Fertilization = **union of egg & sperm to make a zygote**.

- 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.
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.

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

because if another sperm entered, the extra chromosomes would doom the embryo.

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

There are 2 ways that polyspermy is prevented
There are 2 ways that polyspermy is blocked:

1. **Fast block** = occurs within 2-3 sec of 1st sperm entering, change in egg plasma membrane electrical potential from -70 mV to +20 mV.

2. **Slow block** = occurs within 10 sec of 1st sperm entering.
   
   A. Fusion of sperm w/plasma membrane causes a calcium wave of egg.
   
   B. Calcium wave triggers a cortical reaction = cortical granules released from egg causes water to fill perivitalline space. Water lifts ZP off egg and makes it stiff. No other sperm can enter now.

1. Fast Block to Polyspermy:

Before the addition of sperm, the potential difference across the egg cell membrane is about -70 mV.

Within 1–3 seconds after the fertilizing sperm enters the egg, the potential shifts in a positive direction.


### 2. Slow Block:

#### A. Calcium Wave

Click [HERE](#) for video

![Calcium Wave Image]

#### B. Cortical Reaction

![Cortical Reaction Diagram]
Review

**Fertilization:**

- Layers around the egg:
  - corona radiata
  - zona pellucida
  - Perivitelline space, and
  - egg membrane

- Sperm (acrosome cap, and acrosome reaction)

- **Polyspermy**
  > Blocks to polyspermy:
    1. Fast block (membrane electrical potential goes from -70 to +20)
    2. Slow block (Calcium wave and cortical reaction)
2. Development

Divided into 3 Classifications:

1. **Pre-embryonic Period** = 1st week of development.
2. **Embryonic Period** = 2nd week up to 2 months of development.
3. **Fetal Period** = from months 3 – 9 of development.

1. **Pre-embryonic period** = 1st 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.

   **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)

   Chorion becomes placenta.
**Pre-embryonic period** = 1st week after single cell zygote created.

Single celled zygote differentiates into several cells:
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- Separated into:
  a) Inner cell mass (this will become the embryo)
  b) 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.
Recap of Pre-embryonic period (1\textsuperscript{st} week)
Pre-embryonic period (1\textsuperscript{st} week)

**Implantation**

- **What is this?**
  - Uterus
  - Endometrium
  - Chorionic villi
  - Umbilical cord
  - Trophoblast

- **What does it become?**

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

- A = Inner cell mass
- B = Trophoblast

---

2. Embryonic period (week 2 to week 8)

**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.

**Endo = within**
**Meso = middle**
**Ecto = outer**

**hCG = produced by embryo to rescue corpus luteum**
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.

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

Heart at 8 weeks
3. Fetal period (3rd to 9th month)

Month 3 (end of 1st trimester):
Best time to determine gender by ultrasound. Uterus size of grapefruit.

Month 4 (start of 2nd trimester):
Organ systems become more developed. Fetal movement felt. Minimum time fetus needs to survive outside of womb (90% survival @26 – 28 weeks).
3. Fetal period (3rd to 9th month)

Month 5:
Fetus covered by protective cheesy coating called “vernix caseosa”.

Month 6 (end of 2nd trimester):
Fetus covered by fine hairs called “lanugo”. Mom’s breasts swell.

March 3/30/2023

3. Fetal period (3rd to 9th month)

Month 7 (start of 3rd 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.
Striae (gravidarum)

Fetal period (3\textsuperscript{rd} to 9\textsuperscript{th} month)

\textbf{Month 9 (end of 3\textsuperscript{rd} trimester):}
Fetus ready for birth
Fetus controls events of start of labor!
Changes in Woman's Body During Pregnancy

(a) First trimester  (b) Second trimester  (c) Third trimester

Embryonic period

Fetal period

1 MONTH  2 MONTHS

3 MONTHS

4 MONTHS  5 MONTHS  6 MONTHS

7 MONTHS  8 MONTHS  9 MONTHS
Effects of Placental Hormones on Mom:

The placenta actually makes several hormones that affect the mother:

1. **Progesterone** = pregnancy hormone
   - 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.  

3. **Peptide hormone** – causes insulin-resistance in mom (mom's tissues take up less blood glucose and fetus diverts glucose to itself)

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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.
Question: What is an ultrasound?

Sonogram (ultrasound) at 4 ½ months

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

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

*Safer but more expensive than amnio.*

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**Review**

- **Development:**
  - **> 3 Periods:**
    1. Pre-embryonic period (week 1)
    2. Embryonic period (week 2 to 2 months)
    3. Fetal period (months 3 – 9)

- **1. Pre-embryonic period vocab:**
  - Morula
  - Blastocyst
    - inner cell mass – becomes the embryo
    - trophoblast – becomes the chorion
  - Chorion – becomes the placenta
  - Chorionic villi – becomes the umbilical cord
  - Amniotic fluid – surrounds the embryo within an amniotic sac
  - Placenta – where mom’s bloodstream allows substances to diffuse across to embryonic bloodstream.
Review

2. Embryonic Period (week 2 – week 8)
   ➢ Know some basic developmental milestones for each week.

3. Fetal Period (know some basic developmental milestones each month)
   ▪ Vocab:
     > implantation
     > gastrulation
       - 3 germ layers and what they give rise to (endoderm, mesoderm, and ectoderm)
     > ultrasound
     > vernix caseosa
     > lanugo
   ▪ Placental hormones & effects on mom:
     > Progesterone
     > Estrogen (can lead to gestational hypertension)
     > Peptide hormone (can lead to gestational diabetes)
   ▪ Prenatal testing (amniocentesis & chorionic villi sampling)

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!

and also placenta is out.
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. (10 cm)
- **Epidural** can be given (catheter placed in spinal lumbar epidural space to give anesthetic).

Epidural = **anesthetic injected into the epidural space around the spinal cord.**

Click [HERE](#) for video
3. Birth

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- Uterine contractions push baby against cervix more.
- Mucus plug of cervix breaks free.
- Baby’s head enters cervix & amniotic sac ruptures (water breaks)
- Cervix dilated 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.

= controlled cut in perineum (area between vagina & anal opening)
3. Birth

Parturition = the process of giving birth.

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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 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.
Stage 3:
▪ Placenta expelled (afterbirth) within 30 min of birth.
▪ Uterine involution starts (uterus returns to normal shape)
[Breast feeding helps uterine involution—it causes oxytocin release & tightens uterus!]

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

Dystocia = problems during birth.

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

External cephalic version = doctor physically reaches in & turns baby’s body into right postion (head down).
  > Can cause bleeding of mom that can lead to blood mixing w/fetus. (see Rh disease later)
**Dystocia** = problems during birth.

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

Might require C-Section

---

**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

Reasons for C-Section

- Breech birth
- Stress of mother (hypertension, diabetes, other)
- Fetal stress
- Placenta previa (placenta blocks birth canal)
- Umbilical cord around baby’s neck
- General herpes or other infectious disease
Postpartum Depression

SYMPTOMS OF POSTPARTUM DEPRESSION

- Intense sadness
- Hopelessness
- Empinness
- Depressive moods
- Loss of interest in activities
- Disrupted sleep
- Reduced appetite
- Fatigue
- Restlessness
- Guilt
- Increased indecisiveness
- Suicidal tendencies

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.

↑ risk
Genetics

THINGS YOU MIGHT NOT KNOW ABOUT POSTPARTUM DEPRESSION

- 80% of women suffer from "baby blues".
- 15% of women suffer from Postpartum Depression.
- 8% of moms are also affected by it.

Commonly symptoms include:
- Decreased appetite,
- Weight loss,
- Insomnia,
- Feelings of guilt and inadequacy,
- Difficulty bonding with the baby,
- Irritability.

There are many symptoms of Postpartum Depression. Some are:

- Parenting self, experiencing stress or overwhelm
- Experiencing anger or rage
- Suffering from physical and emotional pain
- Thinking about self harm or harming the baby

Women with a previous history of depression or experience complications during pregnancy are at a higher risk.

There are many types of treatment available to help women with Postpartum Depression. Some are:

- Counseling
- Antidepressants
- Support groups

Without treatment, postpartum depression can last for months or even years.
## Pros and Cons of Breast Feeding:

<table>
<thead>
<tr>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uterus back to normal shape</td>
<td>Baby allergic to milk proteins IF</td>
</tr>
<tr>
<td>Antibodies in breast milk protects baby</td>
<td>IF mm is highly stressed IF mm is addicted to drugs</td>
</tr>
<tr>
<td>Bond with baby (oxytocin release)</td>
<td></td>
</tr>
<tr>
<td>Free milk for baby (formula too)</td>
<td></td>
</tr>
<tr>
<td>Making milk takes energy! (help mm lose weight)</td>
<td>Can be painful, especially with teething.</td>
</tr>
</tbody>
</table>

### Birth Defects:

**Many!!!**

**Spina bifida** = fetal spinal cord protrudes through back. Requires surgical repair.
Birth Defects:
Many!!!

**Anencephaly** = in adequate head & brain development..
> serious disorder
> usually leads to **miscarriage**.
> if baby is born, likely to die soon after.

**Miscarriage** = spontaneous abortion due to fetal problems
~30% pregnancies

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*fetal alcohol syndrome*

Mom drinks heavily regularly during pregnancy, especially during 1st trimester (organs developing)

Baby born w/ alcohol withdrawal, developmental delays, underweight, classic facial features (see pic above)
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 and fetal Rh+ fetal RBCs in mom’s Body BEFORE her immune system detects & makes own antibodies.

Fertilization, Development, & Birth - VIDEO

Click HERE for video (3.10 min)
Review

- **Labor vocab:**
  - Oxytocin
  - Epidural
  - Episiotomy
  - Uterine involution
  - Dystocia
  - Breech birth
  - External cephalic version
- **C-section, and reasons why it might be needed.**
- **Postpartum depression & its causes:**
- **Birth defects:**
  - Spina bifida
  - Anencephaly
  - Fetal alcohol syndrome
- **Rh incompatibility**
- **Miscarriage**