍī** ≈ umbilical cord; **Garbhodaka** ≈ amniotic fluid.

Learning Objectives

- Describe formation (timeline, sources, structural milestones) of **placenta**, **umbilical cord**, and **amniotic fluid**.
- Recall key **functions** and **hormones** of placenta; transport mechanisms.
- Classify and manage **abnormalities** (previa, abruption, accreta spectrum, cord anomalies, poly-/oligohydramnios).
- Integrate relevant **Ayurvedic terminology** and conceptual mapping without over-claiming.

गर्भ-नाभि-नाडी (Umbilical cord)

गर्भस्य नाभौ मातुश् च हृदि नाडी निबध्यते ।
यया स पुष्टिम् आप्नोति केदार इव कुल्यया ॥ ५६ ॥

(अष्टाङ्गहृदय, शारीरस्थान 1.56)

सप्त सिराशतानि भवन्ति ... तासां नाभिर् मूलं, ततश् च प्रसरन्त्य् ऊर्ध्वम् अधस् तिर्यक् च ॥

(सुश्रुतसंहिता, शारीरस्थान 7.3 — नाभि को शरीर-शिराओं का मूल बताने वाला संदर्भ)

अपरा/जरायु (Placenta)

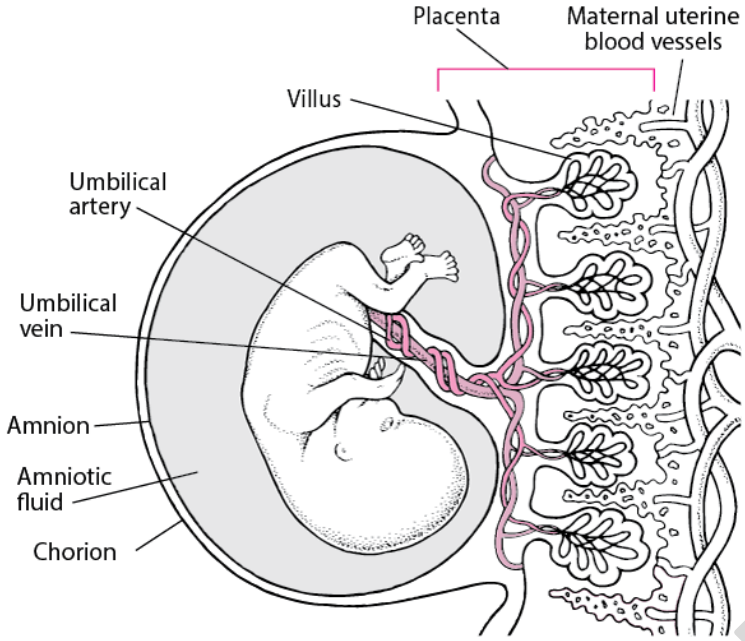
धूपयेद् गर्भसङ्गे तु योनिं कृष्णाहि-कञ्चुकैः ।
हिरण्यपुष्पी-मूलं च पाणि-पादेन धारयेत् ॥ ८३ ॥
सुवर्चलां विशल्यां वा जराय्व्-अपतनेऽपि च ।
कार्यम् एतत् तथोत्क्षिप्य बाह्तोर् एनां विकम्पयेत् ॥ ८४ ॥

(अष्टाङ्गहृदय, शारीरस्थान 1.83–84 — प्रसवकालीन उपक्रम ; “जराय्व्-अपतन” = प्लासेण्टा का न उतरना/रिटेन्ड प्लेसेंटा)

गर्भोदक (Amniotic fluid)

यदा गर्भोदकं योनौ सशूलं संप्रवर्तते ।
कालेन चोदितो गर्भो विमुच्य हृदयोदरम् ॥

(काश्यपसंहिता, शारीर–अध्याय—प्रसव-प्रक्रिया के लक्षण)



Placenta and Embryo At About 11 4/7 Weeks Gestation
The embryo measures 4.2 cm.

1) Aparā / Jarāyu (Placenta)

1.1 Formation & Timeline (modern–classical bridge)

- **Week 1–2 (implantation):** Trophoblast differentiates into **syncytiotrophoblast** (invasive, lacunae) and **cytotrophoblast**; maternal blood enters lacunar network.
- **Week 3: Primary → secondary → tertiary chorionic villi** form (mesoderm core with fetal vessels).
- **Decidua basalis** (maternal) + **chorion frondosum** (fetal villous chorion) develop into the **definitive placenta**; **chorion laeve** (smooth chorion) persists away from implantation site.
- **Placenta functional by ~10–12 weeks**; grows till late 2nd trimester; typical **diameter 15–20 cm**, **thickness 2–3 cm**, **weight ~500–600 g** at term (≈ one-sixth of fetal weight).

Ayurvedic correlation: The **Aparā/Jarāyu** encloses and nourishes the **Garbha**, mapping to the *Rasaja* stream of **Garbhakāra Bhāva** (nutritive endowment) and the protective “śayyā” (bed) of the fetus.

1.2 Placental Microanatomy & Transport

- **Fetal side:** chorionic plate → stem villi → terminal villi (site of exchange).
- **Maternal side:** basal plate with **decidual spiral arteries** remodeled into low-resistance channels.
- **Membrane (“barrier”) layers (term):** syncytiotrophoblast → thin cytotrophoblast remnants → villous stroma → **fetal capillary endothelium**.
- **Transport:** simple diffusion (O_2, CO_2), facilitated diffusion (glucose via GLUT-1), active transport (amino acids, ions), endocytosis (IgG), solvent drag.

1.3 Functions

- **Respiratory exchange:** O_2 to fetus, CO_2 removal.
- **Nutrition:** glucose, amino acids, fatty acids, micronutrients.
- **Excretion:** urea, creatinine, bilirubin (indirect).
- **Endocrine:**
  - **hCG** (maintains corpus luteum early),

- **Progesterone** (from ~10 wks), **Estrogens** (estriol),
- **hPL** (insulin antagonism; prepares for lactation),
- **CRH, leptin, GH-variant** (metabolic adaptations).

- **Immune:** selective transfer of **maternal IgG**; partial immunoprotection.
- **Barrier/protection:** detoxification enzymes; yet many drugs cross → always write "placenta is a **selective**, not absolute barrier**."

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2) Placental Abnormalities (with applied management)

2.1 Site & Invasion

- **Placenta previa / low-lying placenta**
  - *Definition:* placental tissue overlies or approaches the **internal os** (currently described as **previa** if covering; **low-lying** if placental edge within ~2 cm of os on late 3rd-trimester scan).
  - *Risk factors:* prior cesarean, multiparity, large placenta, smoking.
  - *Presentation:* **painless, recurrent, bright-red bleeding** in late pregnancy.
  - *Management:* pelvic rest; avoid digital exams; plan delivery timing (elective CS for major previa), anti-D if Rh-neg, transfusion readiness.
- **Placenta accreta spectrum (PAS): accreta/increta/percreta**
  - *Pathology:* abnormal adherence/invasion into myometrium/serosa/adjacent organs due to **defective decidua basalis**.
  - *Risks:* previa **+** prior CS (risk rises with number of scars), curettage, Asherman's.
  - *Diagnosis:* targeted ultrasound ± MRI; look for **loss of clear zone**, placental lacunae, bridging vessels.
  - *Management:* **multidisciplinary delivery planning** at tertiary centre; common plan = **cesarean hysterectomy with placenta left in situ** if life-saving; blood products ready; interventional radiology when available.

2.2 Separation & Attachment

- **Abruptio placentae (placental abruption)**
  - *Definition:* premature separation of normally situated placenta after 20 weeks.
  - *Risk factors:* hypertension/preeclampsia, trauma, smoking/cocaine, multiparity.
  - *Presentation:* **painful bleeding**, uterine tenderness/hypertonus, fetal distress.
  - *Complications:* DIC, shock, fetal demise.
  - *Management:* resuscitation; expedite delivery if maternal/fetal compromise (often **urgent delivery**), correct coagulopathy.
- **Morphological variants (often viva points)**
  - **Bilobed / succenturiate lobe:** accessory lobe(s); risk **retained placenta**, **vasa previa** if velamentous vessels traverse membranes.
  - **Circumvallate / extrachorial:** rolled/raised edges; association with bleeding, IUGR, preterm.
  - **Membranacea (placenta membranacea):** placental tissue over large membrane area—PPH risk.
  - **Velamentous / marginal insertion (battledore):** umbilical vessels in membranes or at margin; **vasa previa** risk with velamentous.

Vasa previa = fetal vessels (unsupported by Wharton's jelly) over internal os → **acute fetal exsanguination if membranes rupture**; plan **elective CS** once diagnosed; avoid membrane rupture in labour.

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3) Garbha-Nābhināḍī (Umbilical Cord)

3.1 Development & Structure

- **Origin:** from connecting stalk; by wk 5 the **body stalk + vitelline duct** become incorporated into the cord.
- **Contents: one umbilical vein (oxygenated blood to fetus)**, **two umbilical arteries (deoxygenated blood to placenta)**, all embedded in **Wharton's jelly** (mucoid, protective), covered by amnion.
- **Length:** average **50–60 cm**; **short <35 cm**; **long >70 cm**.
- **Coiling:** normally **left-handed** coils; **umbilical coiling index (UCI)** ~0.2 coils/cm (for viva awareness).

Ayurvedic correlation: Nābhināḍī is the life-link between **Garbha** and mother for **poshana (nutrition)** and **prāṇa-pravṛtti (vital flow)**—a conceptual mirror of the vascular exchange.

3.2 Cord Abnormalities (high-yield list)

- **Single umbilical artery (SUA):** may associate with renal/cardiac anomalies; needs **targeted anomaly scan** and growth surveillance.
- **Velamentous insertion:** vessels in membranes—risk **vasa previa**, fetal bleeding.
- **Marginal insertion (battledore):** edge insertion; usually benign but monitor growth.
- **True knot(s):** formed by fetal movements; may tighten in labour → variable decelerations; intrapartum vigilance.
- **False knot(s):** redundant vessel looping; benign.
- **Nuchal cord:** around neck; common; monitor intrapartum tracing.
- **Short cord:** linked to **fetal constraint**, **abruption**, **intrapartum fetal distress**; delivery difficulty.
- **Long cord:** ↑ risk **entanglement**, true knots, **cord prolapse** (especially with polyhydramnios or malpresentation).
- **Cord prolapse:** cord below presenting part after membrane rupture—**obstetric emergency**: elevate presenting part, knee-chest, **immediate delivery (usually CS)**, avoid handling cord (spasm).

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4) Garbhodaka (Amniotic Fluid)

4.1 Formation & Regulation (gestation-wise)

- **Early 1st trimester:** transudation from **maternal plasma** across membranes and fetal skin; small volume.
- **By 2nd trimester:** major contributions from **fetal urine** (primary source) and **fetal lung fluid**; swallowed by fetus → fluid homeostasis.
- **Regulation:** balance of **fetal urination**, **fetal swallowing**, **intramembranous flow** (across amnion to fetal circulation), and **transmembranous flow** (to maternal).

Normal volume (remember these numbers):

- 12 w: ~50 mL; 20 w: ~350 mL; 28–32 w: **peak ~800–1000 mL**; term: ~600–800 mL.

Functions (answer as bullets):

- Shock absorption & **mechanical protection**.
- **Permits growth & movements** → musculoskeletal development.
- **Thermal stability**, lubrication (prevents adhesions).
- **Supports lung development** (fetal breathing, surfactant dynamics).
- **Barrier** against infection (with membranes intact).

4.2 Disorders of Quantity

Polyhydramnios

- **Definition: AFI ≥ 24–25 cm** or **MVP ≥ 8 cm**.

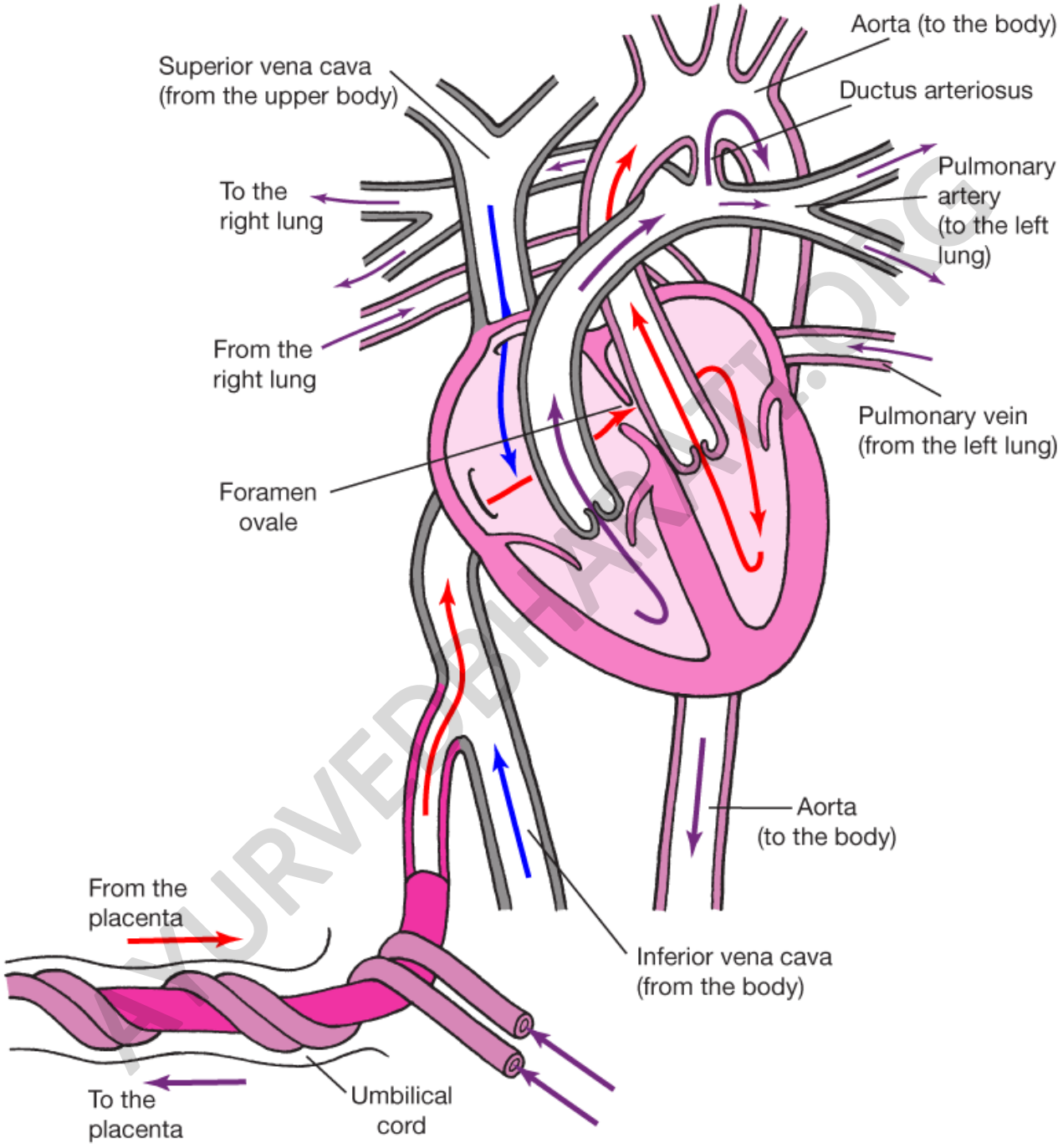
- **Causes:**
  - **Fetal swallowing impairment** (anencephaly, **oesophageal/duodenal atresia**, neuromuscular disorders).
  - **High urine output** (maternal **diabetes**, fetal anaemia, twin-to-twin transfusion syndrome in MCDA twins).
  - **Idiopathic** (~60%).
- **Complications:** preterm labour, malpresentation, **cord prolapse**, maternal dyspnoea, PPH.
- **Management:** search for **anomalies/diabetes**; serial surveillance; **indomethacin** (restricted, specialist use, mid-trimester only) or **amnioreduction** in symptomatic severe cases; plan delivery and PPH prophylaxis.

Oligohydramnios

- **Definition: AFI ≤ 5 cm** or **MVP < 2 cm**.
- **Causes: Pre-labour ROM**, **uteroplacental insufficiency/IUGR**, fetal **renal agenesis/obstructive uropathy**, post-term.
- **Complications:** pulmonary hypoplasia (early severe), skeletal contractures, cord compression → decelerations, meconium, labour dystocia.
- **Management:** ascertain cause; hydration strategies (limited benefit), close **Doppler/CTG** surveillance, **timely delivery** when risk outweighs prolongation; **amnioinfusion** in labour for variable decelerations (selected cases).

4.3 Disorders of Quality

- **Meconium-stained** liquor (term/post-term distress), **cholestasis**-related changes; **infective** (chorioamnionitis → foul odour, maternal fever); **bloody liquor** (placental bleed/abruption). Management follows cause and fetal status.



Normal Circulation in a Fetus

In the fetus, blood entering the right side of the heart has already been oxygenated via the placenta. Because the lungs are not ventilated, only a small amount of blood needs to go through the pulmonary artery. Most of the blood from the right side of the heart bypasses the lungs through the

- Foramen ovale

- Ductus arteriosus

Normally, these 2 structures close shortly after birth.

Red arrows represent the most highly oxygenated fetal blood (oxygen saturation ≥ 65%). Blue arrows represent the least highly oxygenated blood (oxygen saturation ≤ 45%). Purple arrows represent intermediate oxygen saturation (oxygen saturation 50–60%). Note that oxygen saturation throughout is significantly lower than in postnatal life.

5) Integrative "At-a-glance" Tables

5.1 Placenta: formation → functions → abnormalities

Aspect	Key points (write concisely)
Formation	Implantation → trophoblast split → villi (primary→tertiary); **decidua basalis + chorion frondosum** = placenta; functional by **10–12 w**
Functions	Exchange (O_2/CO_2), nutrition, waste excretion, **endocrine** (hCG, hPL, progesterone, estrogens), immune (IgG)
Abnormal site/invasion	**Previa/low-lying**, **PAS** (accreta/increta/percreta)
Separation	**Abruption**—painful bleed, fetal/maternal risk
Morphology	Bilobed, succenturiate, circumvallate, membranacea
Insertion	**Velamentous**, marginal (battledore) → **vasa previa** risk

5.2 Umbilical cord: essentials

Feature	Points
Structure	2 arteries + 1 vein in **Wharton's jelly**, amniotic covering
Length	Avg 50–60 cm; **short** <35; **long** >70
Variants	**SUA**, velamentous/marginal insertion, knots (true/false), **nuchal**, prolapse
Emergency	**Cord prolapse** → immediate measures, usually CS

5.3 Amniotic fluid: sources, functions, quantity disorders

Item	Polyhydramnios	Oligohydramnios
Definition	AFI ≥ 24–25 cm / MVP ≥ 8 cm	AFI ≤ 5 cm / MVP < 2 cm
Major causes	Swallowing block, DM, fetal anaemia, TTTS	ROM, placental insufficiency, renal agenesis
Complications	Preterm labour, malpresentation, **cord prolapse**, PPH	Pulmonary hypoplasia (early), cord compression, IUGR
Management	Etiology work-up, surveillance, amnioreduction (selected)	Etiology work-up, surveillance, timely delivery; amnioinfusion in labour (selected)

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6) Viva & OSCE Pearls

- **"Placenta is a selective—not absolute—barrier."** Drugs, viruses (e.g., some TORCH) cross.
- **Ureter under the uterine artery** (surgical proximity) matters in **placental surgery** and PAS hysterectomy planning.
- **SUA** requires **renal and cardiac** evaluation.
- **Vasa previa** = **painless bleeding + fetal distress** after ROM; think **fetal** blood loss, not maternal.
- **AFI vs MVP:** In **twin gestations**, use **MVP** per sac rather than AFI.

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7) Applied Ayurveda Pointers (exam-oriented, cautious)

- Use **Aparā/Jarāyu** for placenta-membranes complex (protective bed; nutritive interface).
- **Garbha-nābhināḍī** conveys **rasa-poshana** to the fetus—conceptually aligns with **rasavaha/artavavaha-like** supply to **kṣetra**.
- **Garbhodaka** signifies the protective, cushioning aqueous environment aiding **śarīra-vṛddhi** (growth) and **indriya-paripāka** (sensory maturation).
- Do **not** equate terms 1:1 mechanically; write **"conceptually corresponds to"** to avoid over-claiming.

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8) High-Yield Review (20 lines)

1. **Placenta** forms from **chorion frondosum + decidua basalis**; villi mature by end of 1st trimester.
2. **Hormones:** hCG (early), **progesterone/estrogens** (maintain pregnancy), **hPL** (maternal insulin resistance & lactation prep).
3. **Transport:** diffusion (gases), facilitated (glucose), active (AAs), endocytosis (IgG).
4. **Previa** → **painless** late bleeding; **abruption** → **painful**, tender uterus.
5. **PAS** risk jumps with **previa + prior CS**.
6. Morphology to list: **bilobed, succenturiate, circumvallate, membranacea**.
7. **Umbilical cord**: 2A+1V; **Wharton's jelly**; avg 55 cm.
8. **SUA** → scan for anomalies; **velamentous** → look for **vasa previa**.
9. **True knot** may cause intrapartum decelerations; **cord prolapse = emergency**.
10. **Garbhodaka** early from transudate; later from **fetal urine + lung fluid**.
11. **AFI normal peak ~1 L at 28–32 w**; term ~600–800 mL.
12. **Polyhydramnios**—think **DM, swallowing block**; **oligo**—think **ROM, placental insufficiency, renal agenesis**.
13. **Oligo** early and severe → **pulmonary hypoplasia** risk.
14. **Amnioreduction** only for severe symptomatic poly; **amnioinfusion** for intrapartum variables (selected).
15. **IgG** crosses placenta (passive immunity).
16. **Placental insufficiency** → IUGR, oligohydramnios; requires Doppler surveillance.
17. **Circumvallate** placenta associates with bleeding and IUGR.
18. **Bilobed/succenturiate** → retained placenta risk; examine membranes post-delivery.
19. **Postpartum** haemorrhage risk ↑ with **placenta membranacea/PAS**.
20. In answers, **name–define–give cause–state complication–write management**.

Assessment

A. Long Answer Questions (LAQ)

1. Describe the **formation and functions of the placenta**. Add a detailed note on **placenta previa** and **placenta accreta spectrum** with applied obstetric management.
2. Explain **Garbha-nābhināḍī** development and enumerate **cord abnormalities** with fetomaternal risks and management.
3. Discuss the **formation, functions, and regulation of Garbhodaka (amniotic fluid)**. Add causes, complications, and management of **polyhydramnios** and **oligohydramnios**.

B. Short Answer Questions (SAQ)

1. List **placental hormones** and write one function for each.
2. Define **vasa previa** and state its obstetric significance.
3. Write short notes on **succenturiate lobe** and **circumvallate placenta**.
4. Define **SUA** and its clinical implications.
5. Compare **AFI** and **MVP** methods for assessing amniotic fluid.

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C. MCQs (single best answer)

1. The **fetal vessel(s)** normally present in the umbilical cord are:
   A) 1 artery + 1 vein
   B) **2 arteries + 1 vein**
   C) 2 arteries + 2 veins
   D) 1 artery only
   Ans: B
2. **Painless** third-trimester bleeding suggests:
   A) Abruption
   B) Uterine rupture
   C) **Placenta previa**
   D) Chorioamnionitis
   Ans: C
3. The hormone causing maternal insulin resistance is:
   A) hCG
   B) **hPL**
   C) Progesterone
   D) Relaxin
   Ans: B
4. **Polyhydramnios** is commonly associated with:
   A) Fetal renal agenesis
   B) **Maternal diabetes**
   C) Oliguria
   D) PROM
   Ans: B
5. **Velamentous insertion** predisposes to:
   A) PAS
   B) Abruption
   C) **Vasa previa**
   D) Cord hematoma
   Ans: C

References

Classical

- **Suśruta Saṃhitā**, Śārīrasthāna 2–3: descriptions of *garbha*, *jarāyu* (placental–membrane enclosure), and fetal development stages; conceptual basis for **Aparā** and **Garbha-nābhināḍī**.
- **Caraka Saṃhitā**, Śārīrasthāna 3–4: **Garbhakāra Bhāva** (Rasaja, Sattvaja), nutritive streams supporting fetal growth—context for placental–amniotic milieu.
- **Kāśyapa Saṃhitā**, Khila-sthāna & Garbhiṇī-paricaryā sections: protective measures for **garbha-rakṣā** and the nurturing environment (conceptual analogue to **garbhodaka** support).

Modern & Standard Texts

- **Williams Obstetrics** (latest ed.): placental development, uteroplacental circulation, PAS, amniotic fluid physiology; management guidelines.
- **Dutta's Textbook of Obstetrics**: Indian practice-oriented discussions of placenta previa, abruption, AFI/MVP assessment.
- **Gabbe's Obstetrics** / **Shaw's Textbook of Gynaecology**: cord anomalies, vasa previa, fetal surveillance.
- **WHO** / **RCOG** / **ACOG** bulletins (summaries in your departmental notes) for PAS pathways and fluid disorders.