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
Extraembryonic Tissues

8 days

9 days

14 days
Amnion
Amnion
Amnionic 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 – amnionic 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.

Hydraminos – 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 extremsbryonic 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
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Placenta - Chorion / Maternal Decidua
Chorion

2 weeks
- Amniotic cavity
- Body of embryo
- Yolk sac
- Extraembryonic coelom
- Trophoblast

3 weeks
- Amnion
- Chorion

3 1/2 weeks
- Yolk sac
- Extraembryonic coelom

4 1/2 weeks
- Body stalk
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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**Placenta** - Chorion / Maternal Decidua
Decidua

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

Decidua basalis - forms maternal component of the placenta; associates with the chorion frondosom

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
Decidua Basalis

Yolk Sac

Chorion Frondosum

Amnion

Cervical Glands

Mucous Plug

Fundus of Uterus

Embryo

Uterine Mucosa (decidua)

Cervix of Uterus

Myometrium

Decidua Parietalis

Decidua Capsularis

Cervical Canal

Fornix of Vagina

Yolk Sac
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 is a term used in embryology to describe the maternal tissue that surrounds the developing embryo. It is composed of two types of cells: decidua vera and decidua basalis. The decidua vera is the inner layer that forms around the embryo, while the decidua basalis is the outer layer that forms against the uterine wall.

- **Decidua vera** (inner layer): Forms around the embryo and contributes to the formation of the placenta.
- **Decidua basalis** (outer layer): Forms against the uterine wall and provides a supportive layer for the developing embryo.

The diagram illustrates the development from 3 weeks to 8 weeks, showing the growth of the embryo within the decidua. Key structures include:

- **Embryo**
- **Uterine mucosa**
- **Cervix of uterus**
- **Amnion**
- **Myometrium**
- **Decidua parietalis**
- **Decidua capsularis**
- **Cervical canal**
- **Fornix of vagina**
- **Yolk sac**

At 5 months, the diagram highlights the development of the fetus within the decidua, including the formation of the placenta and the expansion of the fetus's features.
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
Placental Anatomy

- Umbilical vein
- Umbilical arteries
- Chorionic plate

Villous tree  Fetal circulation  Maternal circulation

Pathways of maternal blood through intervillous space

Placental margin
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 decreases with gestation

Placental Barrier – syncytiotrophoblast + basal lamina, basal lamin + 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.
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
Multiple Pregnancies

Monochorionic/Dichorionic

Monoamnionic/Diamnionic
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