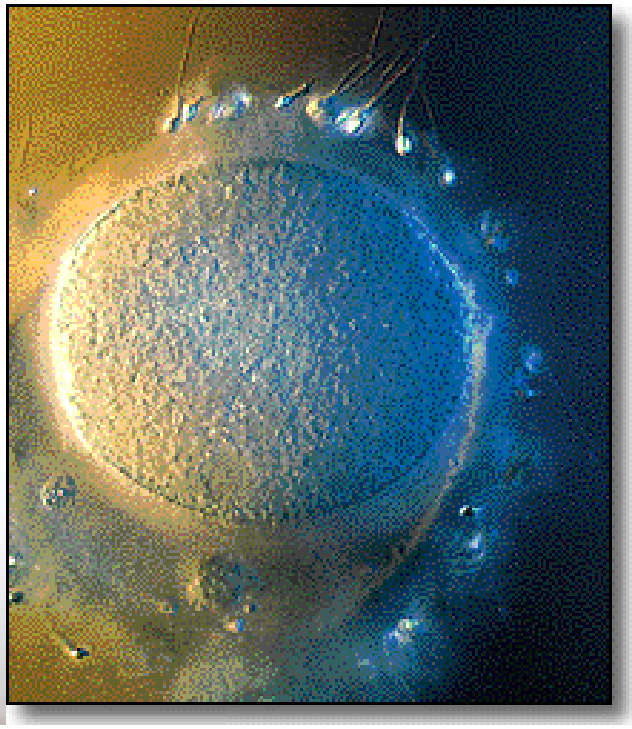
Biology 3201 Unit 2 Reproduction : 15.3 - Early Development



Fertilization and Implantation

- fertilization – first stage of embryonic development, when a sperm and egg interact successfully to form a zygote (reproductive cell)
- Implantation – the embryo's attachment of itself to the endometrium, occurs within the first week after fertilization in humans
- Sperm develop in testes → epididymis → vas deferens→ urethra → vagina → cervix → uterus → oviduct (fertilization)
- After fertilization, the zygote travels down the oviduct to the uterus to implant. As it does, it undergoes cell divisions called cleavage

How do we change form??

Overview - Four Major Developmental Events

- 1. Cell Division (Cleavage)
  - -Converts 1 cell to many; the egg is one cell, the embryo is multicellular

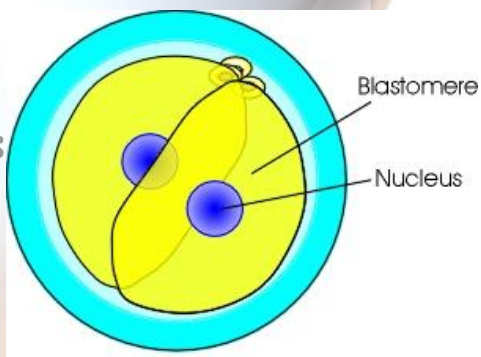
2. Cell Differentiation
   -formation of different, specialized cell types; the egg is one cell type, the embryo contains hundreds of cell types

- 3. Morphogenetic Events
  - -literally the "generation of shape", morphogenesis results in the embryonic organization
  - specific organization of multiple layers of different cells

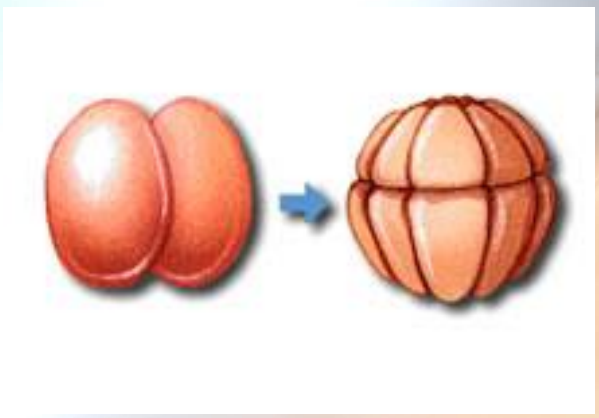
4. Growth--Increases size of organism

1. Cleavage

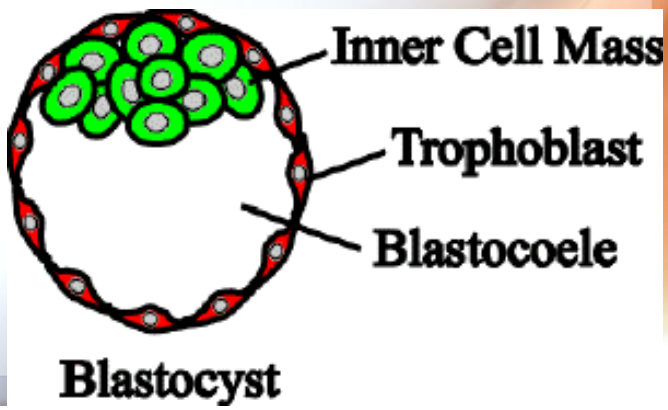
- After fertilization the zygote undergoes a series of rapid mitotic divisions.
- begins after 24h
- arrives at the uterus after four days



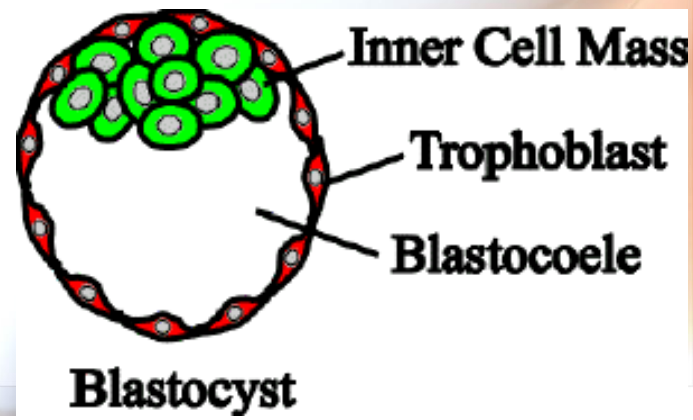
Two-Cell Stage



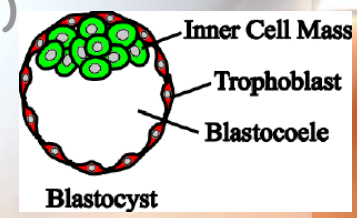
- results in a mass of identical cells (morula) and eventually a *blastocyst.* (see fig 15.12 pp 507)



- blastocyst contains a hollow, fluid-filled cavity containing an inner cell mass in one area (embryo).

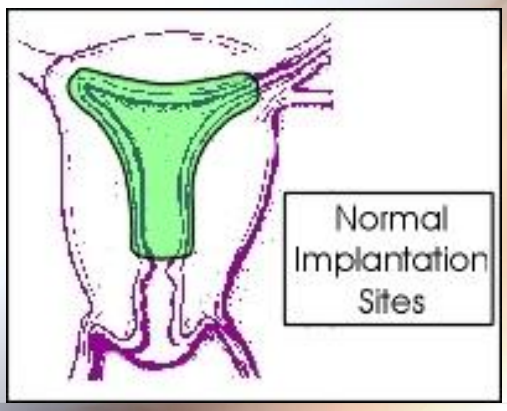


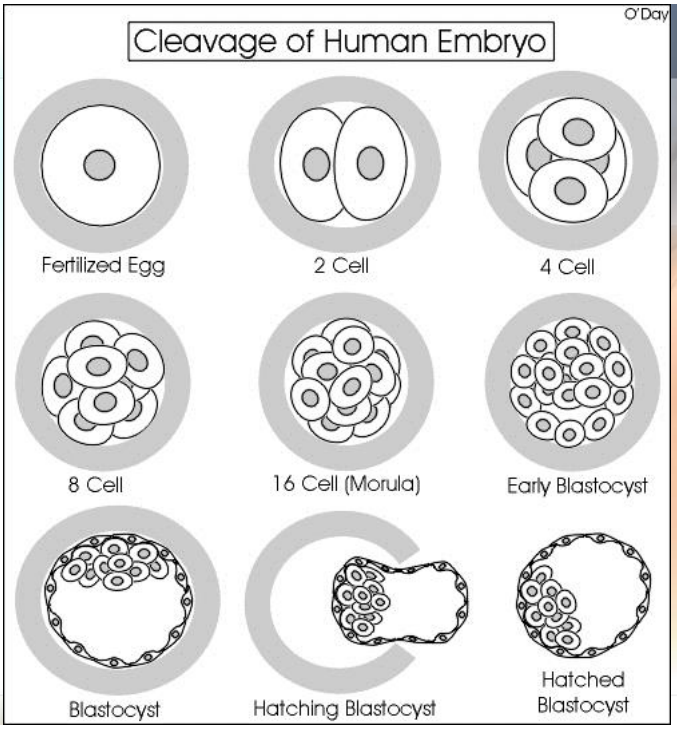
- Layer of cells surrounding are the *trophoblast* (membranes that protect the embryo.)



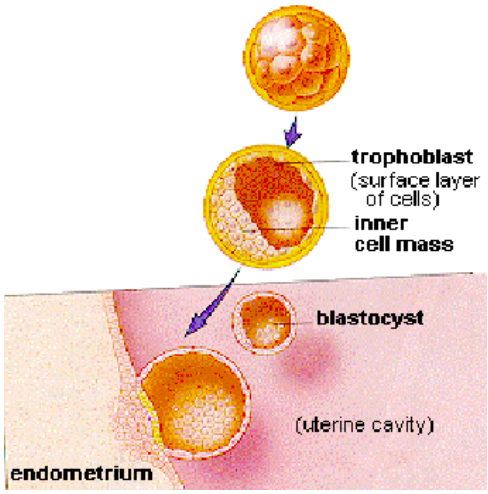
The blastocyst "hatches"from the zona pellucida (thick membrane around the blastocyst) preparing it for implantation in the uterine wall.

- Six or seven days after fertilization, the blastocyst burries itself in the endometrium





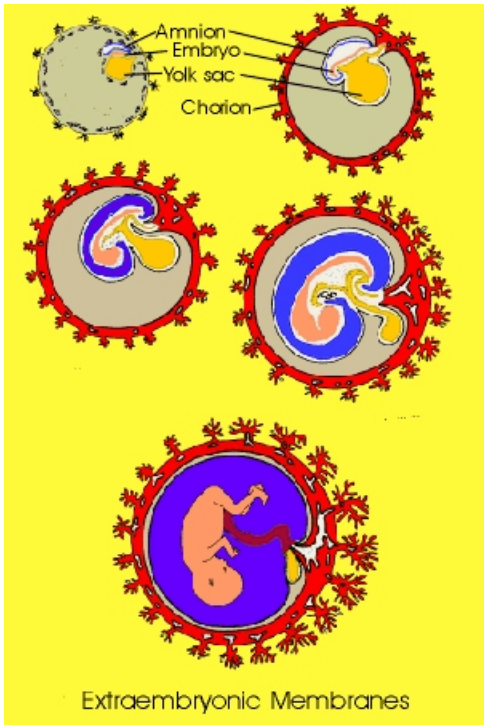
Implantation



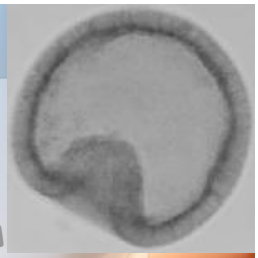
Embryonic Membranes:

- Chorion: finger-like projections (villi) protrude into the endometrium. Mother's blood fills spaces around villi.
- Amnion: forms protective, fluid filled sac around embryo

- Yolk Sac: originally held yolk (lower animals)
- Allantois: used for waste removal
- Umbilical Cord: conduit for food, oxygen, etc.
  - chorion and the amnion start from the trophoblast



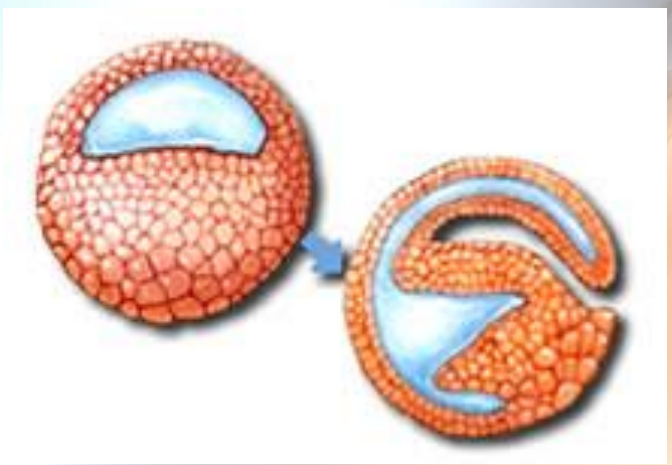
2. Gastrulation

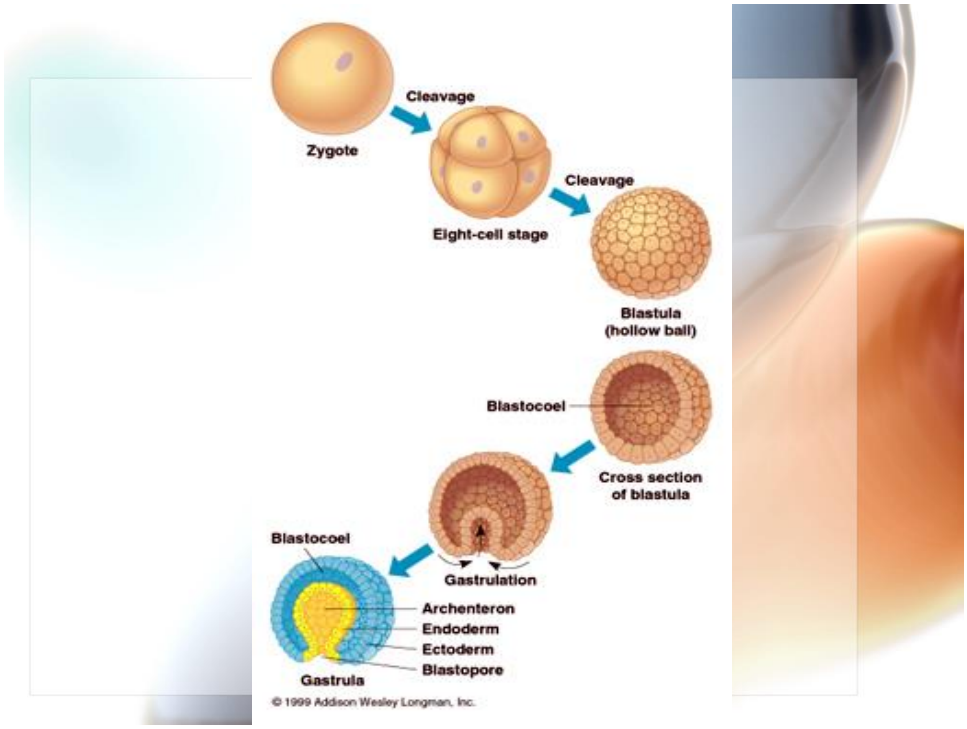


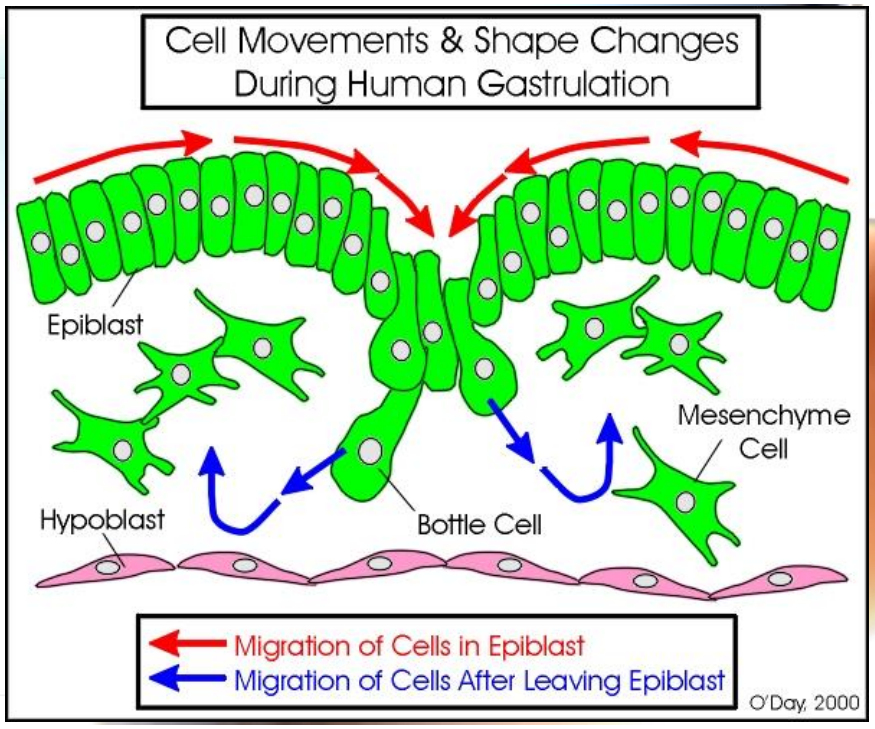
- 10th day after fertilization
- reorganization of cells to form three distinct cell layers.

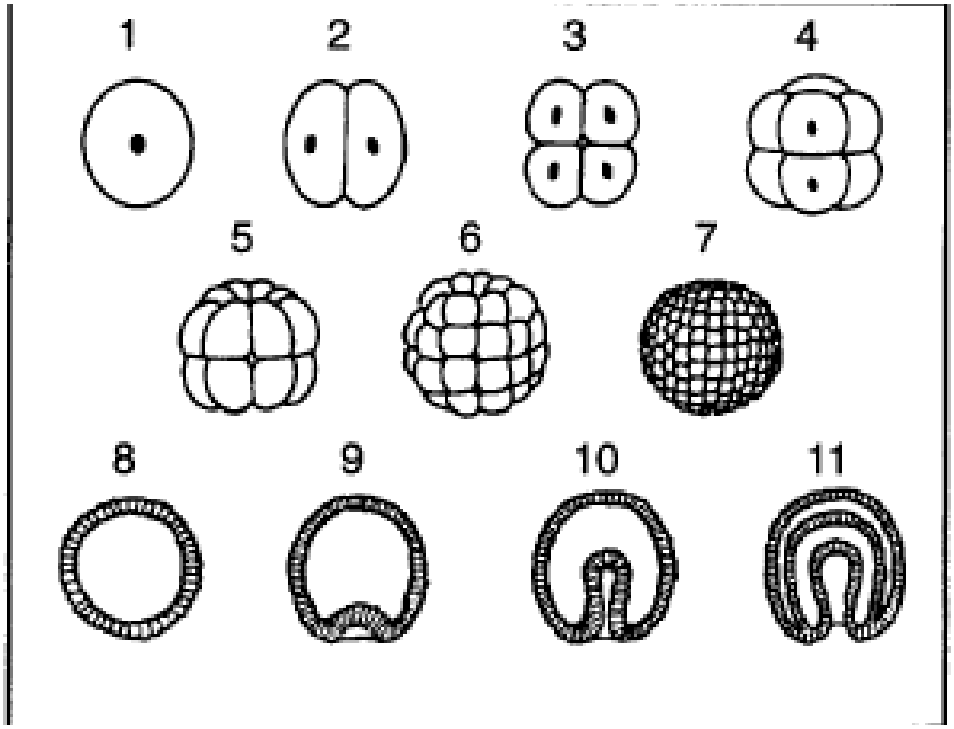
Most experimental knowledge from chick and mice embryos

Gastrulation




Zygote
Cleavage
Eight-cell stage
Cleavage
Blastula
(hollow ball)
Blastocoel
Cross section
of blastula
Blastocoel
Gastrulation
Archenteron
Endoderm
Ectoderm
Blastopore
Gastrula
© 1999 Addison Wesley Longman, Inc.


Cell Movements & Shape Changes
During Human Gastrulation
Epiblast
Mesenchyme
Cell
Hypoblast
Bottle Cell
Migration of Cells in Epiblast
Migration of Cells After Leaving Epiblast
O'Day, 2000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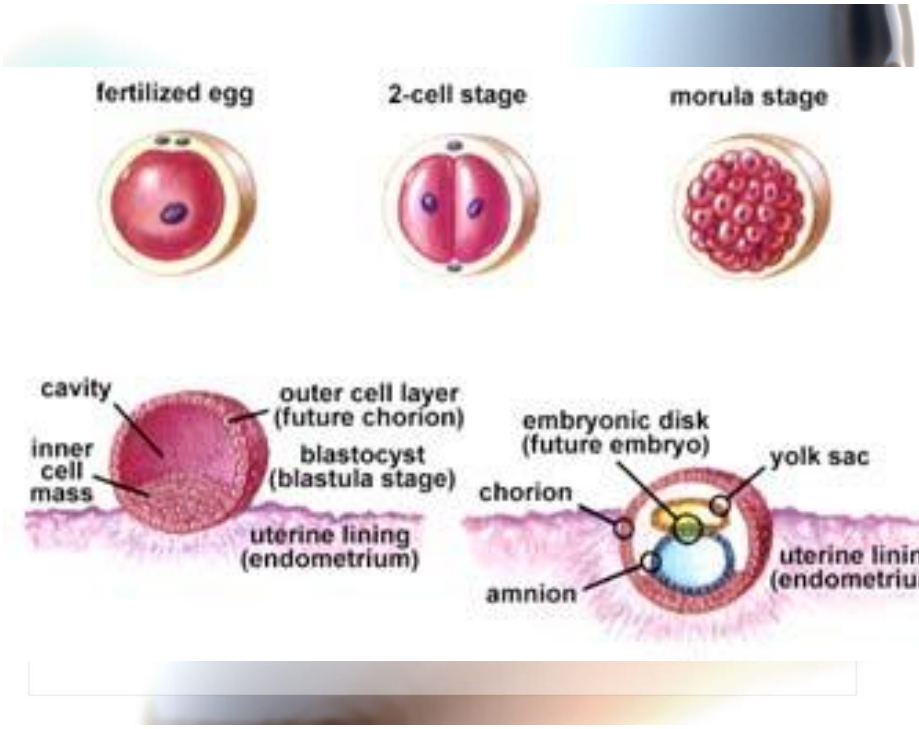
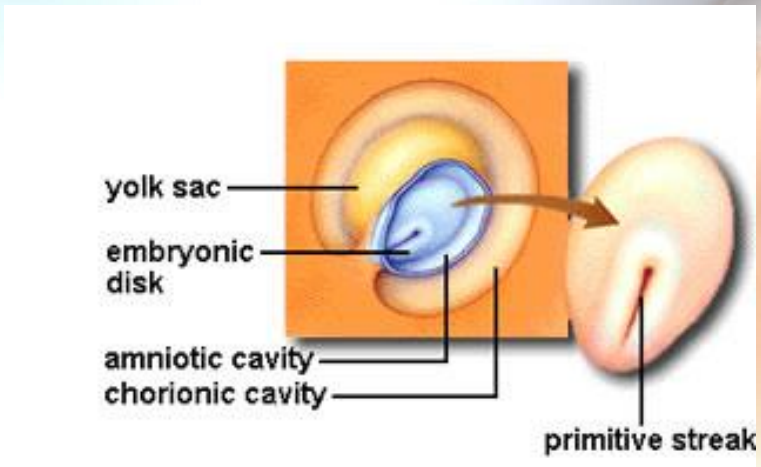

fertilized egg
2-cell stage
morula stage
cavity
outer cell layer
(future chorion)
inner
cell
mass
blastocyst
(blastula stage)
uterine lining
(endometrium)
embryonic disk
(future embryo)
yolk sac
chorion
amnion
uterine lining
(endometrium)

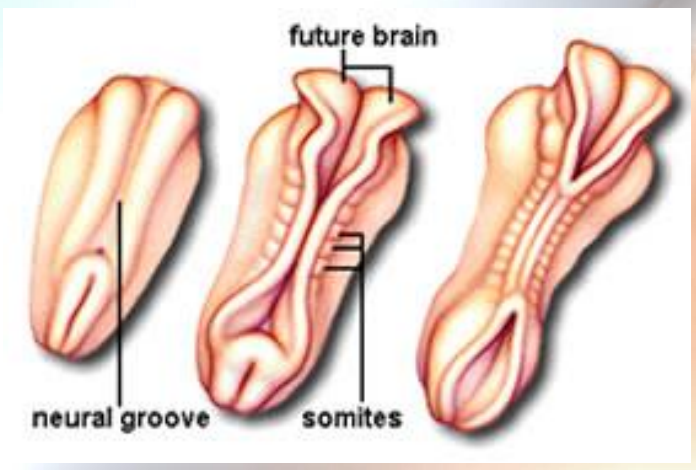
3. Differentiation

- Occurs up until the eighth week. Different germ layers develop into different organs and systems.
- After the eighth week the embryo is known as a fetus.

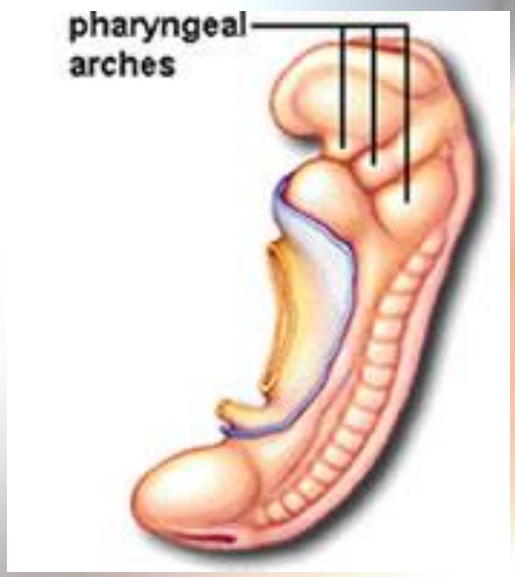
Day 15



Day 19



Day 24



Development

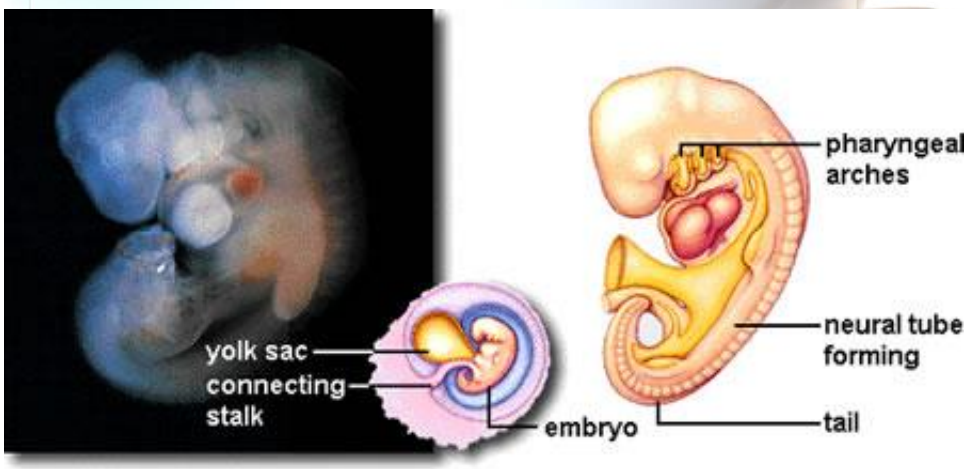
- In the third week of human development, the nervous system begins to form.
- Neurula – vertebrate embryo in an early stage where the nervous system begins to develop
- In the gastrula, the mesoderm cells that lie along what will be the back of the vertebrate come together to form a rod called the notochord (develops into spinal column). The nervous system develops from ectoderm that is located just above the notochord. First, cells above the surface of the notochord begin to thicken. Folds develop on each side of the groove along the surface. The folds become a tube when they fuse. The anterior, or "head" end, of the neural tube becomes a brain

Ectoderm	Nervous system (brain/spinal cord) Skin
Mesoderm	Skeleton, muscles, gonads
Endoderm	Internal organs, pancreas, liver, lungs, digestive system

4. Growth

- Addition of more cells.

Week 4



Week 8

Harmful Effects on the Fetus

- A teratogen is an agent that can cause malformations of an embryo or fetus.

These substances are relatively more concentrated in the baby's blood.

Teratogens

- Mutated Genes: interfere with development
- Physical Agents: X-Rays, Heat
- Chemical Agents: Steroids, Alcohol, Drugs
- Viruses: herpes, Rubella (German Measles)
- Lack of a specific, essential component can also lead to abnormal development (e.g., FA & Spina Bifida)

SOME CHEMICAL TERATOGENS IN HUMANS

Agent	*Effect on Human Development*
Alcohol	*Mental Retardation, Microcephaly, Various Malformations of the Face & Trunk*
Mercury	*Mental Retardation, Cerebral Atrophy, Spasticity, Blindness*
Thalidomide	*Limb Defects, Ear Defects, Cardiovascular Anomalies*

ORGANISMS THAT MAY CAUSE BIRTH DEFECTS

ORGANISM	DISEASE	CONGENITAL DEFECTS
Rubella Virus	German Measles	Cataracts, Deafness, Cardiovascular Defects, Slow Growth of Fetus
Trepanoma pallidum (Spirochete bacterium)	Syphilis	Dental Abnormalities, Deafness, Mental Retardation, Skin & Bone Lesions, Meningitis

Twins

- Identical twins – form when one sperm fertilizes one egg, but the zygote or blastocyst splits into two separate bodies. They have the same genetic material.
- Fraternal twins – form when more than one egg is released at a time by the ovary or ovaries and more than one egg becomes fertilized. Fraternal twins are as different as normal siblings.