### Critical Periods of Development

<table>
<thead>
<tr>
<th>Time Period</th>
<th>Embryonic Period (in weeks)</th>
<th>Total Period (in weeks)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-2</td>
<td>1st trimester</td>
<td>12-20</td>
</tr>
<tr>
<td>3-8</td>
<td>2nd trimester</td>
<td>20-30</td>
</tr>
<tr>
<td>9-16</td>
<td>3rd trimester</td>
<td>30-36</td>
</tr>
<tr>
<td>20-36</td>
<td></td>
<td>36-40</td>
</tr>
</tbody>
</table>

- **Central nervous system**
- **Heart**
- **Arms**
- **Eyes**
- **Legs**
- **Teeth**
- **Palate**
- **External genitalia**
- **Ear**

**Notes:**
- Critical periods are highly sensitive periods.
- Prenatal death refers to major morphological abnormalities.
- Physiological defects refer to minor morphological abnormalities.

**Timeline:**
- **C.N.S.** (Central Nervous System)
- **Eye**
- **Heart**
- **Ear**
- **External Genitalia**
Sperm Penetration and Meiosis II

Activation of Sperm.

Capacitation: Changes undergone by spermatozoa in the female genital tract that enables them to penetrate and fertilize an egg.

- Facilitated by the removal of sterols (e.g. cholesterol) and non-covalently bound epididymal/seminal glycoproteins. The result is a more fluid membrane with an increased permeability to Ca^{2+}.
- An influx of Ca^{2+} produces increased intracellular cAMP levels and thus, an increase in motility.
- The tripeptide FPP (fertilization promoting factor) produced by the male is essential for capacitation. It has a synergistic stimulatory effect with adenosine that increases adenyl cyclase activity in the sperm.
- FPP is found in the seminal fluid, and comes into contact with the spermatozoa upon ejaculation.
"Polyspermy" means fertilization by more than one sperm.

**“Fast block” to polyspermy:**
- Uses a propagated change in electrical voltage across the plasma membrane of the oocyte.
- This depolarization is closely equivalent to nerve action potentials!
- Before being sperm contact, the oocyte membrane is at a resting voltage of -70 millivolts, same as most cells.
- At sperm contact ion channels open in the plasma membrane that let sodium ions leak in (& also calcium ions).
- The oocyte membrane (somehow!) won't fuse with the sperm membrane after it has depolarized

**“Slow blocks” to polyspermy**
- Just under the plasma membrane of oocytes are thousands of Cortical vesicles.
- The increased calcium concentration causes these cortical vesicles to fuse with the plasma membrane and release their content.
- Enzymes in the cortical vesicles digest away adhesion molecules on the oocyte surface that are needed for sperm to stick to oocyte membrane.
- In some animals these Cortical vesicles form a “fertilization membrane” by lifting the Zona pellucida away from the plasma membrane.
Problems Associated with Polyspermy

Partial molar pregnancy
- The placenta grows abnormally into tissue called a “mole.” Any fetal tissue that develops is likely to have severe defects.
- Caused when a normal egg is fertilized by two sperm, “polyspermy.”

Complete molar pregnancy.
- In place of a normal placenta and embryo, a mole of abnormal placental tissue grows into a grapelike cluster that can fill the uterus.
- An abnormal egg with no genetic information is fertilized by a sperm. The sperm’s chromosomes duplicate and develop into a complete mole.
- Some molar pregnancies lead to abnormal cell growth called gestational trophoblastic disease. A small percentage of these may become invasive cancer.

Early Mitotic cell division are called “Cleavage”
Cleavage results in smaller cells and increase cell numbers but the size of the zygote remains the same size as the egg.
Cleavage results in a solid ball of cells “Morula” and finally a hollow ball of cells “Blastrula or Blastocyst”

Blastrula or Blastocyst arrives in the uterus after about 6 days and implants in the endometrium
The Human Fetus develops from a group of cells called the Inner Cell Mass.

The Inner Cell Mass develops into two embryonic tissues.
Embryo develops the third embryonic tissue and extra-embryonic membranes

Extra-embryonic membranes and the modification to form the placenta and the umbilical cord
Formation of the placenta and umbilical cord

Implanted fetus showing the extra-embryonic membranes and layers of the endometrium
Structures of the Placenta
First Trimester, about 5 weeks

Second Trimester, about twenty weeks, late second trimester premature baby
Third Trimester, about 30 weeks
Hormonal Control of Development and Childbirth

Cyclic hormone levels during pregnancy
Childbirth

Formation of Monozygotic Twins

Figure 7-22 Diagrams illustrating how some monozygotic twins may develop from one zygote. Division may occur anywhere from the two-cell to the morula stage, producing two identical blastocysts. Each embryo subsequently develops its own amniotic and chorionic sacs. The placentas may be separate or fused.
Formation of Monozygotic Twins

Figure 7-20 Diagrams illustrating how monozygotic twins develop from one zygote by division of the inner cell mass. This is the most common mechanism by which monozygotic (identical) twins develop. Such twins always have separate amniots, a single chorion, and a common placenta.

Formation of Monozygotic Twins

Figure 7-26 Diagrams illustrating how monozygotic twins may rarely develop. Division of the embryonic disc results in two embryos within one amniotic sac. A, complete division gives rise to separate twins. B and C, incomplete division results in various types of conjoined twins.
Formation of Monozygotic Twins
Formation of Monozygotic Twins