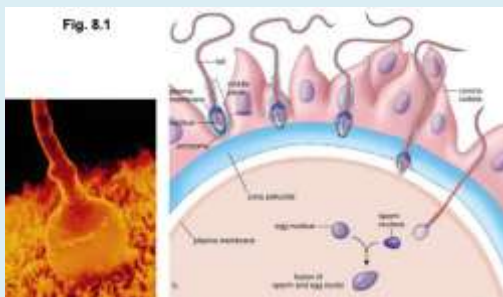


## Fertilization, Development, & Birth



No Reading Assignments:

However, much of the info., the images & videos shown can be found at:

[http://biology.kenyon.edu/courses/biol114/Chap13/Chapter\\_13B.html](http://biology.kenyon.edu/courses/biol114/Chap13/Chapter_13B.html)



1

**Fertilization** = union of egg & sperm

- Sperm has a long journey through reproductive tract (from vagina, uterus, to fallopian tubes).
- Once at egg, sperm compete for entry.
- The egg is a fortress of barriers to sperm entry.

2

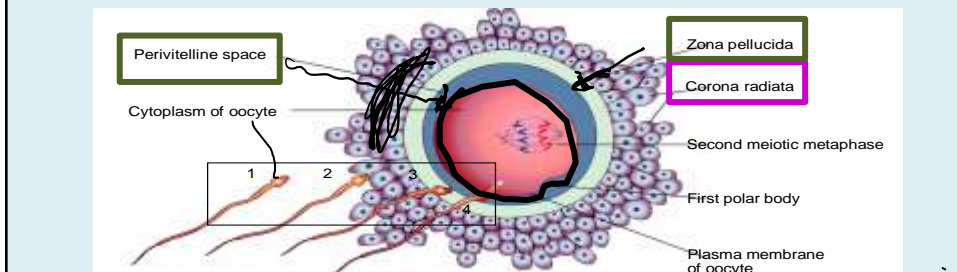
## 1. Fertilization

The egg is a fortress of barriers to sperm entry.

### Layers of the ovulated secondary oocyte (egg):

1. Corona radiata = outermost layer of follicular cells.
2. Zona pellucida (ZP) = layer with receptors for sperm binding.
3. Perivitelline space = space above egg plasma membrane.
4. Egg plasma membrane = innermost layer directly over egg.

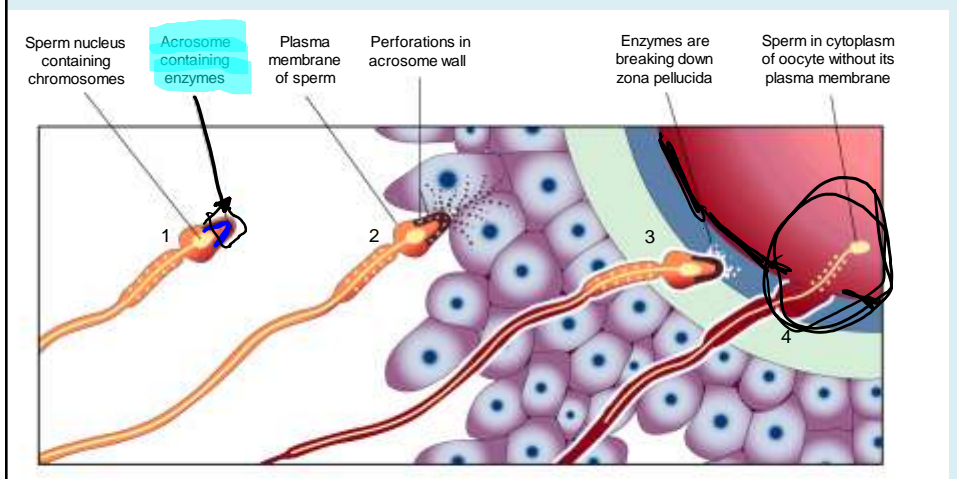
This is place where egg & sperm fuse together.



3

Acrosome = cap of digestive enzymes on head of sperm.

Acrosome reaction = reaction of sperm acrosome when binds to ZP of egg. Enzymes released from acrosome digest egg plasma membrane allowing sperm entry into cell.



4

Click [HERE](#) for YouTube diagrammatic video of fertilization (3.33 min)

Click [HERE](#) for YouTube high quality video of fertilization (5.42 min)

5

**Question?**

**Why can ONLY one sperm enter (fertilize) an egg?**

many

Polysperm = When more than 1 sperm enters an egg. **BAD!**

**There are 2 ways that polyspermy is prevented**

6

There are 2 ways that polyspermy is blocked: 2

1. Fast block = occurs within 2-3 sec of 1<sup>st</sup> sperm entering, change in egg plasma membrane electrical potential from -70 mV to +20 mV.  
~~is~~ gets stimulated

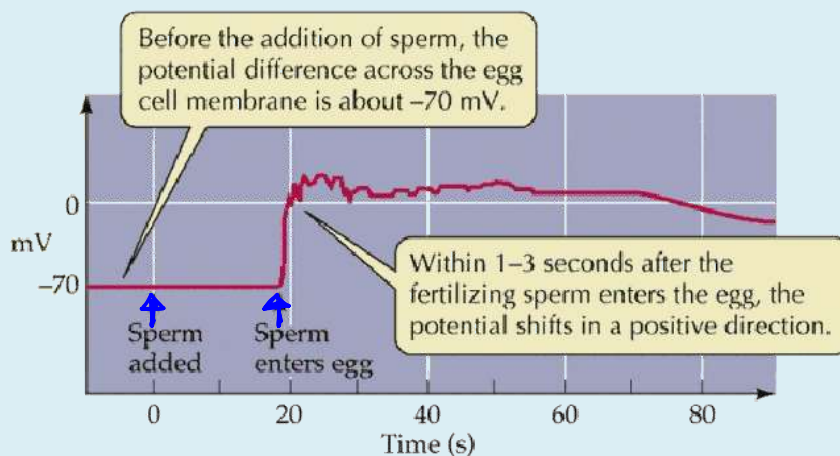
2. Slow block = occurs within 10 sec of 1<sup>st</sup> sperm entering.

A. Fusion of sperm w/plasma membrane causes a Calcium wave to spread through egg.

B. Calcium wave triggers a Cortical reaction = cortical granules released from egg causes water to fill perivitelline space. Water lifts ZP off egg and makes it stiff. No other sperm can enter now. (can't bind to ZP)

7

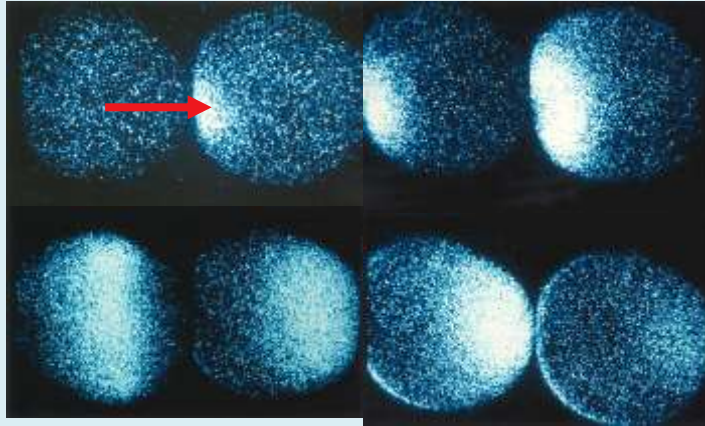
### 1. Fast Block to Polyspermy:



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## 2. Slow Block:

### A. Calcium Wave

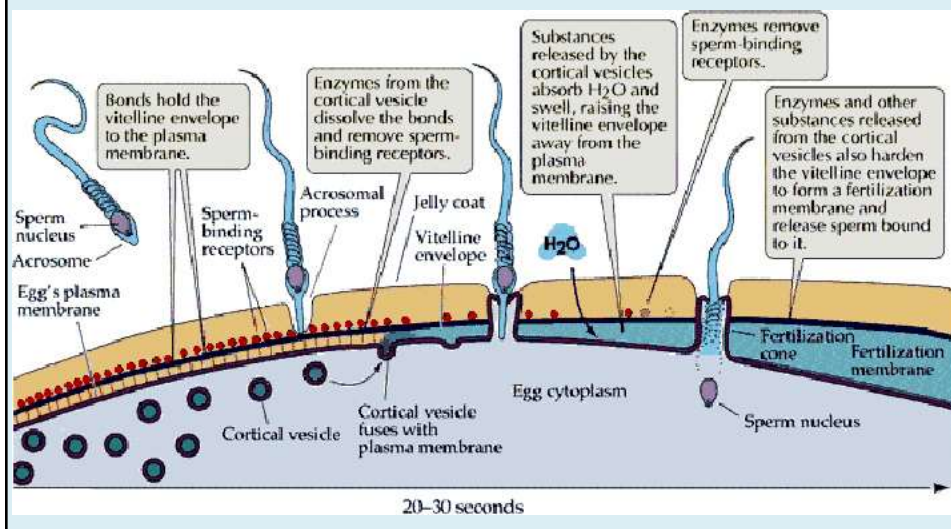


Click [HERE](#) for video

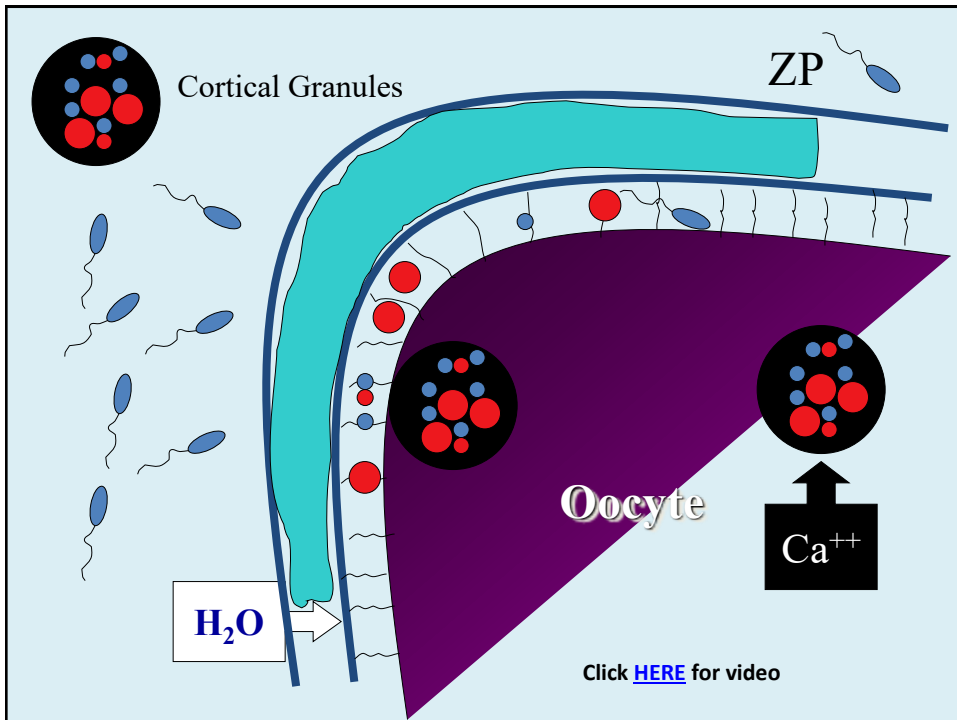
9

## 2. Slow Block:

### B. Cortical Reaction



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## 2. Development

Divided into 3 Classifications:

1. Pre-embryonic period = 1<sup>st</sup> week of development.
2. Embryonic period = 2<sup>nd</sup> week up to 2 months of development.
3. Fetal period = from months 3 – 9 of development.



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## 1. Pre-embryonic period = 1<sup>st</sup> week after single cell zygote created.

Mitosis  
 Single celled zygote differentiates into several cells:  
 2 cell → 4 cell → 8 cell → 16 cell (**Morula**) → Blastocyst

Morula = compact ball of ~ 16 cells.

Blastocyst = ball of cells that secretes **hCG** (& rescues CL).

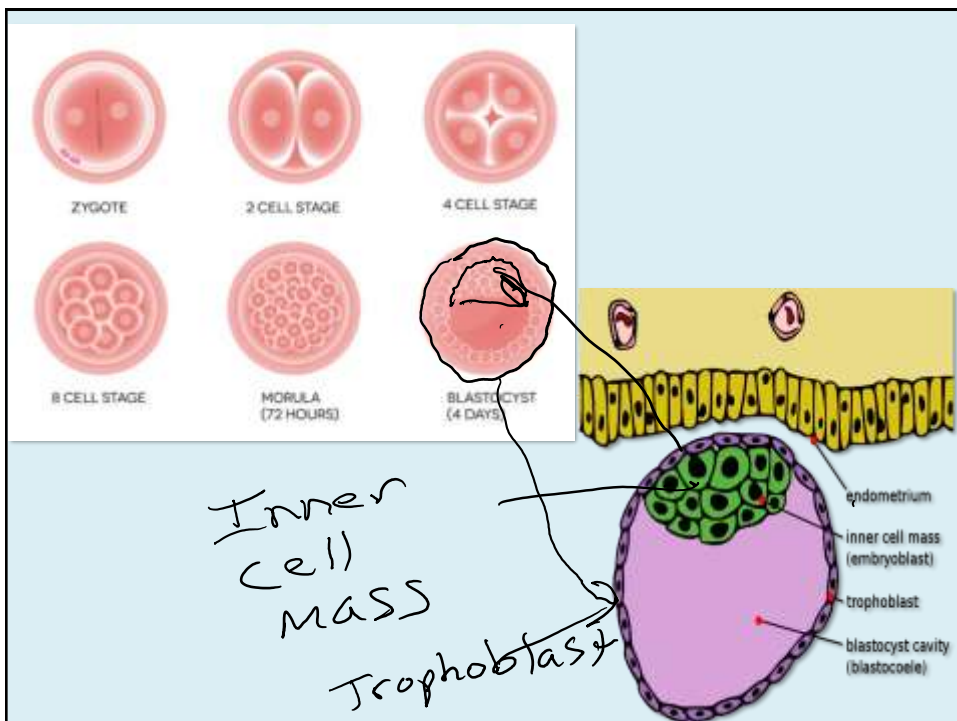
separated into:

a) Inner cell mass (this will become the embryo)

b) Trophoblast (this will become the chorion)

↳ Placenta

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**Pre-embryonic period** = 1<sup>st</sup> week after single cell zygote created.

Single celled zygote differentiates into several cells:

2 cell → 4 cell → 8 cell → 16 cell (Morula) → Blastocyst

Morula = compact ball of ~ 16 cells.

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separated into:

- inner cell mass (this will become the embryo)
- trophoblast (this will become the chorion)

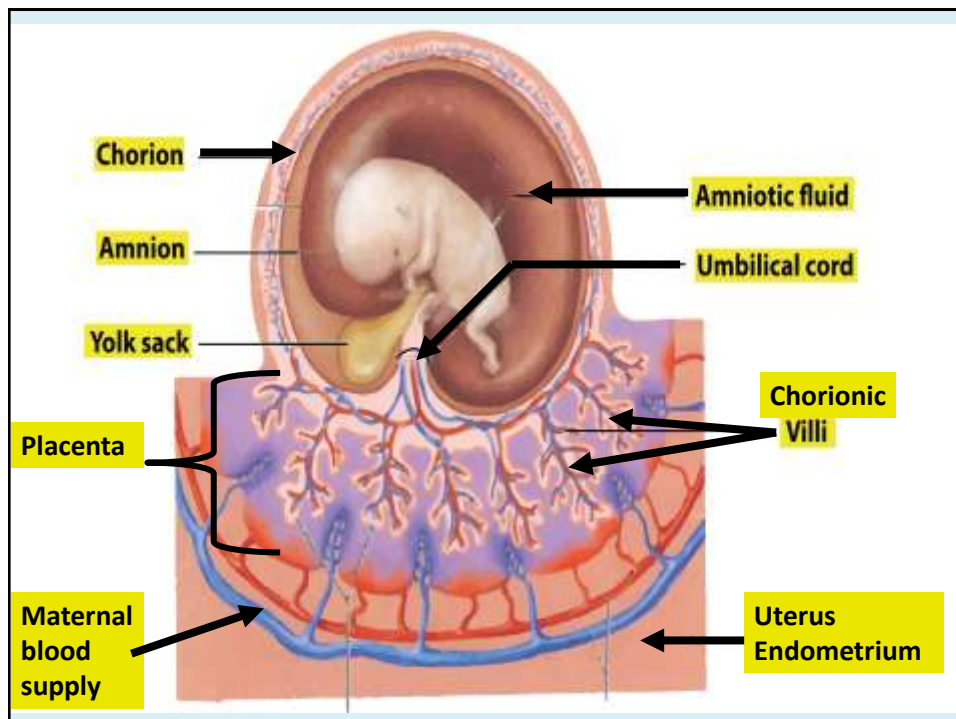
Chorion = structure that becomes the fetal placenta.

Chorionic villi = small projections that burrow into uterus endometrium & becomes the **umbilical cord**.

Amniotic fluid = fluid surrounding embryo/fetus, held within **amniotic sac**.

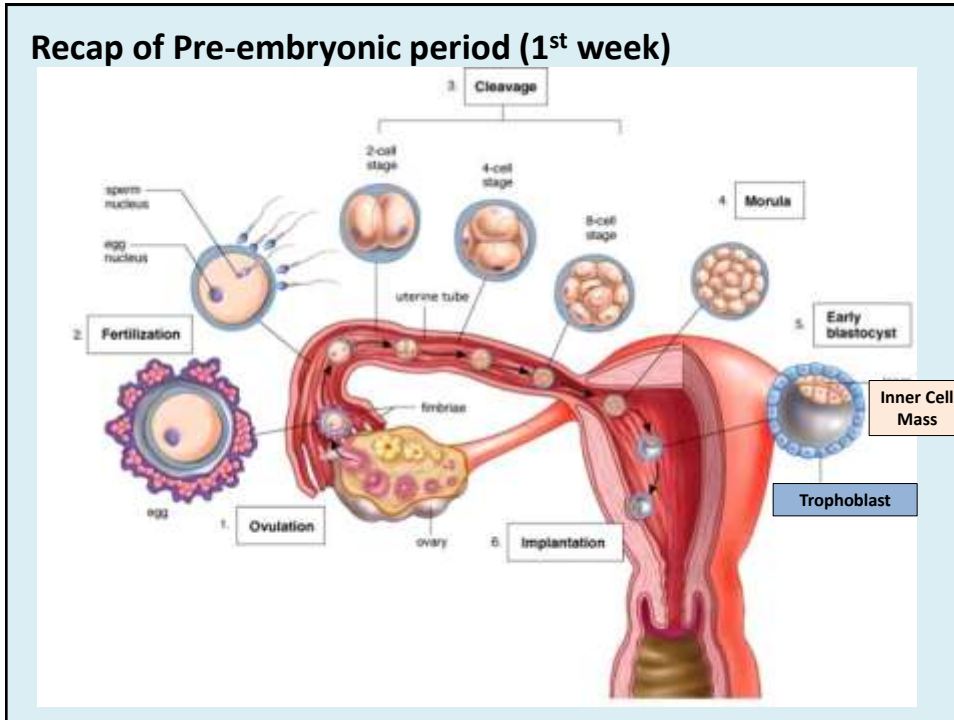
Placenta = connected to the umbilical cord. Allows nutrients, hormones, oxygen (etc...) to enter embryo, and allows waste materials to leave embryo and pass to mom's circulatory system.

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### Pre-embryonic period (1<sup>st</sup> week)

**Implantation**

What is this?

What does it become?

**Question:**  
 What are the 2 divisions of this blastocyst?

**A** = inner cell mass → embryo → placenta  
**B** = trophoblast → chorion → placenta

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## 2. Embryonic period (week 2 to week 8)

Endo = inside  
meso = middle  
Ecto = outside

### Week 2:

- Implantation = embryo implants into endometrium by burrowing its chorionic villi into tissue.
- Gastrulation = embryonic tissues divide into 3 "germ layers":
  1. Endoderm = layer that becomes gastrointestinal & lungs.
  2. Mesoderm = layer becomes skeleton, muscles, heart, blood vessels, urinary & reprod. system.
  3. Ectoderm = layer becomes nervous system, skin, eyes, hair.
- Symptoms of pregnancy begin
- Blood test positive for hCG.

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## 2. Embryonic period (week 2 to week 8)

### Week 3:

- Miss period.
- Urine tests positive for hCG.
- Placenta well formed (attachment between endometrium & embryo)
- Placenta produces progesterone for remainder of pregnancy.

**Week 4:** Heart cells form & make sounds as they contract. No formed heart yet. Limb buds form. Cartilaginous skeleton.



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## 2. Embryonic period (week 2 to week 8)

### Week 8 (2 months & end of embryonic period):

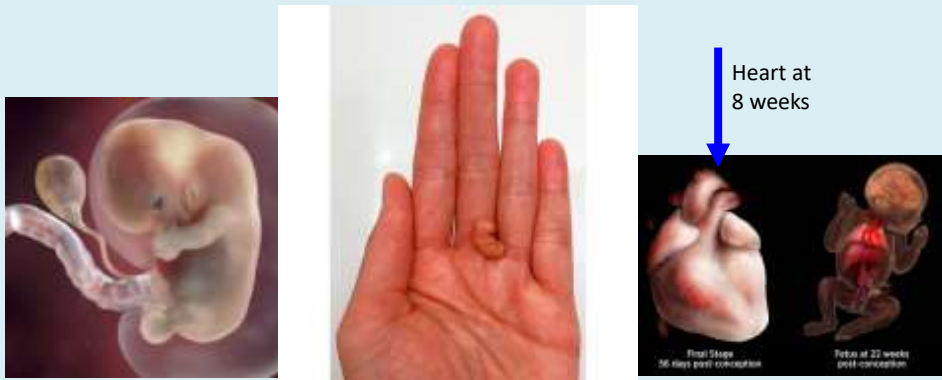
Start to “show” pregnancy (embryo only 1 ½ inches!)

Organ systems form.

Bony skeleton starts.

Nose, ears, fingers & toes.

Sex differentiation starts



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Click [HERE](#) for YouTube video of development from Day 1 – 58 (up to 8 weeks) 3.34 min

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### 3. Fetal period (3<sup>rd</sup> to 9<sup>th</sup> month)

#### Month 3 (end of 1<sup>st</sup> trimester):

Best time to determine gender by **ultrasound**. Uterus size of grapefruit.

#### Month 4 (start of 2<sup>nd</sup> trimester):

Organ systems become more developed. Fetal movement felt.

Minimum time fetus needs to survive outside of womb (90% survival @26 – 28 weeks).



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### 3. Fetal period (3<sup>rd</sup> to 9<sup>th</sup> month)

#### Month 5:

Fetus covered by protective cheesy coating called "**vernix caseosa**".

#### Month 6 (end of 2<sup>nd</sup> trimester):

Fetus covered by fine hairs called "**lanugo**". Mom's breasts swell.

vernix caseosa



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### 3. Fetal period (3<sup>rd</sup> to 9<sup>th</sup> month)

#### Month 7 (start of 3<sup>rd</sup> trimester):

Male fetus testes descend into scrotal sac.

Most organ systems fully formed. Eyes open.

Fetus gains in size & weight. SO DOES MOM! She gets “**striae**” (stretch marks)

#### Month 8:

Baby's body turns head down facing cervix. Baby gains ~1 lb /week.



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## Fetal period (3<sup>rd</sup> to 9<sup>th</sup> month)

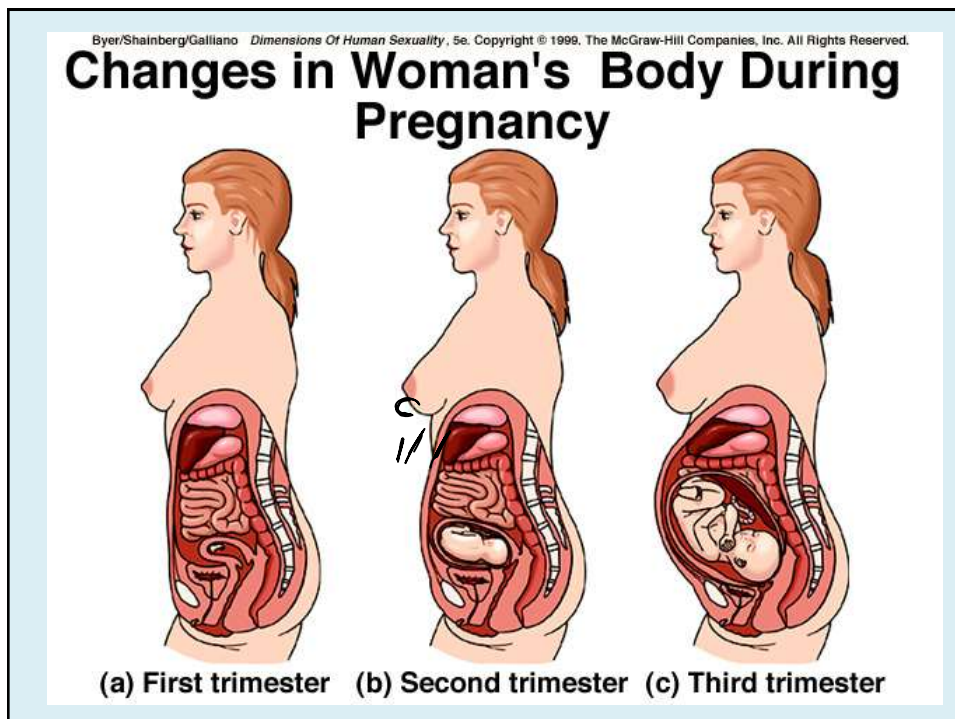
### Month 9 (end of 3<sup>rd</sup> trimester):

Fetus ready for birth

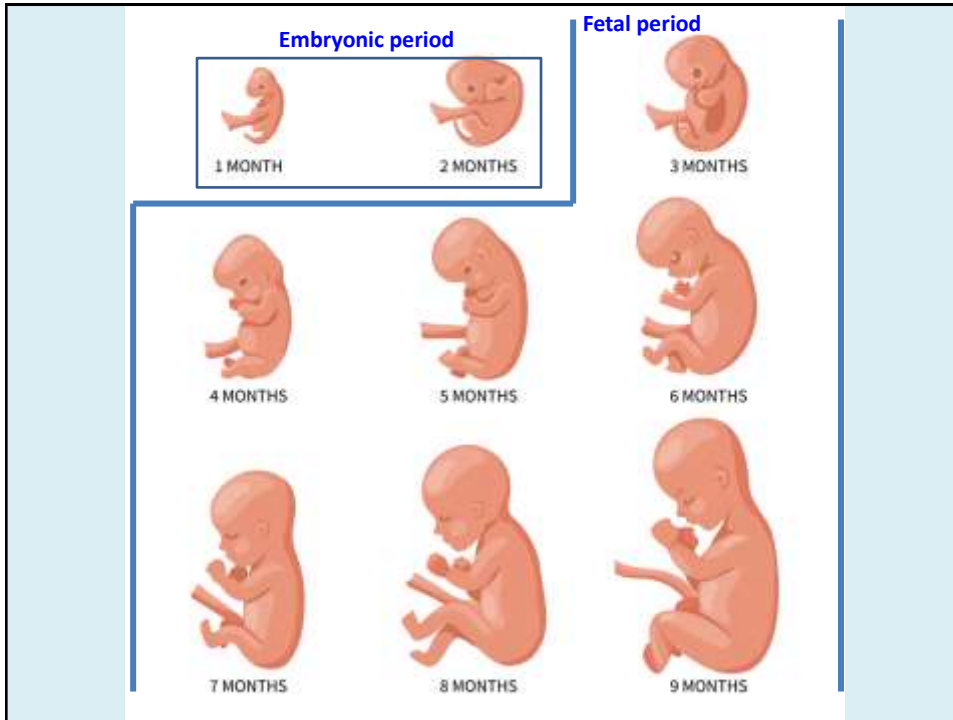
Fetus controls events of start of labor!



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## Effects of Placental Hormones on Mom:

The placenta actually makes several hormones that affect the mother:

1. Progesterone
  - A) keeps uterus pregnancy-friendly.
  - B) suppresses mom's immune system to ↓ chance it will attack fetus.
2. Estrogen
  - A) causes water retention in mom.
  - B) this causes ↑ blood pressure. → gestational hypertension
3. Peptide Hormone - causes insulin-resistance in mom (mom's tissues take up less blood glucose and fetus diverts glucose to itself)

Insulin resistance = Type 2 diabetes  
Gestational diabetes.

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## Effects of Placental Hormones on Mom:

The placenta actually makes several hormones that affect the mother:

Gestational hypertension = high blood pressure in pregnant women due to high placental estrogen. May endanger mom – and BP drugs during pregnancy complicated.

Gestational diabetes = increased blood glucose in pregnant women due to placental peptide hormone. Can also cause problems.

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**Question:**

**What is an ultrasound?**

= use sound waves to create a picture of baby in utero.

"Sonogram"



Sonogram (ultrasound) at 4 ½ months

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**Pre-natal testing** = genetic & other testing done on fetal cells to look for problems in development.

Ex. A) Amniocentesis = insert long needle (carefully!) into amniotic sac to withdraw fluid (and fetal cells) for analysis.



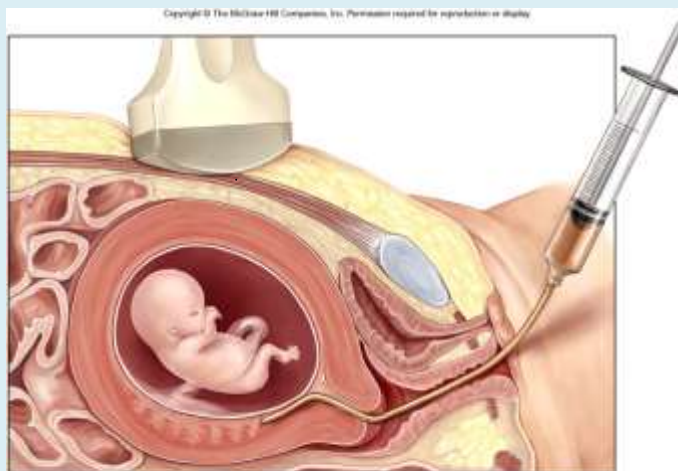
a. During amniocentesis, a long needle is used to withdraw amniotic fluid containing fetal cells.

33

**Pre-natal testing** = genetic & other testing done on fetal cells to look for problems in development.

Ex. B) Chorionic villi sampling = insert catheter into vagina, cervix, uterus, and suctioning some chorionic villi (of placenta) for analysis.

**Safer but more expensive than amnio.**



b. During chorionic villi sampling, a suction tube is used to remove cells from the chorion, where the placenta will develop.

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## Events at Start of Labor:

- > fetus releases **cortisol** (stress hormone) at losing room in uterus.
- > fetal cortisol causes mom's pituitary to release **oxytocin**.
- > Oxytocin causes strong uterine contractions.
- > Uterine contractions squeeze fetus more.
- > Fetus releases more cortisol, causes more oxytocin release.
- > Fetus head pressed against cervix, causes more oxytocin release.
- > cycle repeats until fetus out!

35

## 3. Birth

Parturition = the process of giving birth.

**Has 3 stages:**

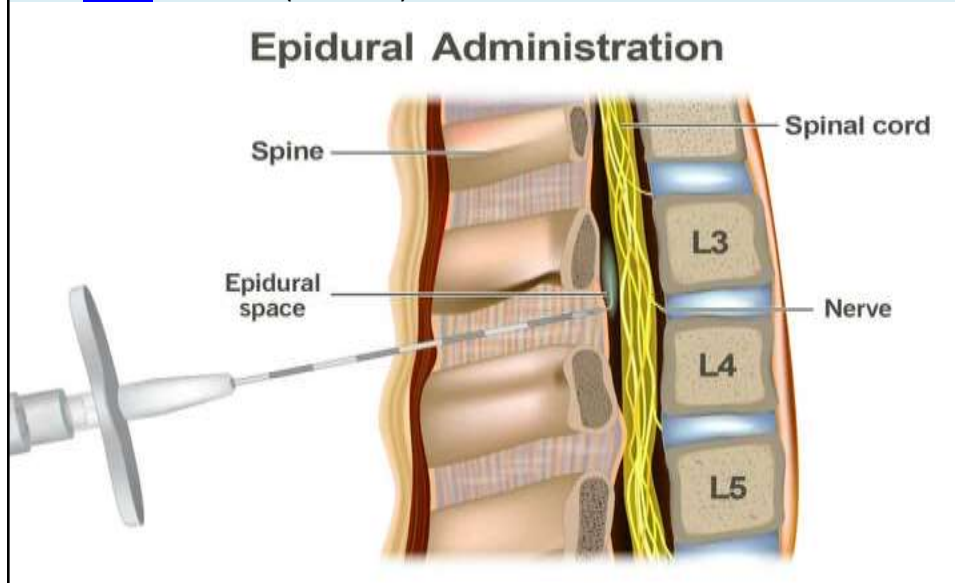
**Stage 1: (can last 1 – 20 hrs or more!)**

- Baby's head presses on cervix causing oxytocin release by mom's brain.
- Uterine contractions push baby against cervix more.
- **Mucus plug** of cervix breaks free.
- Baby's head enters cervix & amniotic sac ruptures (**water breaks**)
- Cervix begins dilating.
- **Epidural** can be given (catheter placed in spinal lumbar epidural space to give anesthetic).

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Epidural = \_\_\_\_\_

Click [HERE](#) for video (1.36min)



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### 3. Birth

**Parturition** = the process of giving birth.

**Has 3 stages:**

**Stage 1: (can last 1 – 20 hrs or more!)**

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- Uterine contractions push baby against cervix more.
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- Baby's head enters cervix & amniotic sac ruptures (**water breaks**)
- Cervix dilated up to 10 cm
- Epidural can be given

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## 3. Birth

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**Has 3 stages:**

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- Baby's head presses on cervix causing oxytocin release by mom's brain.
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- Cervix dilates up to 10 cm
- Epidural can be given

**Stage 2:**

- Baby is delivered (leaving out a lot of excitement in between here!)
- **Episiotomy**, if needed, performed here.

=



39

## 3. Birth

**Parturition** = the process of giving birth.

**Has 3 stages:**

**Stage 1:** (can last 1 – 20 hrs or more!)

- Baby's head presses on cervix causing oxytocin release by mom's brain.
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**Stage 2:**

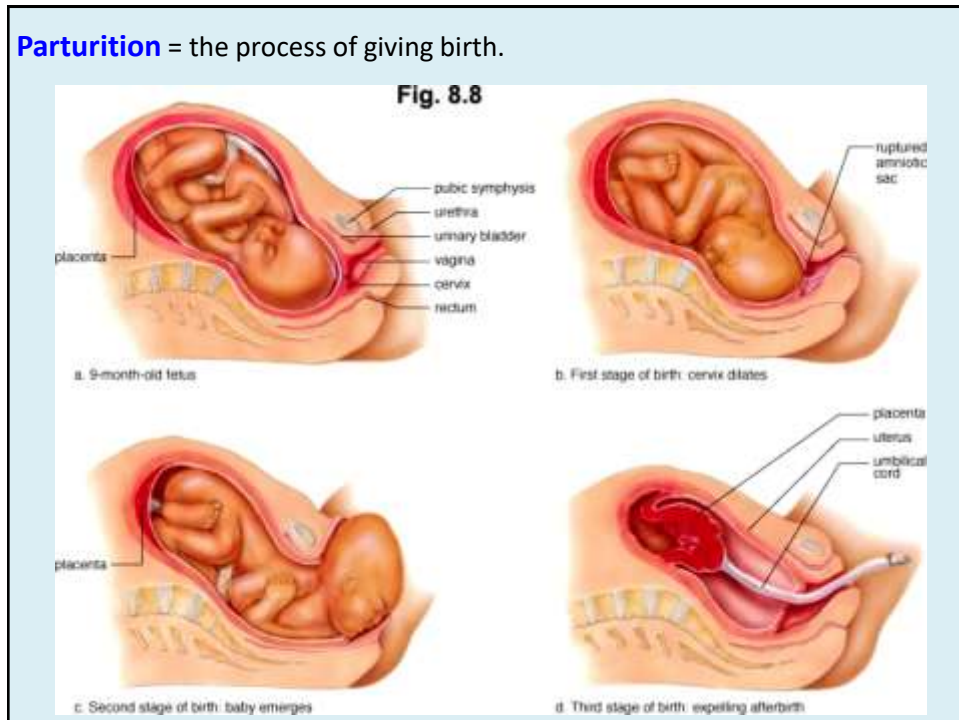
- Baby is delivered (leaving out a lot of excitement in between here!)
- **Episiotomy**, if needed, performed here.

**Stage 3:**

- Placenta expelled (afterbirth)
- **Uterine involution starts** (uterus returns to normal shape)  
[Breast feeding helps uterine involution – it causes oxytocin release & tightening of uterus!]

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**Parturition** = the process of giving birth.



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**Parturition** = the process of giving birth. Click [HERE](#) for video (3.04 min)

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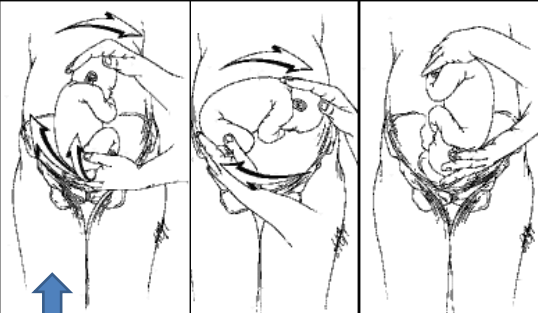
Dystocia = problems during birth.

Breech birth = baby is positioned upside down for birth (butt or feet first)

Variations of the breech presentation



Complete breech      Incomplete breech      Frank breech



head moving

**External cephalic version** = doctor physically reaches in & turns baby's body into right position (head down).

- > Can cause bleeding of mom that can lead to blood mixing w/fetus. (see **Rh disease** later)

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**Dystocia** = problems during birth.

if mom is compromised  
if mom has a STD (herpes, HIV)

- Breech birth
- Fetus too big for mother's pelvic opening
- Mother is not able to push enough (low oxytocin?)

Might require C-Section

Cesarean section

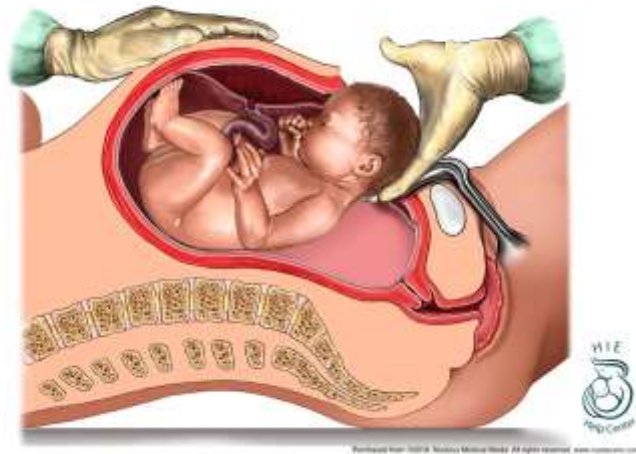


With both hands, the surgeon reaches into the abdominal incision and lifts the baby's head as an assistant pushes down on the upper uterus

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**C-Section** = surgical removal of fetus due to complications during birth, or when baby's or mother's life is in danger.

Click [HERE](#) for video



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## Postpartum Depression

### —SYMPTOMS OF— POSTPARTUM DEPRESSION



MIND@HELP

MINDJOURNAL




The sudden drop in estrogen and progesterone from the placenta can have a profound effect on the mother's emotional and psychological well being.


That, and the responsibility for a whole new human being, can overwhelm a new mother.

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## THINGS YOU MIGHT NOT KNOW ABOUT POSTPARTUM DEPRESSION



**80%** of women suffer from "baby blues"




**15%** of women suffer from Postpartum Depression




**8%** of men are also affected by it



Commonly begins between a week and a month after delivery




After estrogen and progesterone levels quickly drop, this chemical change in the brain may trigger mood swings




Lack of sleep is another big factor in causing Postpartum Depression


**There are many symptoms of Postpartum Depression. Some are:**




Feeling sad, hopeless, empty, or overwhelmed



Experiencing anger or rage




Struggling from physical aches and pains




Thinking about self-harm or harming the baby

**WOMEN WITH A PREVIOUS HISTORY OF DEPRESSION, SUBSTANCE ABUSE, OR WHO EXPERIENCE COMPLICATIONS DURING CHILD BIRTH ARE AT A HIGHER RISK.**


**ONLY A HEALTH CARE PROVIDER CAN DIAGNOSE A WOMAN WITH POSTPARTUM DEPRESSION, BECAUSE THE SYMPTOMS ARE THE SAME.**



Two types of counseling have shown to be effective: Cognitive Behavioral Therapy (CBT) and Interpersonal Therapy (IPT)



Some healthcare providers also prescribe antidepressant medication when appropriate



Without treatment, postpartum depression can last for months or even years

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### Pros and Cons of Breast Feeding:

Pros	Cons
<p><i>~milk</i> Breast tailored to baby's needs</p> <p>Breast milk has antibodies</p> <p>Oxytocin release = bonding</p> <p>Oxytocin → contract uterus ↳ back to normal shape.</p> <p>Free milk (Formula \$\$\$)</p> <p>Weight loss (making milk a lot energy)</p> <p>Breast Feeding delays ovulation ~ 6 months.</p>	<p>Mom's meds cross breast milk.</p> <p>Time!</p> <p>Mom's <del>post</del> postpartum Leave?</p> <p>Energy expensive</p> <p>Pain - especially w/teething</p> <p>Chapped/dry nipples</p> <p>Mastitis's - breast inflammation</p> <p>clogged milk ducts</p>

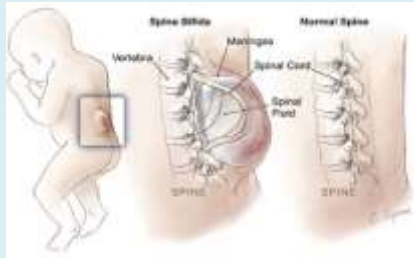
48



## Birth Defects:

Many!!!

**Spina bifida** = fetal spinal cord protrudes through back. Requires surgical repair.



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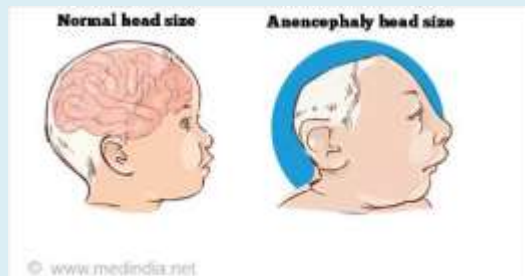
## Birth Defects:

Many!!!

*absent head (brain)*

**Anencephaly** = in adequate head & brain development..

- > serious disorder
- > usually leads to **miscarriage**.
- > if baby is born, likely to die soon after.



**Miscarriage** = embryo or fetus dies in utero.

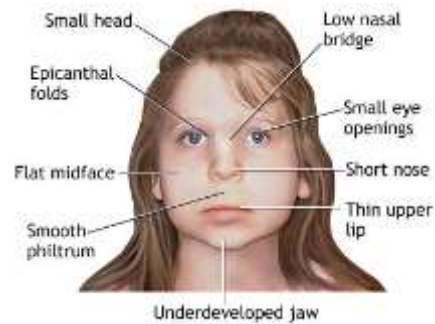
*33% of pregnancies can end in miscarriage*

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## Fetal Alcohol Syndrome



Fetal Alcohol Syndrome



Mom drinks heavily regularly during pregnancy, especially during 1<sup>st</sup> trimester (organs developing)

Baby born w/ alcohol withdrawal, developmental delays, underweight, classic facial features (see pic above)

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## Rh incompatibility in pregnancy

**Rh** = an antigen on some red blood cells.

If Rh- woman pregnant from Rh+ man – 50% chance baby is Rh+

Risk of exposure of mom's blood stream to fetal RBCs with Rh+ antigens.  
(Ex. During miscarriage or tissue tearing during birth or C-section)

Mom's immune system would develop anti-Rh antibodies within 2 weeks of exposure.

- During her **next pregnancy** if baby Rh+, maternal antibodies cross placenta
- Maternal antibodies attack (hemolyze) fetal RBCs
- "autoimmune **hemolytic anemia**" = immune destruction of RBCs in baby from mom's antibodies

### Prevention: Coomb's test to confirm autoimmune hemolytic anemia in newborn

- > If doctor suspects exposure to Rh+ blood in mom's first pregnancy.
  - > Give injection of anti-Rh antibodies to mom
  - > antibodies destroy fetal Rh+ fetal RBCs in mom's
- Body BEFORE her immune system detects & makes own antibodies.



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## Fertilization, Development, & Birth - VIDEO

Click [HERE](#) for video (3.10 min)