

Human Development

Duration & Stages of Pregnancy

Human gestation last an average of 266 days (38 weeks, ~9 months)

is divided in 3 month intervals called **trimesters**

1st trimester (1st 3 months: wk 1 - 12)

preembryonic and embryonic development

stress, drugs and nutritional deficiencies are most threatening during this time

some suggest that "morning sickness" is correlated with this critical period has the evolutionary advantage of making mom less likely to ingest potentially dangerous materials

eg. cabbage, brussel sprouts, potatoes, overcooked meat all contain poisons that could potentially do damage to embryo;

eg. coffee contains over 1,000 different toxins

women who do not experience pregnancy sickness are significantly more likely to miscarriage

2nd trimester (2nd 3 months: wk 13 - 24)

fetal development begins

organs complete most of their development

3rd trimester (3rd 3 months: wk 25 - birth)

fetal development is completed

tremendous increase in size of fetus

Stages of Human Development

0. Fertilization

a. zygote

1. Preembryonic

- cleavage divisions
- morula
- blastocyst
- implantation
- primitive streak

2. Embryonic

- neurula
- tailbud
- metamorphosis

3. Fetal

0. Fertilization

during intercourse 1/4 of sperm die immediately

the rest can remain viable for 28-48 hours

there is typically a high percentage of defective sperm cells

female defense system attacks sperm

sperm make their way to the cervix

half the sperm go up the uterine tube containing the egg

in uterine tube sperm must swim against the current

few sperm cells actually make it to the egg

→ of 200-300 M sperm in a typical ejaculation only 2000-3000 (0.001%) actually make it to the egg

the egg is **fertilized** in the **uterine tube**

the egg has 2 layers of cells around it

when sperm contacts eggs membrane, acrosome secretes enzymes that digests a hole to break through these layers

sperm penetrates the cell membrane of the eggs

egg prevents more than 1 sperm from penetration:

→egg membrane **depolarizes** and prevents other sperm from binding

→egg generates a **fertilization membrane** that pushes other sperm away

upon fertilization, egg completes meiosis

then 23 chromosomes of the egg and 23 of the sperm mix to produce a **zygote**
→ 46 chromosomes

1. Preembryonic Stage

a. Cleavage

1st cleavage occurs in about 30 hrs after fertilization

mitotic divisions continue for ~ 3 days

as egg divides each cell gets smaller
→ overall size stays the same

each cell → **blastomere**

= all cells are identical

b. Morula

by ~72 hrs, reaches uterus, is a **morula**

= solid ball of about 16 or more cells

no larger than original zygote

c. Blastocyst

morula continues to divide for ~ 4-5 days and develops into ~100 cell **blastocyst**

still ~ same size as original egg

blastocyst is hollow & filled with liquid

wall = **trophoblast** → will help form placenta

thickened clump of cells = **inner cell mass**
will become embryo and membranes

d. Implantation

within ~10 days after fertilization,
blastocyst begins to implant in **endometrium**

implantation takes ~ 1 week

cells of **trophoblast** secrete enzyme allowing
embryo to eat a hole into the uterine lining

Ectopic Pregnancies

~1 in 300 pregnancies blastocyst implants somewhere other
than in the uterus

most cases are **tubal pregnancies**
→ if not detected can rupture and kill the mother

conceptus can also implant somewhere in the abdominal
cavity → anywhere there is an adequate blood supply.

eg outside of uterus, colon or bladder

usually are life threatening and require abortions to
save mother

but: ~9% of abdominal pregnancies result in live births by
caesarian

e. Primitive Streak

When the human embryo is 2-2 1/2 weeks old it is
~1/10th of an inch long

a groove forms along surface of epiblast
= **primitive streak**

cells migrate into this streak and forms 3 cell
layers

=**primary tissue layers:**

ectoderm
mesoderm
endoderm

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

once the 3 tissue layers are formed = **embryo**

Miscarriage

only about 1/3rd of all zygotes develop to term

most miscarriages are early spontaneous abortions
→ easily mistaken for a late or heavy menstrual period

estimates:

25-30% of blastocysts fail to implant

42% of implanted blastocysts die by the end of the
second week

16% of those that make it through 2 weeks are
seriously abnormal and abort within the next
week

61% of early spontaneous abortions were due to chromosomal
abnormalities

2. Embryonic Stages

begins about day 16

organogenesis one of main processes

a. Neurula

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**.

if neural tube doesn't close properly along its length
→ spina bifida

circulatory system also is established

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.

somites → will form vertebrae, ribs, spinal nerves and trunk muscles

b. Embryonic Membranes

during embryonic development embryonic membranes form around the embryo

eg. **amnion** (bag of waters)

surrounds the embryo; becomes filled with fluid
→ acts as shock absorber

breaks just before birth

eg. chorion

eventually it becomes principal part of **placenta**

placenta provides an exchange of nutrients and wastes between mom and baby

the maternal and fetal blood vessels are next to each other but blood does not mix
→ exchange is by diffusion

at delivery, the placenta becomes detached from the uterus = **afterbirth**

c. Tailbud

by the end of the 5th week the embryo is fully formed.

→ All structures and organs are laid out in rudimentary form.

the embryo is the size and weight of an aspirin tablet

this embryonic stage it is called a **tailbud**

About one third of its total length is **head** which has flexed forward almost touching the embryonic tail.

Rudiments of eyes, ears & nose are clearly 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**.

e. Metamorphosis

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 **gill 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**.

3. Fetal Stages

Second Month (~1.2" long)

all organs are in place = **fetus**

main changes that occur now are rapid growth and fine tuning the systems that have already been laid out during embryological development

by this time a special circulation pattern has been established between mother & child

fetus gets food and oxygen from mom doesn't depend on lungs for gas exchange or liver for processing nutrients

Fetal Circulation Pattern

- a. **umbilical arteries**
from internal iliac
 - b. **umbilical veins**
to hepatic vein
 - c. **ductus venosus**
bypasses fetal liver
 - d. **foramen ovale**
between rt and lft atrium
most blood bypasses pulmonary circuit
 - e. **ductus arteriosus**
connects pulmonary artery to aorta
most blood bypasses pulmonary circuit
- } = placenta

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 (2.5-3" long; .5-1 oz)

In the third month **finger nails, toenails** and **hair** appear.

fetus can bring hands together and suck thumb

The **kidneys** become functional and

breathing movements are coordinated

The face squints and frowns and the fetus can open its mouth.

Fourth Month (6.5-7" long; 6-7 oz)

A rapid burst of fetal growth occurs in the fourth month.

Fetus is actively turning and moving in uterus

Sucking movements and the **startle reaction**, common in newborns, first develop.

Fifth Month (8-10" long; 1 lb)

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.

the baby has ~15% chance of survival

(the youngest baby to survive a premature birth was born at 23 weeks & 6 days and weighed 10 oz; in 2007)

Sixth Month (11-14"; 1.75-2 lbs)

has 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.

At the end of the 24th week, survival rate is 40-70% outside the uterus without application of intensive care services

Seventh Month (16"; 3 lbs)

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 (13" long; 4-5 lbs)

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

the fetus remains deaf since nerves to the ears have not completely developed.

Ninth Month (19-20"; 7-7.5 lbs)

By the ninth month fetal development is essentially completed.

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.

Parturition

labor begins = complex nervous and hormonal controls

oxytocin from post pituitary

estrogens from placenta & ovary → rhythmic contractions

The placenta begins to fail and the birth process begins.

At delivery, the placenta becomes detached from the uterus and is delivered as the "afterbirth"