Lectures of Human Embryology

By

DR. ABDEL-MONEM AWAD HEGAZY

M.B. with honor 1983,
Dipl."Gynecology and Obstetrics "1989,
Master "Anatomy and Embryology" 1994,
M.D. "Anatomy and Embryology" 1999

Associate Professor of Anatomy and Embryology

Faculty of Medicine, Zagazig University (Egypt) &
College of Medicine, Majmaah University (Saudi Arabia)
Fetal Membranes

These membranes include:
1. Chorion,
2. Amnion,
3. Yolk sac,
4. Allantois.

Development of Placenta
(Chorio-decidual membrane)

Placenta represents the site of communication between the fetus and mother.
It develops from 2 components; fetal (chorion) and maternal (decidua) portions.

I. Development of Decidua
- After fertilization, the endometrium is thickened under the effect of progesterone secreted by corpus luteum.
- The thick, vascular and glandular endometrium is then called decidua, containing leucocytes and decidual cells.
- With further growth of the embryo, the decidua is divided into 3 portions, as follows:
  1. Decidua capsularis: is the part that forms a capsule separating the embryo from the cavity of uterus.
2. **Decidua basalis**: is the part that lies at base of the embryo at the site of implantation, separating it from the muscle wall of uterus.

3. **Decidua parietalis**: is the part that lines the rest of uterine cavity.

- **Fate of decidua**: As a result of further growth of the embryo, the cavity of the uterus is obliterated. This results in the following changes:
  1. Decidua capsularis disappears (as it becomes stretched).
  2. Decidua parietalis disappears (as it becomes compressed).
  3. Decidua basalis persists and forms the maternal part of placenta.

II. **Development of Chorion**
The chorion is the envelope of trophoblast and its associated extra-embryonic mesoderm (*See development of chorionic vesicle*).
1. Development of trabeculae:
All around the chorionic vesicle, trabeculae "finger-like processes" arise from the syncytiotrophoblast, eroding the endometrium. This results in formation of irregular lacunae inbetween the trabeculae, containing maternal blood, due to erosion of the endometrial vessels by the trabeculae.

2. Development of primary chorionic villi:
They are developed by growth and extension of cytotrophoblast cells in the center of trabeculae. Then the cells extend deep in the decidua (of endometrium) to form continuous shell, preventing further erosion to the endometrium.

3. Development of secondary chorionic villi:
They are developed by growth and extension of extra-embryonic mesoderm in the center of primary villi.

4. Development of tertiary chorionic villi:
They are developed by growth and extension of fetal blood vessels in the center of secondary villi. The terminal ends of fetal blood vessels break into blood capillaries that connect the arteries with veins.

5. Development of decidual septa:
A number of incomplete decidual septa appear and projects into the intervillous spaces. These septa incompletely divide the placenta into 15-20 cotyledons.

6. Fate of chorionic villi:
All villi degenerate except that situated at the base of the developing chorionic vesicle. So, villi related to decidua basalis persist and enlarge to form the chorion frondosum "fetal part of placenta".

3. Formation of Placenta
- The chorion frondosum of the fetus joins the decidua basalis of the mother to form the placenta (or choriodecidual membrane).

**Placental Barrier**
- It is barrier (membrane) separating the fetal blood from the maternal blood.
- Its thickness and structure differs according to stage of development as follows:
  1. In the early stages of pregnancy (up to the 4 month), it is thick (of about 25 µ), formed of 4 layers, as follows:
     i. Syncytiotrophoblast,
     ii. Cytotrophoblast,
     iii. Extra-embryonic mesoderm (connective tissue),
     iv. Endothelium of fetal blood vessels.
  2. After the 4th month and for compensation of the increased fetal demands, it becomes gradually thinner to reach about 1-2 µ. Then it is formed only of 2 layers, as follows:
     i. Layer of syncytiotrophoblast,
     ii. Endothelium of fetal blood vessels.
     (i.e. The middle layers disappear)
Placental Circulation

- Oxygenated blood reaches the inter-villous spaces from the terminal branches of the endometrial arteries. In the spaces, gas exchange occurs between the maternal and fetal blood through the placental barrier, where O₂ passes from the maternal to the fetal blood.
- Oxygenated blood drained by fine capillaries inside the chorionic villi passes through the umbilical vein to nourish the fetus.
- Deoxygenated blood returns back from the fetus through the 2 umbilical arteries to reach the capillaries inside the chorionic villi. Gaseous exchange occurs, where CO₂ passes from the fetal side towards the maternal blood inside the intervillous spaces.
- Deoxygenated blood leaves the inter-villous spaces as the pressure decreases during pulses to reach the endometrial veins.

N.B.: Normally no mixing occurs between fetal and maternal blood. The blood in the intervillous space is exchanged 3-4 times per minute.

Blood is pumped into the intervillous spaces under pressure of about 70-80 mmHg. Blood pressure in the spaces is 10 mmHg and increases to about 20-30 mmHg during uterine contractions. In veins, blood pressure does not exceeds 8 mmHg.

Functions of Placenta (TPS):

I. Transfer

II. Protection

III. Secretion

I. Transfer (systems' functions):

1. Gases: Exchange of gases (lung function) occurs through simple diffusion.
   - O₂ passes from blood of fetus to that of mother.
   - CO₂ passes from blood of mother to that of fetus.

2. Nutrients (GIT function):
It allows passage of nutritive substances from the blood of fetus to that of mother.

This may be achieved by:

- simple diffusion, e.g. water, electrolytes and urea.
- facilitated diffusion, e.g. glucose.
- active transport, e.g. amino acids.

3. Wastes (Kidney function):
Waste products are excreted from the blood of fetus to that of mother.

II. Protection: (Mechanical & Immunological)
1. Mechanical protection:

- It anchors the fetus (acting as the root for the tree).

2. Immunological protection (function of placental barrier):

- It prevents passage of most maternal hormones to the fetus.
- It prevents passage of most micro-organisms.
- At the same time, it allows passage of antibodies from the mother to the fetus.

However, the placental barrier is incomplete one, as follows:

- Some synthetic hormones can cross the placental barrier, e.g. progestin crosses placenta causing masculinization.
- Some micro-organisms e.g. rubella, measles and poliomyelitis virus can pass it.
- Most drugs can pass it and many cause serious effects e.g. thalidomide.
- Also, addiction of mother with heroin or cocaine can result in habituation of her fetus.

III. Secretion (Endocrine function)
- The placenta is considered as a temporary endocrine gland (in the period of pregnancy).
- By the end of the 4th month, it takes the function of ovary, secreting the following hormones:

  - **Progesterone** to maintain pregnancy.
  - **Estrogen** to stimulate growth of uterus and mammary glands.

- Also it secretes anther 2 hormones:
- **Human chorionic gonadotropin (hCG):** is secreted in the first 2 months of pregnancy, to maintain the corpus luteum. This hormone is secreted early in pregnancy and excreted in urine. Its presence in urine is used for diagnosis of pregnancy.
- **Somatomammotropin (placental lactogen):** stimulates the mammary development for milk production.

### Gross Anatomy (Naked-Eye Appearance) of Full-Term Placenta

1. **Shape:** Discoid (flattened cake).
2. **Diameter:** 15-25 cm.
3. **Thickness:** about 30 mm at center, diminished gradually towards the periphery.
4. **Weight:** about 500-600 gm.
5. **Surfaces:** 2 surfaces; fetal and maternal.
   Differences between the fetal and maternal surfaces of placenta:

<table>
<thead>
<tr>
<th></th>
<th>Fetal surface</th>
<th>Maternal surface</th>
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<tbody>
<tr>
<td>1</td>
<td>View</td>
<td></td>
</tr>
<tr>
<td></td>
<td>- Smooth</td>
<td>- Rough</td>
</tr>
<tr>
<td></td>
<td>- Umbilical cord is attached near its center.</td>
<td>- No umbilical cord attachment but instead, the surface shows depressions and is divided into 15-20 slightly bulging areas, called cotyledons</td>
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<tr>
<td>2</td>
<td>Formed of</td>
<td></td>
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<tr>
<td></td>
<td>- Chorion frondosum, covered by amnion.</td>
<td>- Decidua basalis.</td>
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### Congenital Variations (or Anomalies) of Placenta \( (P+PLACE) \)

1. **Placenta previa:** In this case, the placenta is attached to the lower uterine segment.
   There are 3 types:
   i. **Placenta previa centralis:** It covers the internal cervical os.
      It mostly cause ante-partum hemorrhage, so the case needs cesarean section for labor.
   ii. **Placenta previa marginalis:** Its margin reaches the the internal cervical os.
   iii. **Placenta previa lateralis:** It is low in attachment, but not reach the internal cervical os.
2. **Partite placenta**:
   i. **Bi-partite** placenta: Placenta is formed of 2 parts.
   ii. **Tri-partite** placenta: Placenta is formed of 3 parts.

3. **Large thin placenta** "membranous placenta" The placenta is thin and lines the greater part of uterine cavity.

4. **Accessory lobes** "succenturiate placenta": The placenta has one or more accessory lobes.

5. **Circumvallate placenta**: The placenta has thickened white ring around the edges.

6. **Errors in insertion of the umbilical cord**:
   i. **Velamentous insertion**: The cord is attached to the membranes, some distance from the margin of placenta.
   ii. **Battledore insertion**: The cord is attached at the periphery (margin) of placenta.