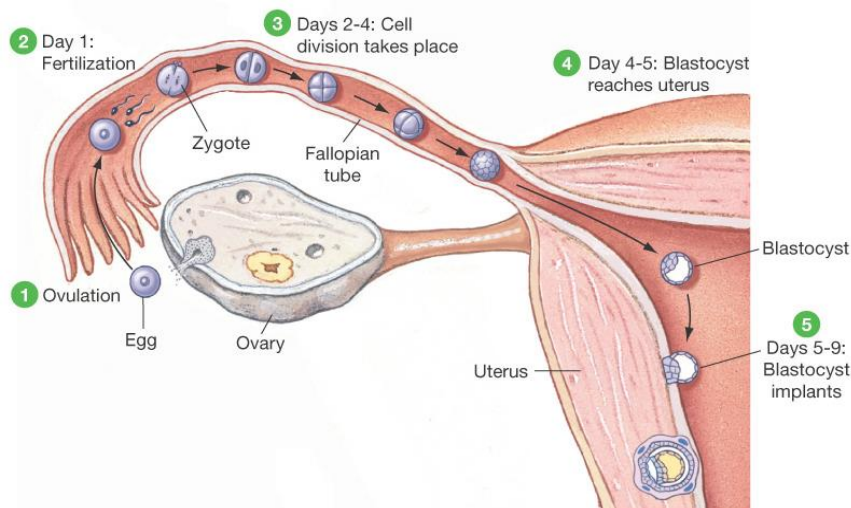


Unit IV – Problem 10 – Physiology: Intra-Uterine Growth Restriction (IUGR)



Ovulation:

- Oocyte contains half the number of chromosomes (23; because the other half will be obtained from the sperm of the father). Oocyte will be released from the ovary and then captured by cilia of fallopian tubes to be fertilized by one sperm in the ampulla.
- Movement of sperm is mediated by prostaglandin (in semen) and oxytocin (from the mother).
- Fertilization occurs when the sperm penetrates corona radiata and zona pellucida which surround the ovum. The sperm will lose its head and tail turning into (male pronucleus).



- The fertilized ovum spends 7 days in fallopian tube until reaching the (blastocyst) stage which contains 100 cells. Then, it will be implanted in the wall of the uterus by the action of trophoblast cells (which later will form the placenta). At this stage progesterone will cause swelling of endometrial cells and they will be called (decidua) providing nutrition for the embryo until the 8th week of gestation after which placenta will take this role.

Placenta:

- **It is composed of:**

- ✓ Fetal placenta: developing from the blastocyst which forms the fetus.
- ✓ Maternal placenta (decidua basalis): developing from maternal uterine tissue.

- Exchange of gases and nutrients will occur between placental villi and the surrounding maternal blood in the intervillous spaces.

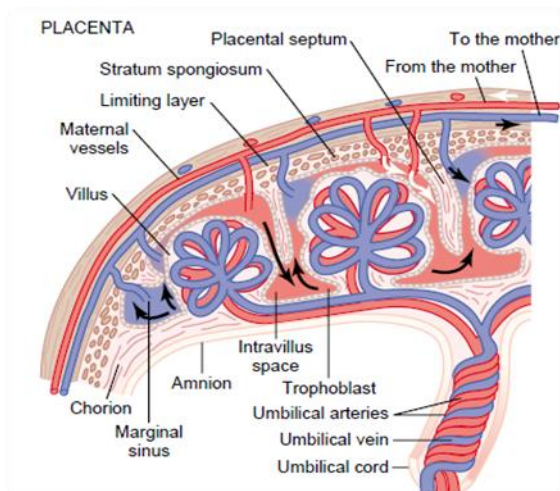
- **Functions:**

- ✓ Exchange of nutrients and waste products between fetus and mother:

- ❖ *Glucose*: transported by facilitated diffusion (carrier protein is needed).
- ❖ *Amino acids*: transported by active transport (carrier protein is needed + ATP).
- ❖ *Lipids (TAG and FA)*: transported from the mother (in early pregnancy); synthesized by the fetus (in late pregnancy).

- ✓ Immunological function (preventing effect of mother cytotoxic T-cell thus no rejection of fetus occurs).

- ✓ Functions as a barrier (preventing infections from reaching the fetus).



✓ Produces hormones and enzymes need to maintain pregnancy:



<p style="text-align: center;">human Chorionic Gonadotropin (hCG)</p>	<ul style="list-style-type: none"> • Secreted by: syncytiotrophoblasts. • Detected in blood 8 days after ovulation and reaches its peak at 10-12 weeks of pregnancy. • It maintains corpus luteum thus increasing levels of progesterone and estrogen until the 13th week when placenta itself will start producing sex hormones. • hCG also stimulate Leydig cells of male fetus to secrete testosterone until the time of birth.
<p style="text-align: center;">human Chorionic Somatomammo- tropin (hCS)</p>	<ul style="list-style-type: none"> • Secreted by: placenta at 5th week of pregnancy • Large amounts are present in maternal blood (but not reaching the fetus). • Its structure is similar to growth hormone and can cause breast development and even lactation. • Decreases maternal sensitivity to insulin which might result in gestational diabetes. • Enhancing the release of free fatty acids from maternal stores (used as another source of energy instead of glucose).
<p style="text-align: center;">Estrogen</p>	<ul style="list-style-type: none"> • Secreted by: syncytiotrophoblasts. • Forms: estradiol, estriol and estrone. • Androgenic steroid compounds formed in adrenal glands of the fetus are used by the placenta to make estrogens. • Functions: <ul style="list-style-type: none"> ✓ Enlargement of the uterus and external genitalia. ✓ Inducing myometrial oxytocin receptors thus preparing uterus for birth. ✓ Development of mammary glands. ✓ Relaxing pelvic ligaments.
<p style="text-align: center;">Progesterone</p>	<ul style="list-style-type: none"> • Secreted by: placenta and increasing throughout pregnancy. • Functions: <ul style="list-style-type: none"> ✓ Supporting endometrium to maintain pregnancy. ✓ suppression of uterine smooth muscle contraction. This will be antagonized at time of birth by high levels of estrogen. ✓ Aids in implantation of blastocyst and providing nutrition for the embryo. ✓ Aids in development of the breast.



- **PO₂ of fetal blood is lower than of the mother (30 mmHg) but fetal tissues obtain sufficient O₂ due to:**
 - ✓ HbF which has more affinity for oxygen when compared to normal adult hemoglobin (HbA).
 - ✓ High Hb contents (50% more than maternal blood).

- **Labor:**

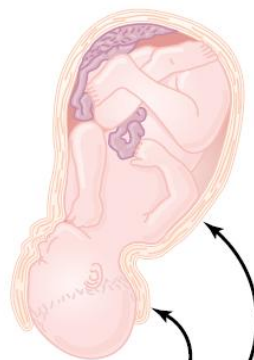
- **Uterus becomes more excitable due to the following factors:**

- ✓ Hormonal factors:

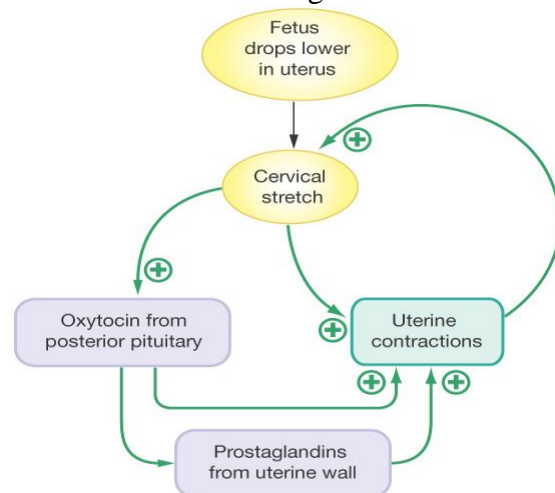
- ❖ *Increased estrogen-progesterone ratio:* as mentioned previously progesterone inhibits contractility of uterine smooth muscles while estrogen stimulates it.
- ❖ *Oxytocin:* irritation of the cervix or its stretching (which occurs at time of labor) stimulates the release of oxytocin from posterior pituitary thus enhancing contractility of the uterus.
- ❖ *Fetal hormones:* especially prostaglandins which are released by fetal membranes.

- ✓ Mechanical factors:

- ❖ *Stretch of uterine muscles increases its contractility.* Therefore, twins are born earlier due to over-stretching of the uterus.
- ❖ *Stretch of the cervix:* when membranes rupture the head of the fetus will descend and stretch the cervix thus increasing uterine contractility.



1. Baby's head stretches cervix
2. Cervical stretch excites fundic contraction
3. Fundic contraction pushes baby down and stretches cervix some more
4. Cycle repeats over and over again



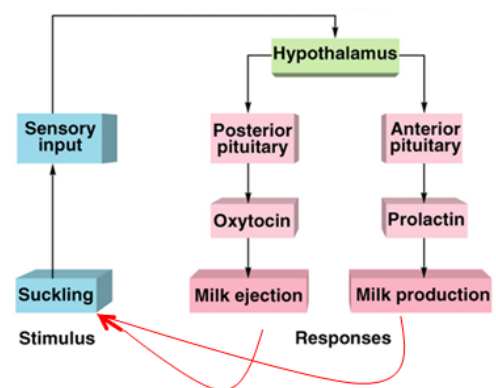
- **Lactation:**

- When adulthood is reached, development of the breast starts by the action of estrogen.

- **In pregnancy:**

- ✓ Estrogen: causes complete development of breast glandular tissue.
- ✓ Progesterone: causes development of breast ductal system.

Although they cause growth of the breast but they act as milk secretion inhibitors (by inhibiting the action of prolactin). After delivery, the drop of estrogen and progesterone increases milk production and stimulates lactation.

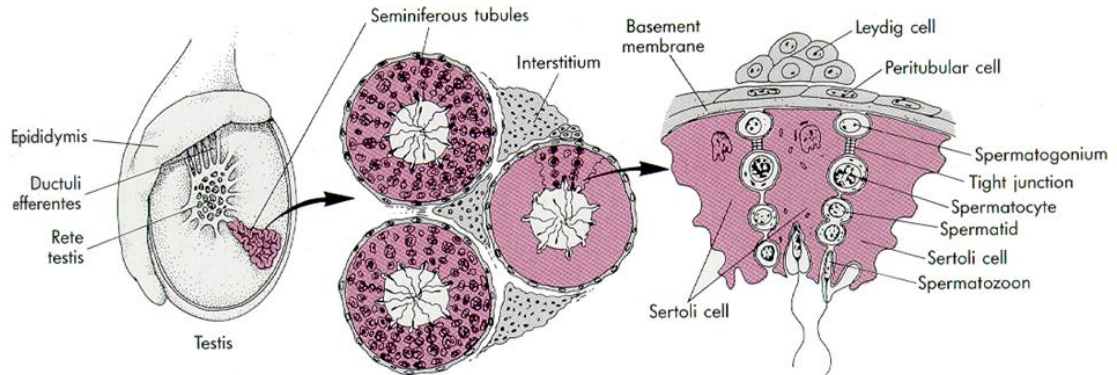


- **Colostrum:** a fluid rich in protein and fructose (but not fat) secreted 1-2 after delivery.
- Suckling by the baby stimulates the production of prolactin while dopamine released from hypothalamus inhibits prolactin.
- Notice that prolactin has an inhibitory effect on GnRH (no secretion of FSH and LH). Therefore, menstrual cycle and ovulation are suppressed.



- **Spermatogenesis and functions of testosterone:**

- Testosterone which is produced by Leydig cells is needed for induction and maintenance of spermatogenesis.
- FSH is essential for spermatogenesis (converting spermatids to sperms).
- Notice that for spermatogenesis to occur, testicular temperature has to be 2-3 C lower than core body temperature.



• **Sertoli cells:**

✓ Functions:

- ❖ Support proliferating cells.
- ❖ Provide special micro-environment for meiosis and spermiogenesis.
- ❖ Releasing clusters of fully formed sperms from time to time.
- ❖ Phagocytosis: to remove defective cells and cytoplasmic debris.
- ❖ Blood-testis barrier.

✓ Synthesis and secretion:

- ❖ *Sertoli cells have FSH receptors. Therefore, FSH stimulates proteins synthesis:*
 - Androgen Binding Protein (ABP): maintains a high stable supply of androgen in tubular fluid.
 - Inhibin: inhibits FSH secretion and considered to be a regulator for spermatogenesis.
 - Mullerian-Inhibiting Substance (MID): causes regression of mullerian ducts in males during fetal life.

• **Process of spermatogenesis (takes about 74 days to be completed):**

✓ Spermatogonial multiplication:

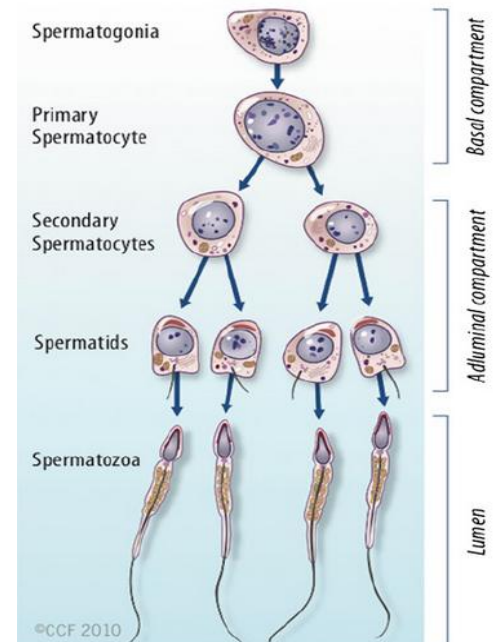
Type-A	Providing more spermatogonia
Type-B	Providing spermatocytes

✓ Meiosis: a spermatocyte divide to → two short-lived secondary spermatocytes → giving two spermatids.

✓ Spermiogenesis (120-150 million sperms are produced by day):

- ❖ Formation of acrosome which covers the head of the sperm. It contains hydrolytic enzymes which allow fusion of sperm and egg for fertilization.
- ❖ Condensation of nuclear chromatin in the head.
- ❖ Growth of the tail and loss of excess cytoplasmic material.

✓ Capacitation: a process to render the sperms competent to fertilize the ovum.





• **Semen (pH = 7.5):**

10%	Fluid and sperm from vas deferens
60%	Fluid from seminal vesicles
30%	Fluid from prostate gland

✓ **Functions:**

- ❖ Provides bulk to sperm.
- ❖ Maintains alkaline environment and buffers vaginal acidity.
- ❖ Contains prostaglandins.
- ❖ Prevents capacitation of sperm and inhibits sperm motility in male tract.
- ❖ Provides nutrients to sperm.

• **Leydig cells:**

- ✓ LH binds to its receptors found on the membrane of Leydig cells. This increases intracellular cAMP which accelerates metabolism of cholesterol leading to production of testosterone.

✓ **Functions of testosterone:**

- ❖ Male sexual differentiation and maturation.
- ❖ Normal potency and ejaculatory capability.
- ❖ Spermatogenic maturation.
- ❖ Seminal fluid consistency.

✓ **Functions of testosterone depending on the age:**

Fetal	Male sex development
Neonatal	Brain masculinization
Adult	Sperm production + primary and secondary characterization

