

## **EARLY EMBRYOLOGY:**

### **The First Three Weeks**

Thomas A. Marino, Ph.D.  
Professor of Anatomy and Cell Biology  
608 Old Medical School Building

**Competencies:** Upon completion of this section of the course, the student must be able to:

1. Recall the events that occur during the first three weeks of development including:
  - A. Cleavage,
  - B. Cell division
  - C. Formation of the blastocyst.
  - D. Gastrulation
  - E. Neurulation
  - F. Formation of the vertebrate body plan.
2. Correlate the timing of events during early pregnancy to the woman's menstrual cycle. These events include:
  - A. Implantation
  - B. Gastrulation
  - C. Beginning of embryogenesis
3. Follow the formation of the embryo from the bilaminar to the trilaminar stage and then through the formation of the vertebrate body plan.
4. Understand the different types of stem cells and be able to correlate the type of stem cell with its origin.
5. Recall the effect of age on the ability of a couple to have a child.
6. Remember the basis of pregnancy testing.

## WEEK ONE: PREIMPLANTATION

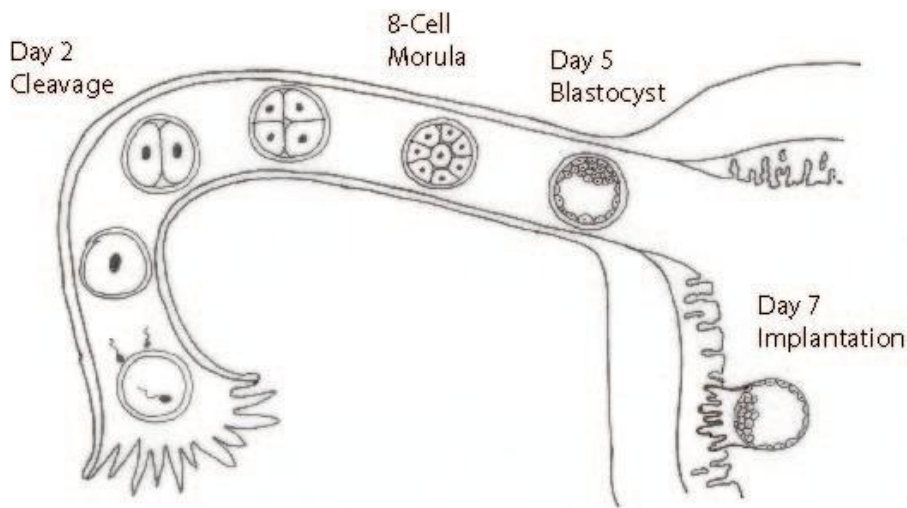
**Day1:** Fertilization

**Day2:** The fertilized egg begins to divide during the second day. The first division is called **cleavage**. Until the 8-cell stage, each individual cell is capable of forming a complete embryo and the cells are called totipotent. Identical twins develop when totipotent cells separate and develop into individual, genetically identical babies.

**Day 2-5:** The fertilized egg continues to divide in a series of divisions in which the daughter cells all are smaller than the cells from which they arose. At this point the embryo is called a **morula**.

**Day 5:** The **morula** enters the uterus and a cavity, called the **blastocyst cavity**, begins to form. Surrounding this cavity, there is an outer layer of cells, the **trophoblast** which will develop into the placenta and other supporting tissues. Inside of the trophoblast is a cluster of cells called the **inner cell mass**. The inner cell mass will go on to form virtually all of the tissues found in the human body. However, alone the inner cell mass cannot form an organism because the placenta and supporting tissues needed for development come from the trophoblast. Therefore cells of the inner cell mass are not totipotent. They are **pluripotent**.

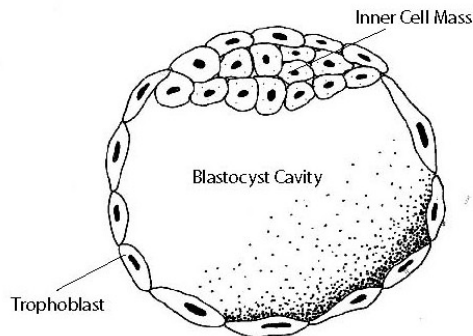
**End of Week 1:** During the second week of development the **blastocyst cavity** will be called the **primary yolk sac** and the whole implanting embryo will be called the **blastocyst**.



## THE SECOND WEEK

### Implantation

- The blastocyst enters the uterus and attaches to the endometrial epithelium if it is properly prepared for implantation. The uterus has been undergoing changes under the control of the ovary that makes the epithelium of the uterine wall receptive to the blastocyst.
- The blastocyst, at this point, consists of an **inner cell mass** (embryoblast- becomes the embryo), a **trophoblast** (becomes part of the placenta), and the **primary yolk sac** (at this point also called the blastocyst cavity).

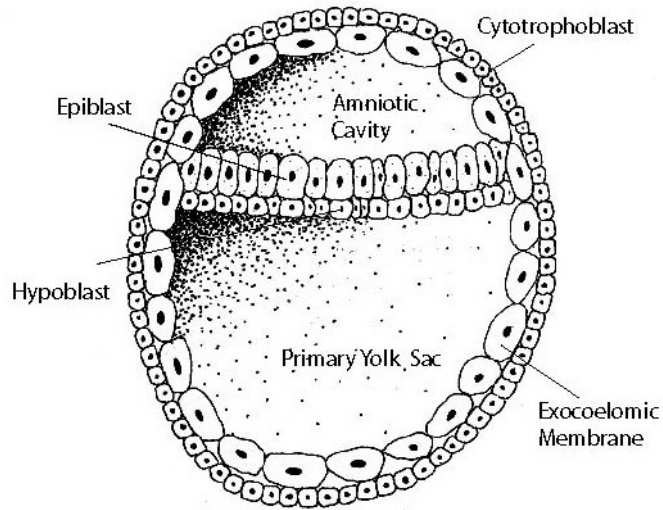


### Development of the Trophoblast

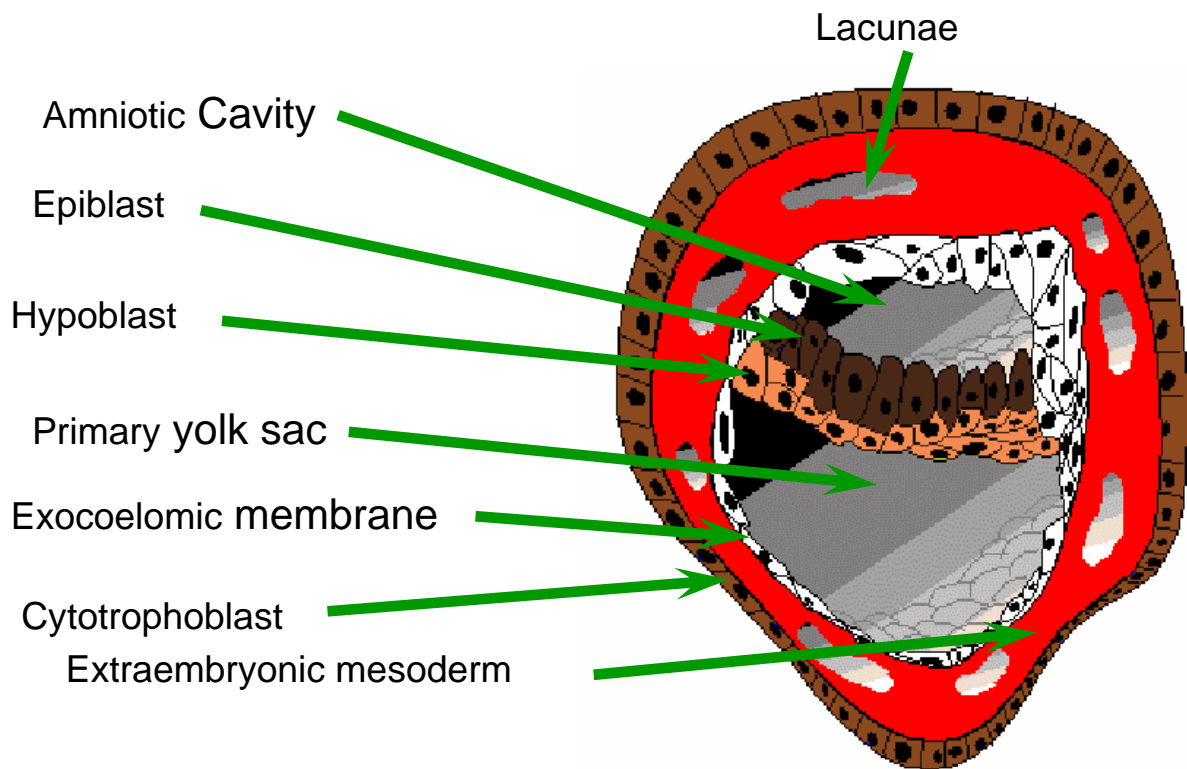
- The trophoblast, surrounding the inner cell mass, develops into two layers:
  1. The **cytotrophoblast** - a layer of cells that are mononucleate and lie closest to the inner cell mass.
  2. The **syncytiotrophoblast** a layer formed by a multinucleate, syncytium of cells located outside the cytotrophoblast. The syncytiotrophoblast cells come from the cytotrophoblast. The syncytiotrophoblast cells invade the endometrium of the uterus during the formation of the placenta.

### Development of the Embryoblast

- At the beginning of the second week, a second cavity appears within the inner cell mass and when it enlarges it becomes the **amniotic cavity**. Cells that are derived mostly from the inner cell mass line the amniotic cavity, but some cells may be derived from the trophoblast as well.
- The inner cell mass, will begin to develop into a two layered structure:
  1. A layer of columnar cells called the **epiblast**.
  2. A second layer that lies closer to the Primary Yolk Sac (blastocyst cavity) called the **hypoblast**.
- At this point, the embryo consists of an amniotic cavity and a primary yolk sac with the epiblast and hypoblast in between. The embryo is surrounded by the cytotrophoblast.



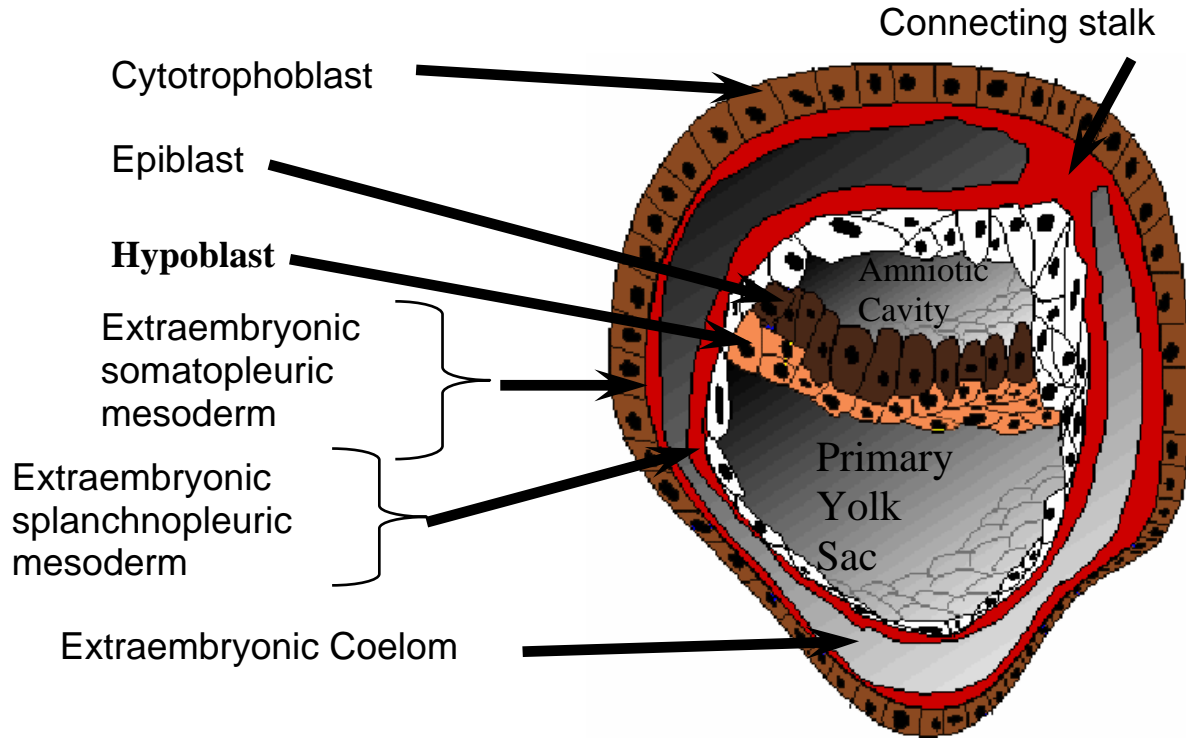
- Cells that were derived from the hypoblast line the primary yolk sac (blastocyst cavity (or sometimes called the exocoelomic cavity)). The cells form a membrane called the exocoelomic membrane (Heusner's) membrane.
- A new population of cells appear between the cytotrophoblast and the exocoelomic membrane. These cells become the exocoelomic mesoderm.



- Cavities develop in the extraembryonic mesoderm. These cavities coalesce to form a new space called the extraembryonic coelom (chorionic cavity). This cavity now surrounds the amnion and the yolk sac. The mesoderm lining the cytotrophoblast is called the

**extraembryonic somatic mesoderm.** The extraembryonic mesoderm lining the yolk sac is called the **extraembryonic splanchnic mesoderm.**

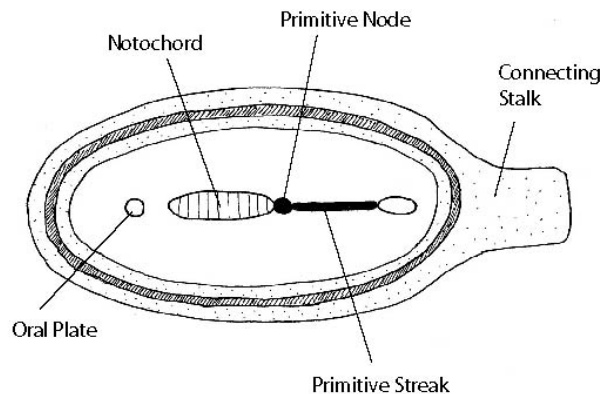
- There is one place where the extraembryonic mesoderm traverses the chorionic cavity and this is the **connecting stalk** that will become the umbilical cord.



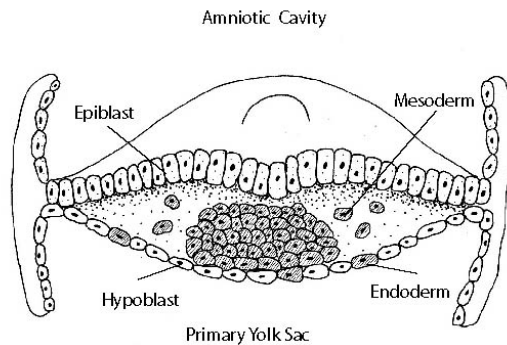
## THE THIRD WEEK

### Gastrulation

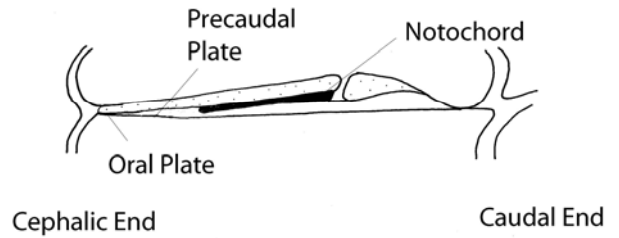
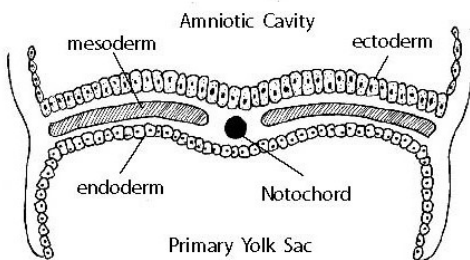
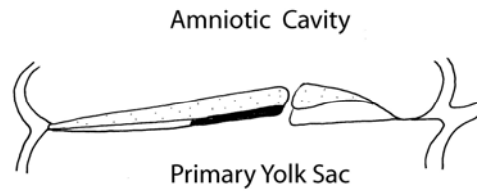
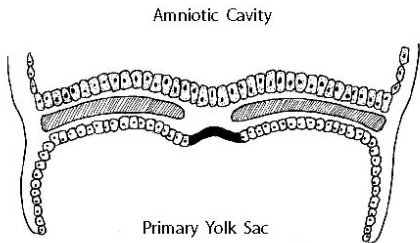
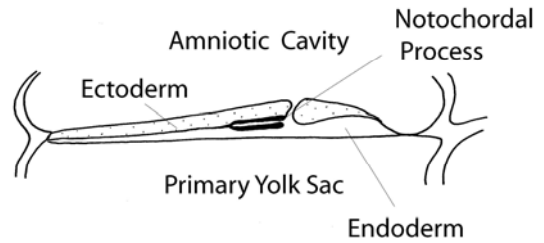
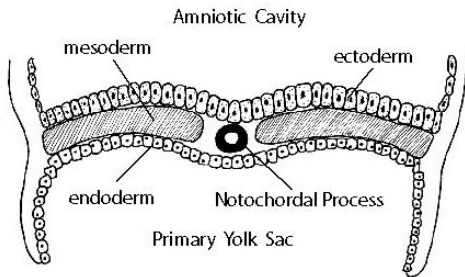
- Gastrulation** is the process that establishes three germ layers or a **trilaminar** embryonic disk. Gastrulation begins around day 14 of gestation or 28 days after the beginning of the mother's last menstrual cycle.
- The first sign of gastrulation is the formation of the **primitive streak** in the epiblast. The primitive streak consists of the primitive groove, primitive node and the primitive pit.



- Epiblast cells migrate towards the midline and invaginate into the space between the epiblast and hypoblast. Some of the migrating epiblasts cells replace the cells that were in the hypoblast. At this point a trilaminar disc is formed with the epiblast, giving rise to three germ layers, the:
  1. epiblast that remains becomes the **ectoderm**,
  2. cells that replace the hypoblast become the **endoderm**
  3. cells in between become the **mesoderm**.



- The **notochord** lies between the endoderm and the ectoderm, from the prechordal plate to the primitive node. It is derived from the notochordal process, which is formed from cells that invaginate into the primitive pit and move in a cephalic direction in the midline. The cells continue forward until they reach the **prechordal plate**. The prechordal plate is the region between the notochord and the oral plate and it is composed of endodermal cells. The migrating cells forming the **notochordal (head) process** will fuse with the endoderm for a short time and will be called the notochordal plate. The notochordal plate will then round up and become the notochord.



- The **oral plate** is the area anterior to the prechordal plate and the notochordal process where ectoderm and endoderm are adjacent to each other without intervening mesoderm.
- **Neurenteric canal** – located posterior to the primitive node, connects the amniotic cavity with the yolk sac for a short time.
- **Cloacal (anal) membrane (plate)** – located posterior to the neurenteric canal, is another area where the endoderm and ectoderm meet without intervening mesoderm.
- **Allantois** – located posterior to the cloacal membrane, is a small diverticulum of the yolk sac, which invaginates into the connecting stalk.