Placenta and Fetal Membranes

**Amnion** - Epiblast / Extraembryonic Mesoderm

Yolk Sac - Hypoblast / Extraembryonic Mesoderm

Allantois - Embryonic Hindgut

Chorion - Trophoblasts / Extraembryonic Mesoderm

Placenta - Chorion / Maternal Decidua

Amnion

Amnionic membrane is two cell layers

1) epiblast derived extraembryonic ectodermal layer

2) thin non-vascular extraembryonic mesoderm

As the amnion enlarges it encompasses the embryo on the ventral side, merging around the umbilical cord.

Amnion forms the epithelial layer of the umbilical cord

With embryo growth the amnion obliterates the chorionic cavity

Amnionic sac is fluid filled called amnionic fluid: the embryo is bathed in the fluid
Amnion

Amniotic Fluid

Up to week 20 - fluid is similar to fetal serum (keratinization)

After 20 weeks – Contribution from urine, maternal serum filtered thru endothelium of nearby vessels, filtration from fetal vessels in cord

Near birth - can contain fetal feces called meconium

Near birth – amniotic fluid (500-1000 ml) exchanges every 3 hrs

1) across the amnion – exchange with maternal fluids.

2) fetal swallowing (20 ml/hour) – to gut – adsorption by fetus – out the umbilical cord to placenta.

Hydramnios – Excess fluid (>2000 ml), esophageal atresia

Oligohydramnios – Insufficient fluid (<500 ml), renal agenesis

Amnion Function

Mechanical protection: hydrostatic pressure

Allows free movement - which aids in neuromuscular development

Antibacterial

Allow for fetal growth

Protection from adhesions

Amnion Band Syndrome (ABS)

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Yolk Sac

- Hypoblast - the primary yolk sac or Heuser's membrane.
- Day 12 - Second wave of cell migration - forms definitive yolk sac
- Composed of extreembryonic endoderm
- Early nutrition (2-3 weeks) for the embryo - later shrinking - nonfunctional – Meckels diverticulum (outpocketing of small intestine)
- Connects to midgut via the yolk sac stalk
- Derivatives:
  - Early blood cells forms from blood islands
  - Primordial germ cells
  - The early gut, epithelium of the respiratory and digestive tracts

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Allantois

- Endodermal origin – caudal outpocketing of the yolk sac
- Invades the connecting stalk (extraembryonic mesoderm) that suspends the embryo in the chorionic cavity
- Involved in early hematopoiesis (up to 2 months)
- The allantois blood vessels - artery and vein - becomes the umbilical vessels
- Remnants of Allantois becomes the urachus ligament that connects the belly button to the bladder

Chorion

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Chorion
Chorionic cavity (extraembryonic coelom) - lined with extraembryonic mesoderm
Chorionic cavity expands separating amnion from cytotrophoblast
Chorionic sac consist of:
cytotrophoblastic layer
syncytiotrophoblastic layer
extraembryonic somatic mesoderm
The Chorion / maternal endometrium forms the placenta
Chorion forms stem villi

Stem Villi
Chorionic Plate – Stem villi extends from this tissue
Primary stem villi (day 11-13) - finger-like protrusions into endometrium - contains syncytiotrophoblast, cytotrophoblast.
Secondary stem villi (day 16) - extraembryonic mesoderm invasion into villi core.
Tertiary stem villus (21 day) - extraembryonic vessels - chorionic arteries and veins derived from extraembryonic mesoderm.
Hemichorial type placenta – maternal blood baths villi

Stem Villi
Cytotrophoblastic cell column – terminal villi, solid mass of trophoblast
Cytotrophoblastic shell – surrounds embryo; direct contact with maternal decidual cells
Anchoring Villi – give off cytotrophoblastic extensions - anchoring because they represent the real maternal-embryo link
Floating Villi – branches off anchoring villi – dangles freely in maternal blood

Chorion
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Decidua

Decidual Reaction – stromal cells – accumulate glycogen and lipid, called Decidual Cells

- Decidua basalis - forms maternal component of the placenta; associates with the chorion frondosum
- Decidua capsularis - superficial layer overlying the entire embryoblast - this layer eventually degenerates; associates with the chorion laeve
- Decidua parietalis - all remaining parts of the endometrium - not associated with the embryo

Deciduas

Making the Placenta

By 8 weeks - chorionic stem villi over the entire surface of the chorionic sac
Those villi associated with the decidua basalis increase in size and more villi form.
Enlargement includes further branching of the anchoring villus - chorion frondosum.
The villi continue to enlarge during most of gestation.
The villi project into a blood filled intervillous space resulting from the erosion of the decidua basalis.
Endometrial vessels - spiral arteries and endometrial veins
Villi associated with the decidua capsularis degenerate - this region is called the chorion laeve

Decidua

Placenta

The erosion of the decidua basalis is incomplete - uneroded regions called decidual septa.
The decidual septa define regions of the placenta called cotyledon.
Placental Blood Flow

Umbilical Cord

One umbilical vein, two umbilical arteries
Wharton’s jelly – mucoid connective tissue surrounding vessels
Allantois
Yolk Stalk (vitelline duct) and vitelline vessels (early)
Intestinal loop – umbilical hernia (late)

Placental Circulation

Fetal – Contained within vessels
Umbilical Arteries – chorionic plate – branches to stem villi – capillaries in terminal villi – return via umbilical vein
Maternal – Free-flowing lake
Spiral arteries open into intervillous space and bath the villi
150 ml of maternal blood
Exchanged - 3-4 times/minute
Reduced blood pressure in intervillous space
Oxygenated blood to the chorionic plate, return baths the villi
**Placental Barrier**
- syncytiotrophoblast + basal lamina, basal lamina + fetal capillary endothelium

**Syncytiotrophoblasts**
- many microvilli, no major histocompatibility antigens

**O2**
- H2O
- Fe
- salts
- carbohydrates, amino acids, lipids
- vitamins, hormones, antibodies
- drugs, alcohol
- viruses (rubella, varicella-zoster, HIV)

**CO2**
- H2O
- salts
- urea, uric acid
- creatinine
- bilirubin, hormones, RBC antigens

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**Placenta as an Endocrine Organ**

- **Human Chorionic Gonadotropin** – Corpus Luteum (declines after 8 weeks)
- **Progesterone** – High levels by the end of first trimester
- **Estrogen** – Synthesis involves enzymatic activity of fetal adrenal gland and liver
- **Chorionic Somatomammotropin** – Human Placental Lactogen – similar to GH (growth, lactation, lipid and carbohydrate metabolism)
- **Placental Growth Hormone** – similar to GH – Replaces maternal GH by 15 wks – enhances blood glucose levels
- **Chorionic Thyrotropin**, **Chorionic Corticotropin**

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**Multiple Pregnancies**

- **Monochorionic/Dichorionic**
- **Monoamnionic/Diamnionic**

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**Hydatiform Mole**
Erythroblastosis fetalis

Fetus / newborn - hemolytic disease (anemia)
Rh factor is a RBC surface antigen
Rh- mother with Rh+ 1st baby – Maternal antibodies are induced after birth
At risk is second Rh+ baby
Maternal Rh antibodies cross placenta
Hemolysis of fetal Rh+ RBC