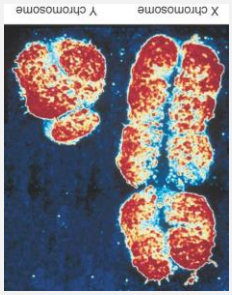
CH. 15 - REPRODUCTIVE SYSTEM

Objectives:

1. Review male & female reproductive anatomy
2. Gametogenesis & steroidogenesis
3. Reproductive problems



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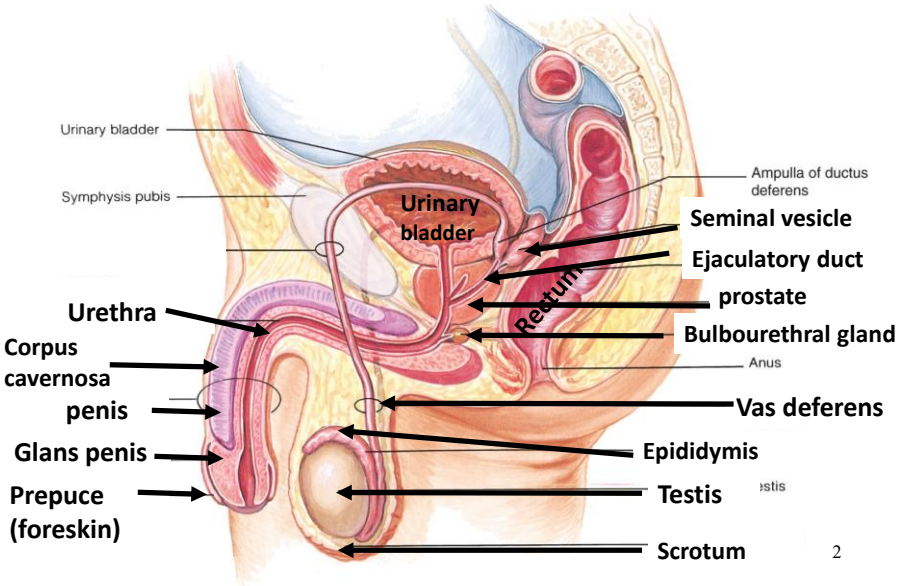
Review of Male Reproductive Anatomy



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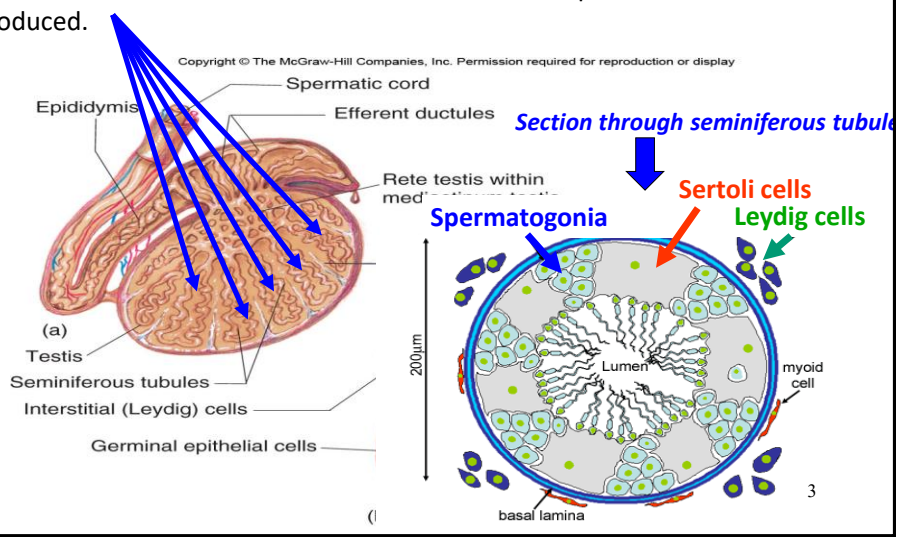
Male Reproductive anatomy and physiology.

Testes = paired gonads containing seminiferous tubules

Seminiferous tubules = tubules within testes where sperm and testosterone are produced.



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3. Male Reproductive anatomy and physiology.

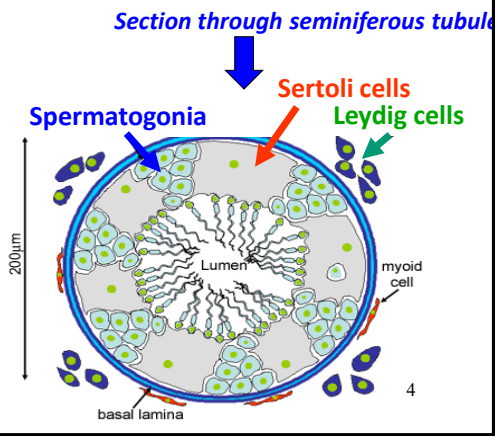
<u>3 cell types in seminiferous tubules:</u>

1. Sertoli cells – _____

2. Leydig cells – _____

3. Spermatogonia = _____

_____



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Epididymis = _____

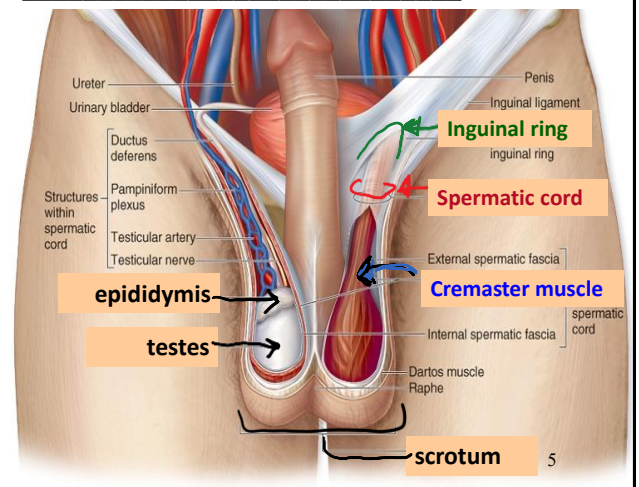
Scrotum = _____

Cremaster muscle =
_____
_____
_____

Spermatic cord =
Connective tissue that wraps aroune cremaster, testes, & testicular nerve and blood vessels

Inguinal ring =
Opening in inguinal ligament through which testes descend (around 7 months gestation).

What is Cryptorchidism? =
_____



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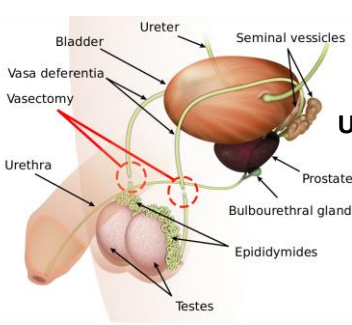
3 Sperm Transport Tubes:

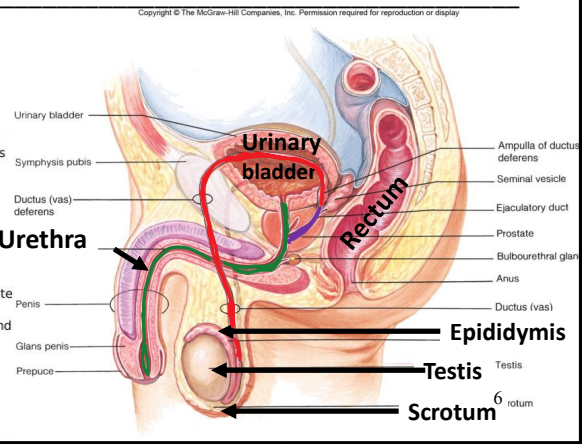
1. **Vas deferens** = _____
_____

2. **Ejaculatory duct** = _____

3. **Urethra** = _____

What is a vasectomy?





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3 Male Secretory Glands:

1. Seminal vesicles = large, paired glands that meet with vas deferens and contribute secretions to seminal fluid.

produces:

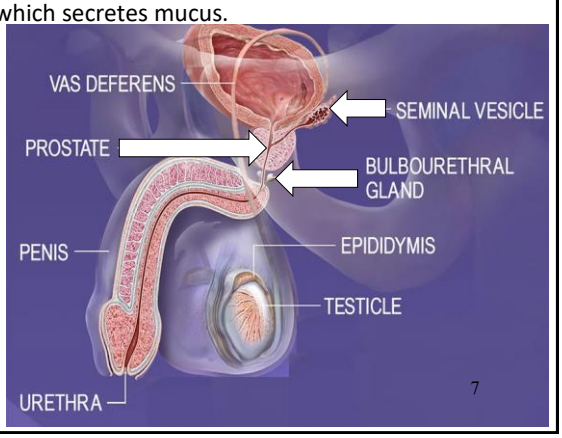
-_____

-_____

-_____

2. Prostate = gland under bladder which secretes mucus.

3. Bulbourethral gland = Gland that secretes lubricating Fluid, to lubricate head of penis, during sexual arousal.



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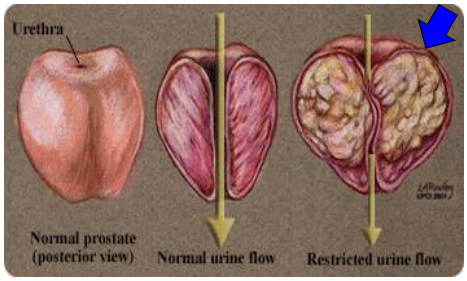
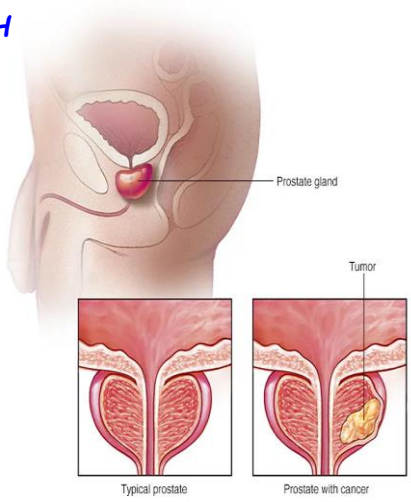
The Prostate Gland





> **Benign prostate hyperplasia (BPH)**

- Prostate grows with age.
- non-cancerous growth of prostate.
- Can block urine or semen transport.

Prostate cancer (1 / 8 men)

- Malignant
- Detect with **PSA** = prostate-specific antigen. High levels in blood indicate possible prostate cancer.
- Increased risk with **mutation in BRCA gene** *(see later in powerpoint)*
  *Click **HERE** to read more about prostate cancer risks, detection, etc…*

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CLINICAL APPLICATIONS

Prostate cancer is commonly tested using a blood test for *prostate-specific antigen* (*PSA*). A more common disorder, affecting most men over 60 to different degrees, is **benign prostatic hyperplasia** (**BPH**). This is responsible for most cases of bladder outlet obstruction, causing difficulty in urination. BPH treatment may involve a surgical procedure called *transurethral resection* (*TUR*), or the use of drugs. These drugs include α_1*-adrenergic receptor blockers* (chapter 6), which decrease the muscle tone of the prostate and bladder neck, making urination easier, and *5α-reductase inhibitors*. The latter drugs block the conversion of testosterone into dihydrotestosterone (DHT), which reduces androgen stimulation and thus the size of the prostate.[2]

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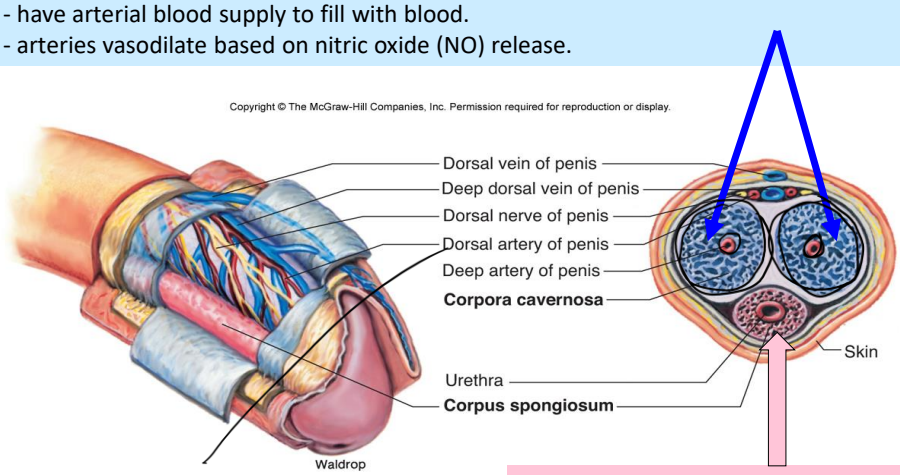
Erectile chambers of penis.

Corpus cavernosa = upper left and right chamber.
- have arterial blood supply to fill with blood.
- arteries vasodilate based on nitric oxide (NO) release.



Corpus spongiosum = lower chamber surrounding urethra

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How an erection works:

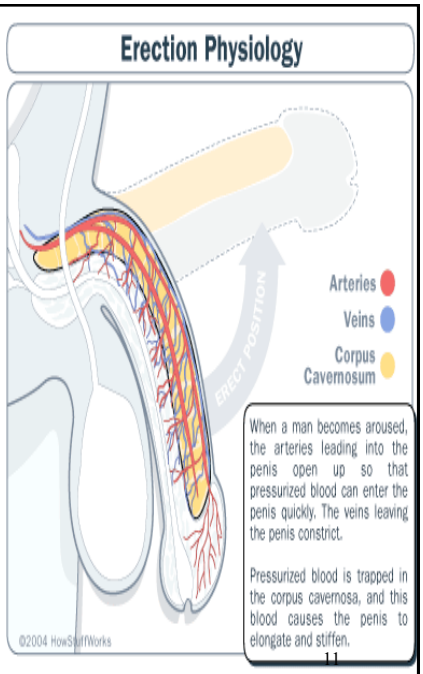
1. Arousal Causes **nitric oxide (NO)** release in arteries of corpus cavernosa.

2. NO causes production of a chemical messenger called cGMP).

3. **cGMP** causes arteries to relax & they open wide (**vasodilate)** allowing blood into spongy chambers.

4. Fluid pressure of blood causes erection.

5. When stimulation done, or after ejaculation, cGMP is broken down by enzyme (**phosphodiesterase**). Erection ends



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CLINICAL APPLICATIONS

Nitric oxide, released in the penis in response to parasympathetic nerve activation, enters the smooth muscle cells in the arterioles and stimulates the production of a second messenger, *cyclic guanosine monophosphate* (*cGMP*). The cGMP causes the smooth muscle cells to relax and the vessels to dilate, so that more blood can flow to the corpora cavernosa and produce erection. A particular *cGMP phosphodiesterase* enzyme then breaks down cGMP, ending the erection. **Erectile dysfunction** is now often treated with drugs such as *sildenafil* (Viagra), which block the cGMP phosphodiesterase enzyme. These drugs increase the cellular concentration of cGMP and thereby promote erection.

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How ED Drugs work (Viagra, Cialis, Levitra):

Phosphodiesterase inhibitor = a chemical that inhibits phosphodiesterase.

So …, what would giving a phosphodiesterase inhibitor do to ***cGMP*** levels in the corpus cavernosa?

_____

What would that do to arteries in the penis? _____

What would that do w/respect to an erection? _____

Viagra, Cialis, & Levitra are phosphodiesterase inhibitors.

Side effects: *drop in blood pressure (dizziness or loss of vision) AND* ***Priapism*** =

*Click **HERE** to read more about priapism (causes, repair, etc…)*

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4. Gametogenesis and Steroidogenesis in Males and Females

Gametogenesis = _____

> **Spermatogenesis** = _____

> **Oogenesis** = _____

Steroidogenesis = _____

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Spermatogenesis:

Spermatogonia (2n) = cells that undergo meiosis to make sperm.

↓

Primary spermatocyte (2n)

↓ Meiosis 1

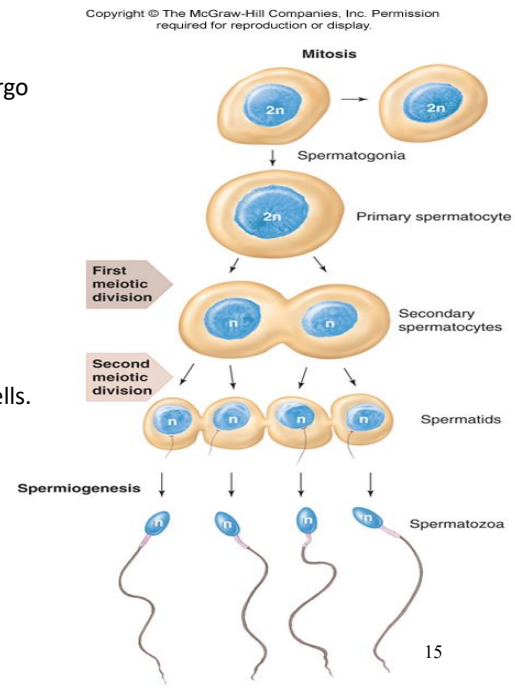
Secondary spermatocytes (1n)

↓ Meiosis 2

Spermatids (1n) = immature sperm cells.

↓

Spermatozoa = mature sperm cells.



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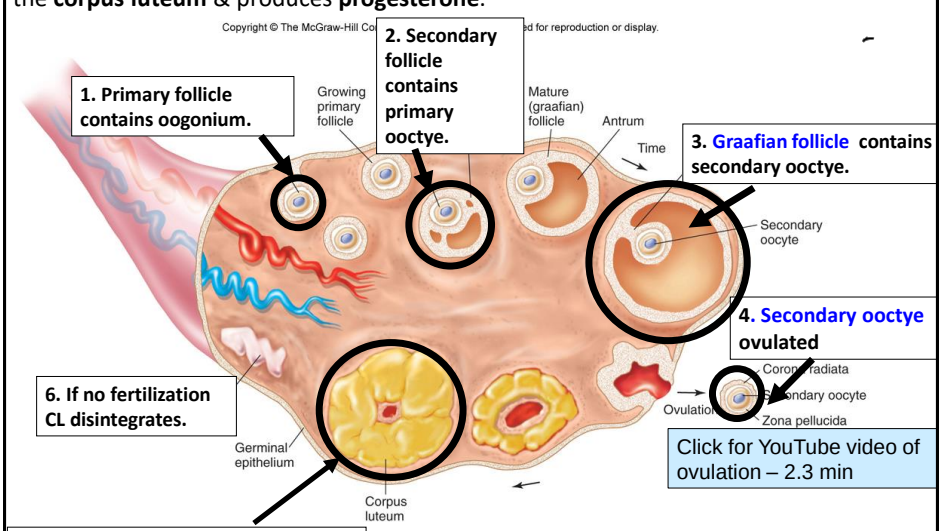
The **Ovaries** have **follicles** that contain a developing egg (**oocyte**). Once a month one follicle & egg mature. A **secondary oocyte** is ovulated. The remaining follicle becomes the **corpus luteum** & produces **progesterone**.



Click for YouTube video of ovulation – 2.3 min

Mittelschmertz =

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Oogenesis:

Oogonium (2n)

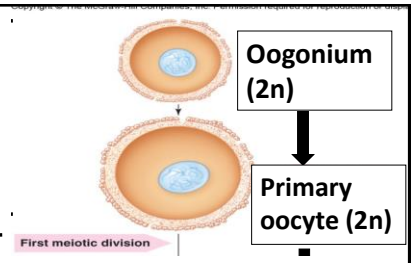
↓

Primary oocyte (2n)

↓ Meiosis 1

Meiosis 2 starts at puberty

Eggs in stasis as primary oocyte (2n) in ovaries from time a fetus to just before puberty.



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Oogenesis:

Oogonium (2n)

↓

Primary oocyte (2n)

↓ Meiosis 1

Meiosis 2 starts at puberty

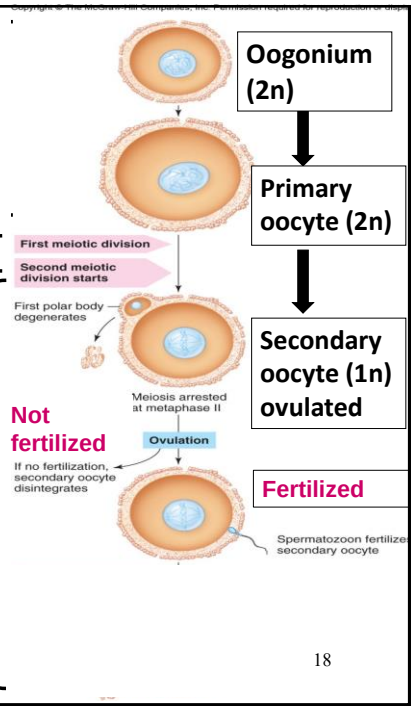
Eggs in stasis as primary oocyte (2n) in ovaries from time a fetus to just before puberty.

Secondary oocyte (1n) within a "**Graafian follicle**"

- 2 ° ooctye is "ovulated" once/month
- graafian follicle becomes **corpus luteum**
- "CL" produces progesterone ~14 days

Progesterone = hormone released from CL that maintains uterus in pregnancy-friendly state. Prevents egg development and ovulation.

Monthly, from puberty to menopause:



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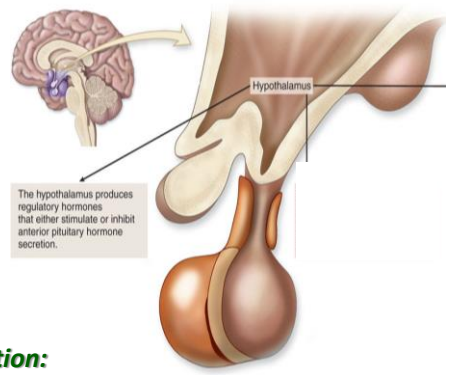
Steroidogenesis (Male & Female) =



review – Hypothalamus endocrine function:

> communicates between nervous and endocrine systems

> Secretes "releasing hormone" to stimulate gonads = _____

> This stimulates anterior pituitary to secrete _____ & _____

> FSH stimulates _____

> LH stimulates testosterone production in testes, and estrogen production, ovulation, and corpus luteum formation in ovaries.

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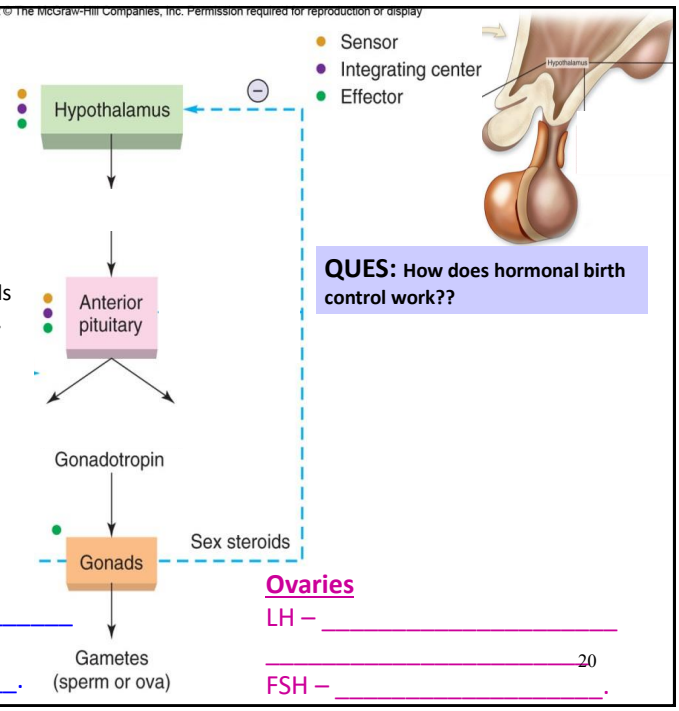
Steroidogenesis



Hypothalamic neurons secrete **"releasing hormone" GnRH**

Anterior pituitary responds to GnRH by secreting **LH & FSH:**

QUES: How does hormonal birth control work??

Testes

LH – _____

FSH – _____.

Ovaries

LH – _____

_____

FSH – _____.

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Clinical Applications

About 60 million women worldwide currently use **oral contraceptives** (**birth control pills**). These contain a synthetic estrogen combined with synthetic progesterone, which are taken each day for 3 weeks after the last day of the menstrual period. Placebo pills are taken for the fourth week, to cause a fall in the blood levels of estrogen and progesterone so that menstruation can occur. The birth control pills immediately produce high blood levels of estrogen and progesterone, mimicking the luteal phase and causing negative feedback inhibition of FSH and LH. Thus, no follicles grow and ovulate (so fertilization is prevented), and no corpus luteum can be formed. The newer contraceptive pills have other benefits: they may reduce the risk of endometrial and ovarian cancer, as well as osteoporosis. However, they may also increase the risk of breast cancer, and possibly cervical cancer. Each woman should consult with a physician to weigh the potential benefits and risks in light of her own medical situation and family history.

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Review

Male reproductive anatomy & physiology
- male sexual structures
- physiology of an erection
- reproductive problems (ED, BPH)

Gametogenesis
- spermatogenesis
- oogenesis

Steroidogenesis
- Hypothalamic-pituitary-gonadal axis
- negative feedback inhibition of steroidogenesis

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5. Female Reproductive Anatomy & Physiology.

External genitalia

> **Vulva**= labia major & minor
> **Clitoris**= erectile tissue with sensory nerves (similar to head of penis)

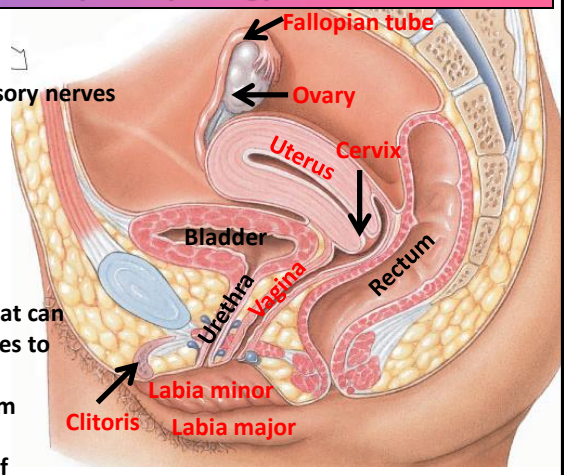
Internal structures:

Vagina = copulatory & birth canal.

Uterus = muscular sac capable of supporting developing fetus.

> **Fallopian tubes**= paired tubes that can transport fertilized egg from ovaries to uterus.
> **Cervix**=entryway into uterus from vagina.
> **Endometrium**= secretory layer of uterus.
> **Myometrium=** muscular layer of uterus, responds to oxytocin & prostaglandin.

Ovaries = paired gonads making eggs, estrogen & progesterone.



sagittal section

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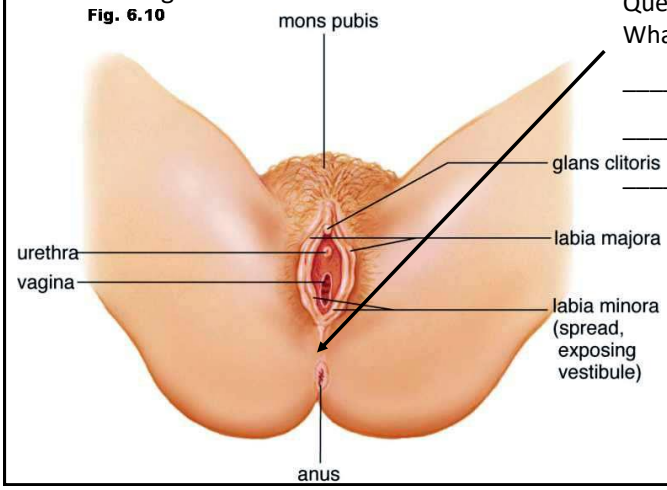
External Genitalia

Clitoris = equivalent of glans penis. Same sensory nerves & erectile tissue
Labia minor = smaller inner labia
Labia major = larger outer labia
Vestibule = tissue surrounding urethral & vaginal openings. Prone to tearing during childbirth!

Fig. 6.10



Question:
What is an **episiotomy**?

_____

_____

_____

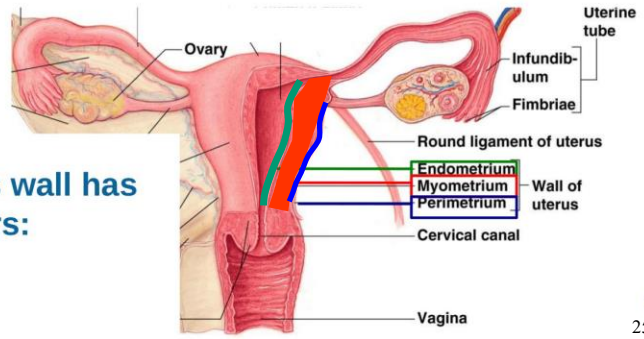
[Click the film strips below to see YouTube videos of the following:

24
episiotomy

24

The Uterus

- **Endometrium –** inner layer where **implantation** (attachment) of fertilized egg occurs
  - Sloughs off if no pregnancy occurs (menses)
- **Myometrium** — middle layer of smooth muscle = childbirth, sperm propulsion Contracts in response to oxytocin
- **Perimetrium** (visceral peritoneum)—outermost serous layer



Uterus wall has 3 layers:

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Human uterus: normal Vs menstrual

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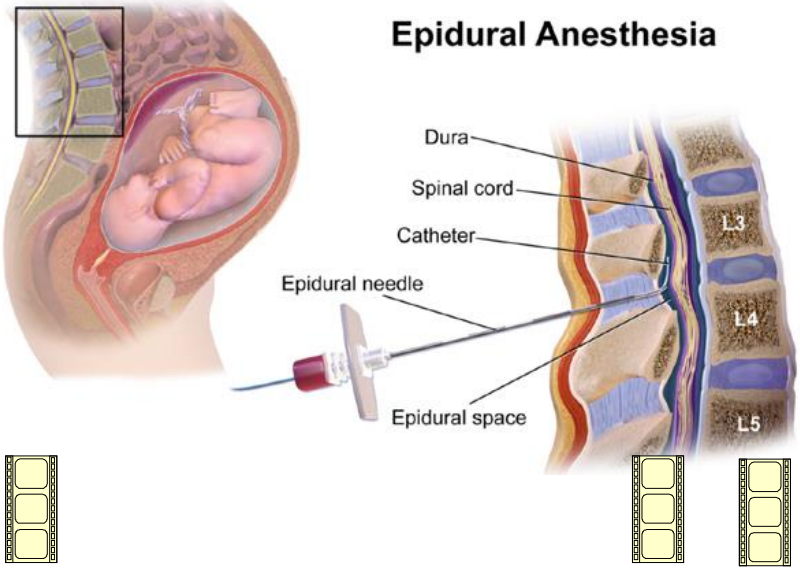
Uterus and Child Birth



delivery **epidural** **C-sec**

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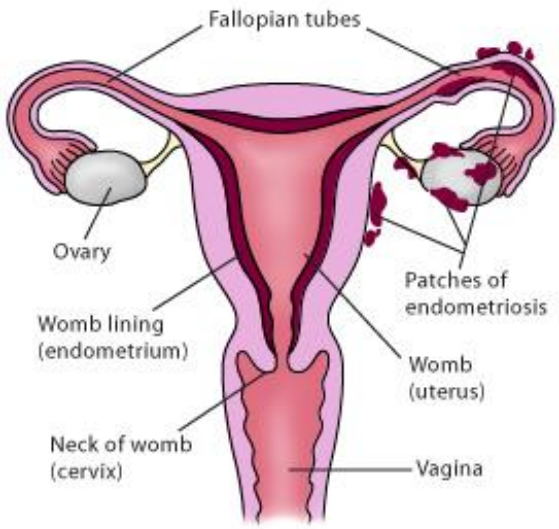
Endometriosis = when endometrial tissue of uterus wanders out of uterus to different locations. Still responds to progesterone by proliferating, and then shedding when progesterone declines each menstrual cycle. *Painful!



10% of women 15-44 yrs

Click HERE to read more about it.

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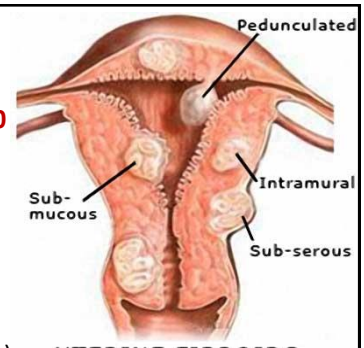
Uterine Fibroids = benign (noncancerous) growths of myometrium, which often appear during childbearing years. **~80% women aged 50 yrs and up**

Also called **leiomyomas** (lie-o-my-O-muhs) or **myomas**.

Are NOT associated with an increased risk of uterine cancer (almost never develop into cancer)



UTERINE FIBROIDS

Symptoms:

May have none
Heavy menstrual bleeding
Pelvic pressure / pain
Backache
Frequent/difficult urination

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CLINICAL APPLICATIONS

The majority of *hysterectomies* (surgical removal of the uterus) are performed because of **uterine fibroids** (**leiomyomas**). These are nonmalignant (noncancerous) neoplasms (growths) in the uterus that also include abundant extracellular matrix. Fibroids can be as small as 10 mm or as large as 20 cm, and produce such symptoms as pelvic discomfort and profuse menstrual bleeding. Uterine fibroids have receptor proteins for estradiol and progesterone, which can stimulate their growth. Because most fibroids are located within the uterine wall, they usually can be surgically removed only by a hysterectomy.

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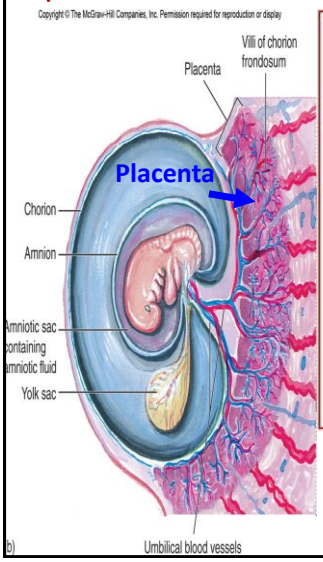
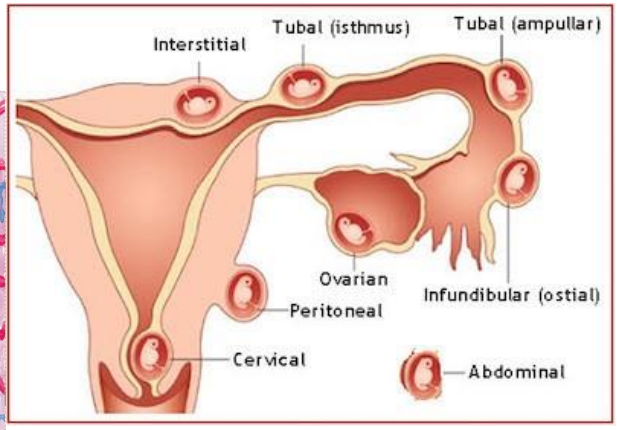
The Fallopian Tubes

Ectopic Pregnancy = _____

(basically anywhere except within the uterus). Frequency of **2% among women, and responsible for 10 – 15% of maternal deaths!**





http://www.aafp.org/afp/2000/0215/p1080.html

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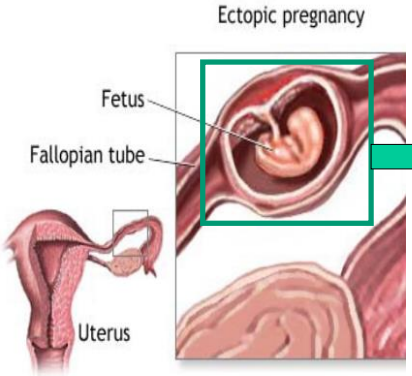
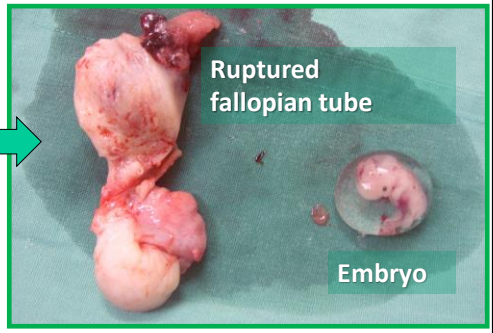
Danger of an Out-of-place pregnancy = only uterus & its strong ligaments can support weight of growing fetus. Only endometrium capable of forming a fully functional placenta. All other tissues not compatible for pregnancy.





An ectopic pregnancy is NEVER viable for the embryo AND is life-threatening for the mother

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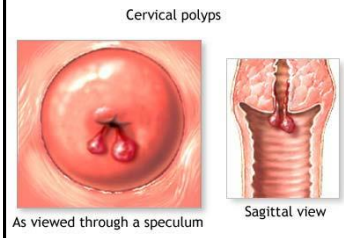
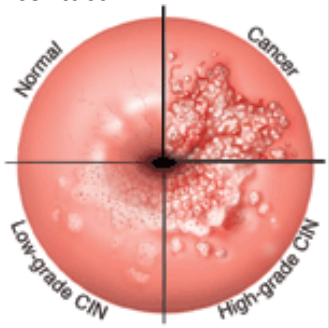
HPV – human papilloma virus. Present in 50% of sexually active adult population. Can cause polyps and warts at site of contact.
Can lead to increased risk for cancer.





Cervical cancer stages

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HPV Vaccine - 2006

- **Gardasil** marketed by Merck & **Cervarix** by GlaxoSmithKline
- Both are set of 3 vaccinations given over a 6 month period.

Only Gardasil is:
- Effective against 4 strains HPV – 2 which cause cancer & 2 which cause warts
- Tested & recommended for 9-26 yr old girls AND boys
  (younger is better - before sexual exposure!)
- Can get up to 21-26 yrs but protection goes down w/sexual exposure.

https://www.cdc.gov/hpv/parents/vaccine.html

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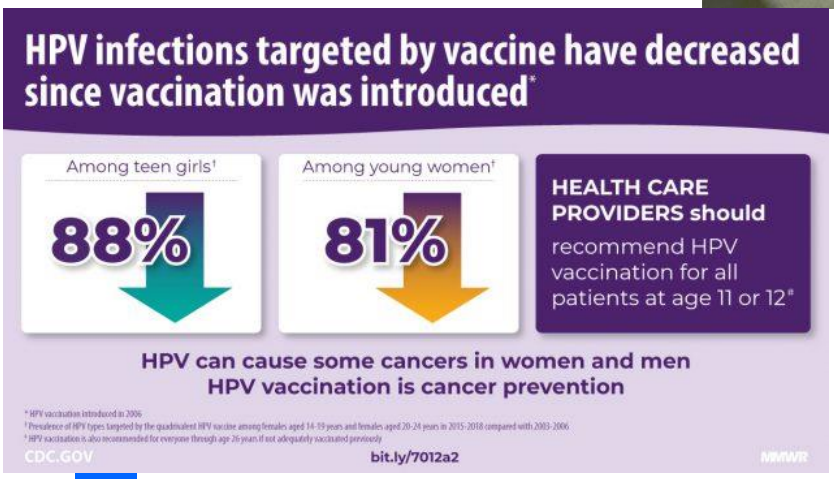
Since 2018 ….



Click HERE to read more about HPV vaccine from CDC.

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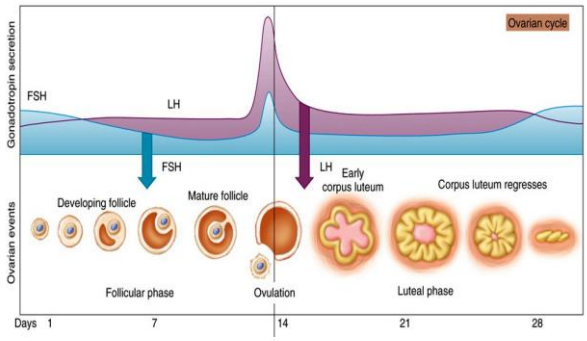
Ovarian cycle

Days: 1- 13 =
Egg development from **FSH**

Day 14 = **ovulation** (**LH high**)

Days 15-28 - CL makes **progesterone**



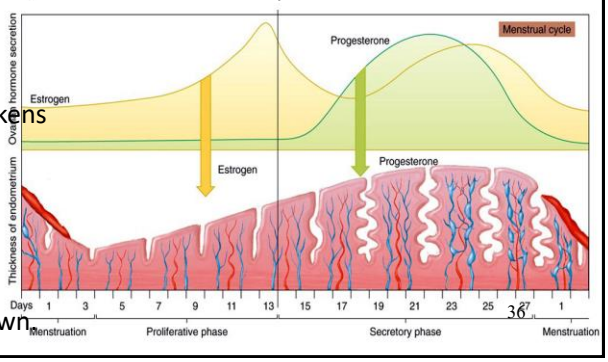
Menstrual cycle

Days: **1- 5** = **menstruation**

15 – 28 = endometrium thickens
Because of **progesterone**

After day 28, if no fertilized egg, CL disintegrates

Endometrial lining breaks down



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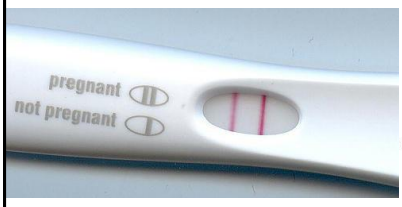
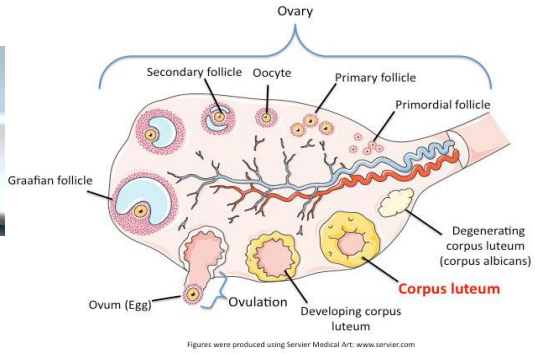
IF no fertilization:

- Corpus luteum breaks down and stops progesterone secretion @day 28.
- Without **progesterone**, endometrium secretes **prostaglandin**, which cause uterine contractions to expel menstrual tissue.
- Menstrual flow – egg and lining shed





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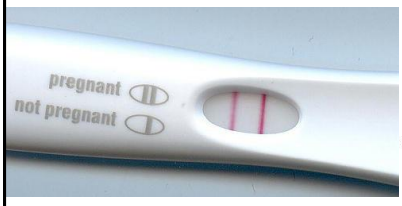
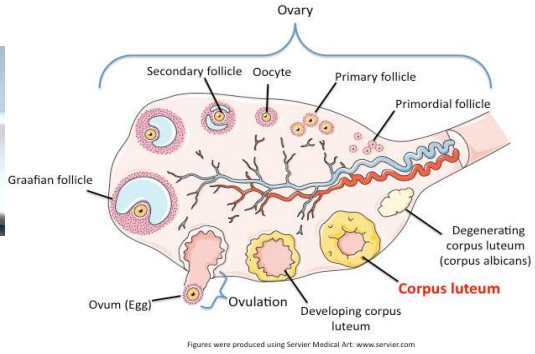
IF no fertilization:

- Corpus luteum breaks down and stops progesterone secretion @day 28.
- Without **progesterone**, endometrium secretes **prostaglandin**, which cause uterine contractions to expel menstrual tissue.
- Menstrual flow – egg and lining shed





IF fertilization:

- Embryo makes **hCG** within 1 week (*the hormone pregnancy tests detect*)
- hCG "rescues" corpus luteum – it keeps making progesterone ~ 1month (until placenta forms and takes over progesterone production).

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CLINICAL APPLICATIONS

Because hCG is secreted by the cells of the chorionic membrane of the embryo, and not by the mother's endocrine glands, all **pregnancy tests** assay (test) for hCG in urine or blood. Modern pregnancy tests detect the beta subunit of hCG (one of two different polypeptide chains that comprise the protein), which is unique to hCG and provides the least amount of cross-reaction with related hormones. Pregnancy tests use *monoclonal antibodies* (produced by lymphocyte clones; see chapter 11), which are specific for the beta subunit of hCG and are produced by animals such as rabbits injected with hCG. Home pregnancy tests, using monoclonal antibodies that react with hCG in urine, are generally accurate in the week following the first missed menstrual period.

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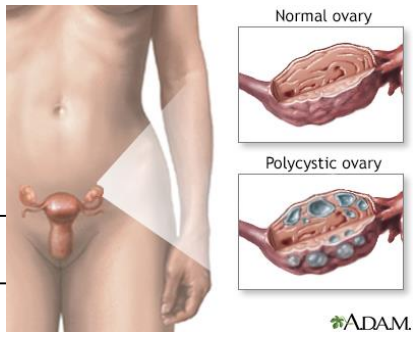
Polycystic Ovarian Syndrome = follicles in ovary fill with fluid (cysts). Painful condition that decreases fertility.

~ 8 – 13 % of reproductive aged women

Treatment:



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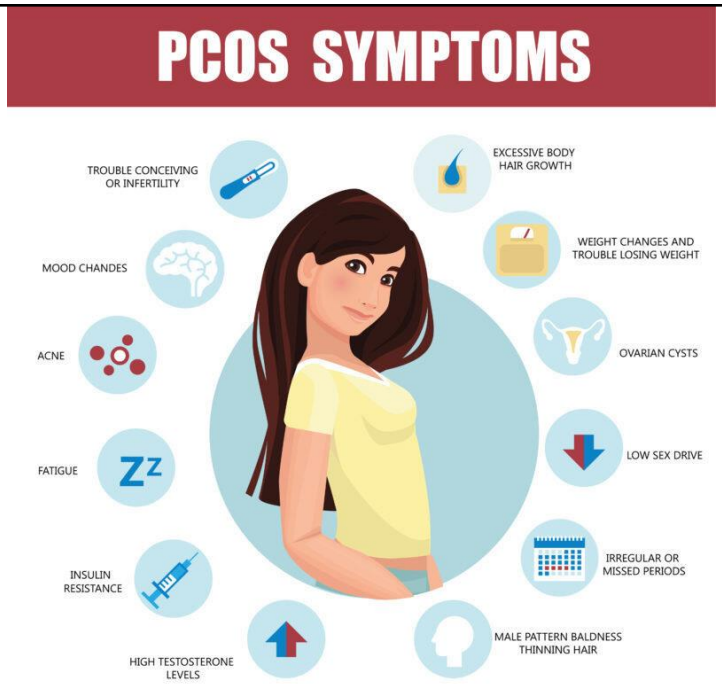

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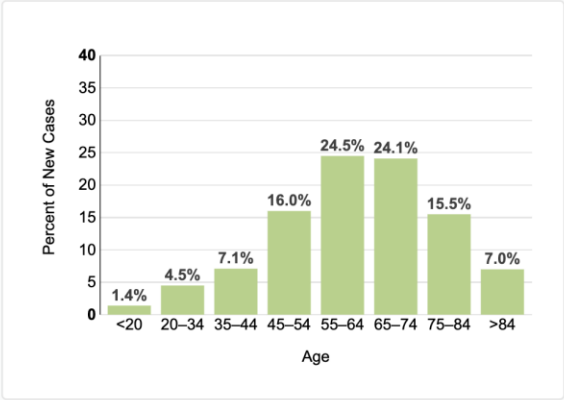
Ovarian cancer

Percent of New Cases by Age Group: Ovarian Cancer



Ovarian cancer is most frequently diagnosed among women aged 55–64.

Median Age At Diagnosis
63

SEER 22 2016–2020, All Races, Females

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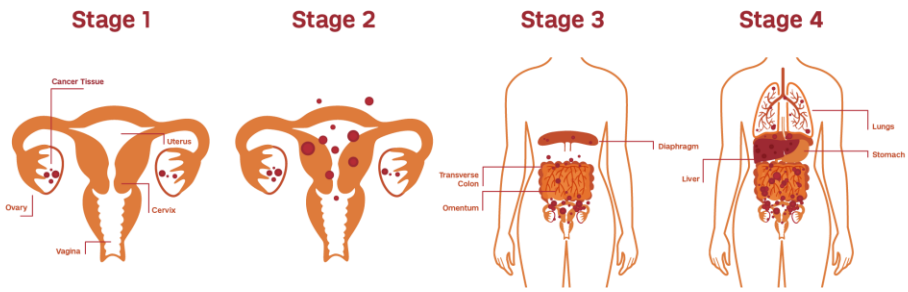
Ovarian Cancer



Cancer is found in one or both ovaries.

Cancerous cells have spread from the ovaries to other parts of the pelvis, such as the fallopian tubes or uterus.

Cancerous cells have spread outside the pelvis to the nearby lymph nodes, diaphragm, intestines, or liver.

The cancer has spread beyond the abdomen, such as to the lungs or spleen.

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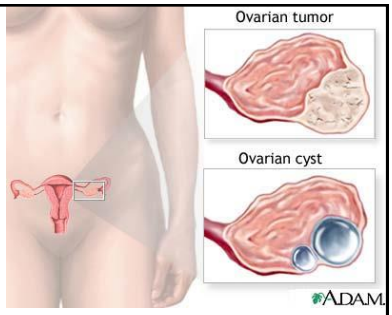
Ovarian cancer **(Click HERE to read more)**



↑ risk factors include:
> Genetics (close female relative had it)
> Have had more ovulations in life
(never been on hormonal birth control or been pregnant)
>Have mutation in the BRCA gene
> Polycystic ovarian syndrome
> hormonal problems

↓ risk factors include:
> not have genetics
> no mutation in BRCA gene
> fewer ovulations in life
(have on hormonal birth control – 50% decreased risk
have been pregnant – lower risk)

Question: Why do you think having been on birth control lowers risk of ovarian cancer??

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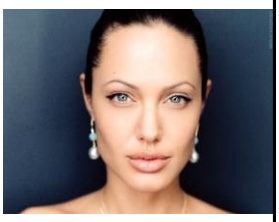
Ovarian and Breast Cancer and the BRCA Gene:



Angelina Jolie
BRCA 1 mutation

BRCA Gene = tumor suppressor gene that normally suppresses tumor growth (a good thing!)

Mutation in BRCA Gene – means the gene does not suppress tumors. Mutation in this gene associated with increased risk for ovarian & breast cancer. **People positive for the gene mutation can pass it on to their children. Each child has 50% chance of inheriting the gene mutation.**

Can get blood test for it.

CA-125 test = cancer antigen 125 (a non-genetic test)
increased levels of this in blood associated with ↑ risk of ovarian cancer (separate from BRCA gene)

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Cancer and the BRCA Gene: Click HERE to read more about it.

Increased risk of cancer in individuals with BRCA 1 or BRCA 2 gene mutation *

Cancer Type	No mutation	BRCA 1 mutation	BRCA 2 mutation
Female Breast**	12%	65%	57%
Male Breast	<1%	2%	6%
Ovarian***	10%	46%	23%
Prostate	10%	26%	61%
Pancreatic	1.7%	3%	7%

* **Children of parents with BRCA gene mutation have 50% chance of inheriting.**
* * Women with BRCA gene mutation have 40% chance of recurrence of cancer if they did not get estrogen blocker treatment or have ovaries removed.
* * * Women with BRCA gene mutation are 100 times more likely to develop cancer in fallopian tubes, before ovaries.

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Click HERE for a YouTube video I made about my breast cancer story AND the BRCA gene mutation.

breast cancer double mastectomy part 1

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Review

Female reproductive anatomy & physiology

- reproductive structures
- ectopic pregnancy & endometriosis, uterine fibroids
- HPV, warts, cervical cancer, HPV vaccine, ovarian & breast cancer
- review of oogeneis
- menstrual & ovarian cycle
- role of hCG in rescuing corpus luteum in pregnancy
- polycystic ovarian syndrome
- tests for cancer (CA-125 antigen and BRCA gene mutation)

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