

Human Development

Laboratory Activity

Gametogenesis

Male

The sperm develop within the highly coiled *seminiferous tubules* of the testes. When the sperm are fully mature they are extremely small, being little more than a bag of genetic material with a tail. The head of the sperm cell contains the nucleus and little else. The tail consists of a flagellum which allows the sperm to swim through the female reproductive tract to the egg.

Female

The egg is one of the largest cells in the body. As the egg ripens in the ovary it accumulates *yolk* which will serve as food for the young embryo until the placenta and umbilical cord are fully functional. Egg development is accomplished with the help of special nurse cells called *follicle cells*. When the egg is fully formed it bursts from the ovary in a process called ovulation. Ovulation is governed by complex nervous and hormonal controls. After the egg is released from the ovary it enters the *oviduct*.

Embryonic Development

Fertilization

Fertilization takes place in the *fallopian tubes* or *oviducts*. Although thousands of sperm cells may complete the trip to the egg only one will penetrate the cell's outermost membrane and fertilize it. From this point on the egg is referred to as a *zygote*.

Cleavage Divisions

Almost as soon as the egg is fertilized it begins to divide. First into two cells, then 4, then 8 and so on. These divisions produce a solid clump of 32-64 cells called the *morula*.

Blastocyst

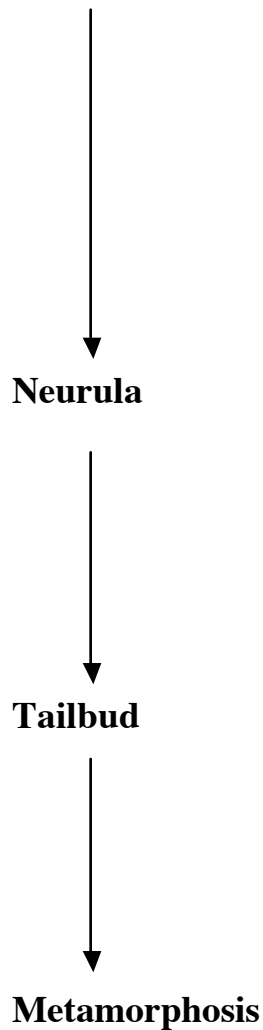
The *morula* continues its trip down the oviduct to the uterus. As the cells continue to divide a hollow cavity appears in the center of the mass. When the mass of cells becomes hollow it is referred to as a *blastocyst*. This occurs after about 4 days. The blastocyst consists of an outer layer of cells called the *trophoblast* and a thickened clump of cells at one end called the *inner cell mass*. The trophoblast will eventually develop into the *placenta*. The inner cell mass will form the actual human *embryo*.

Implantation

By the 6th or 7th day the blastocyst has entered the uterus and attached to the uterine wall. Within the next two days it becomes completely buried in the wall of the uterus. The trophoblast cells establish contact with the maternal blood flow and will later send out small fingerlike projections called *villi* which will further penetrate the uterine lining and intermingle (but not join) with the maternal capillaries. From this union of embryonic and maternal tissues the *placenta* develops.

Primitive Streak

While the process of implantation was occurring, the inner cell mass became organized into two separate cell layers called the *epiblast* (epi-above) and the *hypoblast* (hypo-below). These cell layers are the beginnings of embryonic *differentiation* as cells become *specialized* for specific functions. This process of cell layering is called *gastrulation*. By the 12th day cavities have formed in each of the two cell layers. The cavity in the upper layer will form the *amnion* which will eventually encircle the embryo and protect it from physical shocks. The lower cavity is the *yolk sac* and encloses a small quantity of stored food which may be used by cells developing within the embryo.



When the human embryo is 2-2 1/2 weeks old a groove forms along the upper surface of the epiblast. This groove is called the *primitive streak*. Some cells move into the groove and establish a third cell layer between the epiblast and hypoblast layers. The embryo now consists of three different layers of cells called the *ectoderm* (epiblast), the *mesoderm*, and the *endoderm* (hypoblast). Each of these tissue layers will give rise to a very specific set of organs. The ectoderm will differentiate into the skin and nervous system. The mesoderm develops into the skeletal, muscular and circulatory systems and parts of the urinary and reproductive systems. And the endoderm gives rise to the digestive and respiratory systems and portions of the urinary and reproductive systems.

The nervous system is one of the first systems to develop in the embryo. By the fourth week its formation is well under way. Folds form along each side of the primitive streak and curve upward to join forming a closed tube along the length of the embryo. This tube is expanded in the front and will form the brain. The smaller region further back will form the spinal cord and nerves.

A simple tubular heart begins pumping blood from the placenta through the umbilical cord to the developing embryo bringing oxygen and nutrients and returning wastes to the placenta.

In the 5th week the human embryo is the size and weight of an aspirin tablet. About one third of its total length is head which has flexed forward almost touching the embryonic tail. Rudiments of various sense organs are clearly visible. The *optic bulb* (eye), and portions of the *ears* and *nose* become visible. Several *gill slits* appear just below the head. A pair of thickenings near the front and hind end of the embryo will later develop into *arms* and *legs*. By the end of the fifth week the embryo is fully formed. All structures and organs are laid out in rudimentary form.

Metamorphosis begins on about week 6 and lasts about two weeks. The appendages differentiate first into paddles and then into arms and legs with fully formed fingers and toes. Distinctly human *facial features* develop. One of the *visceral arches* mentioned earlier differentiates into the *lower jaw*. Sensory organs develop further and the eyes become pigmented. By the end of the 8th week the embryo is easily recognizable as human and from this point onward is referred to as a fetus.

The child spends the remainder of his or her sojourn in the womb increasing in size and fine tuning the systems that have already been laid out during embryological development.

Second Month

In the second month the *cartilagenous skeleton* begins to *ossify* into hardened bone. The earliest *reflexes* appear as the fetus for the first time makes visible responses to touch.

Third Month

In the third month *fingernails, toenails* and *hair* appear. The *kidneys* become functional and *breathing movements* are coordinated. The head turns and the fetus can kick and curl its fingers and toes. The face squints and frowns and the fetus can open its mouth.

Fourth Month

A rapid burst of fetal growth occurs in the fourth month. The fetus is about six inches long and weighs 4 ounces. *Sucking movements* and the *startle reaction*, common in newborns, first develop.

Fifth Month

By the fifth month the fetus is 8 inches long and weighs a half pound. Its kicking and turning movements are easily felt by the mother. The fetus sucks its thumb, often gets the hiccups and sleeps. Its body is now covered with a downy coat of hair called *lanugo* some of which may persist until birth.

Sixth Month

In the sixth month the 11/2 pound fetus becomes covered with a waxy *vernix* secreted by oil glands in the skin. Its intestines fill with a green pastelike *meconium* from the breakdown of red blood cells and digestive secretions.

Seventh Month

If the fetus is 7 months old it has a 10% chance of surviving if born early. He/she can regulate temperature, breathing and swallowing - all critical functions for a life outside the womb. The brain develops its characteristic ridges and grooves and the various functional areas of the brain become localized. The testes of the male descend into the scrotum.

Eighth Month

An 8 month old baby has a 70% chance of survival. It weighs 4 to 5 pounds and is 13 inches long. Fat accumulates under the skin somewhat eliminating the "shriveled old man" look of the fetus. The baby's eyes can perceive light and he/she can taste sweet substances but the fetus remains deaf since nerves to the ears have not completely developed.

Ninth Month

By the ninth month fetal development is essentially completed. The baby has grown to about 20 inches long and weighs 6 to 8 pounds. The child is now fully prepared for transit into a new world. It has even acquired temporary *immunity* to some pathogens through its mother's antibodies. The placenta begins to fail and the birth process begins.

Parturition

Now the real fun begins